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Original Paper

Multidisciplinary Integration in Undergraduate Environmental Protection Design Innovation

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Abstract

This paper examines the necessity and implementation of multidisciplinary integration in undergraduate environmental protection design innovation, using the 4th Urban Water Environment and Water Ecology Creative Competition as a case study. Firstly, it explores the significance of the innovation competition itself as a foundation for analyzing the impact of multidisciplinary integration on the development of participating students, faculty teams, and the advancement of disciplines. Secondly, it provides a detailed discussion on the outstanding achievements attained through the integration of three disciplines, namely environmental engineering, computer science, and art and design, within the context of the Water Environment and Water Ecology Creative Competition. Lastly, the paper concludes by summarizing the importance and value of multidisciplinary integration in undergraduate environmental protection design innovation. By presenting the insights and analysis outlined in this paper, readers can gain a comprehensive understanding of the role played by multidisciplinary integration in environmental protection design innovation, thereby offering valuable ideas and perspectives for teaching and research in related fields.

Keywords

multidisciplinary integration, design innovation, environmental protection design

1. Introduction

The creative design of water environments and water ecology holds significant academic and practical importance within the current social context. As the foundation for human survival and development, the quality and sustainable utilization of water resources are essential for maintaining ecological balance and fostering sustainable social development (Xu, 2014). However, the general public possesses limited

knowledge and understanding of water environments and water ecology, thus lacking in-depth comprehension of associated issues. Therefore, the significance of creative design for water environments and water ecology should not be disregarded. Firstly, it facilitates the enhancement of public awareness regarding water resource management (Xu & Ding, 2017). By means of popular science design, the scarcity and fragility of water resources can be effectively conveyed to the public, thereby capturing their attention towards rational utilization and protection of water resources. The increased awareness among the public regarding water resource management will further stimulate the implementation of sustainable practices and the formulation of relevant policies. Secondly, creative design of water environments and water ecology aids in raising public consciousness regarding the significance of water conservation. This enables the public to comprehend the severity of pollution and harm inflicted upon water bodies, leading to a realization of the impact of individual behavior on the water environment. Such awareness will motivate the public to actively adopt water protection measures, reducing the discharge of pollutants, improving the quality of water bodies, and preserving ecosystem stability.

However, the development of a robust and innovative set of creative designs necessitates the collaborative efforts of diverse disciplinary specialties, amalgamating knowledge and skills from various fields. Proficiency in environmental science and engineering plays a pivotal role in the creative design of water environments. Faculty and students specializing in environmental engineering possess comprehensive understanding of water pollution control, environmental monitoring, water cycle processes, and environmental remediation techniques. Their expertise enables them to furnish practical solutions to water environment predicaments and propose feasible environmental protection strategies to creative design teams. Moreover, the software development and application proficiencies of computer professionals lend support to the science design team in devising applications and tools pertinent to the water environment and water ecology. These applications may encompass online educational platforms, mobile applications, and interactive website creation, facilitating the dissemination and communication of knowledge regarding the water environment and water ecology (Han, Yang, Sun Y, Sun P, & Jin, 2020). By crafting user-friendly software interfaces and incorporating interactive features, the general public is afforded opportunities to participate and engage, thereby enriching their learning experience and fostering a sense of involvement. Furthermore, the ornamental nature of artistic and design work offers a distinct advantage. Art designers contribute to the creation of visually captivating and aesthetically valuable pieces that seamlessly integrate scientific information into artistic forms. Through adept utilization of color theory and psychological principles, art designers are capable of selecting appropriate color schemes to effectively convey the ambiance and emotion of the water environment and water ecology. The meticulous animation design showcases vivid depictions of the water environment and water ecology, elucidating intricate concepts such as organism life cycles and the processes underlying the water cycle.

The cross-pollination of disciplines is widely recognized as a significant strategy for universities to deepen the reform of institutional mechanisms, enhance the level of discipline construction, and optimize resource allocation. The term "interdisciplinary" was first introduced by Woodworth, a psychology researcher from Columbia University, as early as the mid-1920s, initially conveying a sense of "collaborative research". Currently, in the realm of emerging engineering disciplines like big data and artificial intelligence, the integration of multiple disciplines has emerged as a crucial focus of research in domestic universities, representing an inevitable trend. Within the realm of teaching practices pertaining to multidisciplinary integration, student competitions play a vital role in fostering such integration (Han & Qu, 2021). Through participation in these competitions, students engage in collaborative teamwork, independent research, and innovative experimentation, thereby honing their critical thinking, creative reasoning, and problem-solving capabilities. These competitions not only allow students to apply their IT knowledge and skills, but also facilitate cross-fertilization with insights derived from other disciplines, ultimately expanding their disciplinary perspectives and cultivating a mindset conducive to interdisciplinary thinking (Jiang, Chi, & Xu, 2020).

2. The Imperative for Multidisciplinary Integration in Creative Competitions

In the realm of contemporary higher education, innovative design competitions stand out as one of the foremost means to foster students' creativity and innovation. Such competitions not only serve as a catalyst for multidisciplinary integration, but also spark inventive thinking and ingenuity. However, in comparison to developed countries in Europe and America, the advancement of diverse innovative competitions in China lags behind. European and American education systems prioritize the cultivation of students' innovative thinking and practical skills, actively encouraging their participation in various innovative design competitions while providing ample resources and support. Furthermore, European and American nations place significant emphasis on fostering students' collaborative and interdisciplinary abilities within the context of student competitions. They actively promote cross-disciplinary collaboration and the application of knowledge from diverse fields in innovative design endeavors.

2.1 Multidisciplinary Integration in Innovative Design Competitions for Faculty Team Enhancement

The multidisciplinary integration in the Innovation Design Competition holds immense significance not only for the participating students but also for the faculty team involved in mentoring and judging. This collaborative environment serves as a platform for students and faculty to foster growth and exchange ideas. Firstly, a multidisciplinary design competition encourages students to transcend the traditional boundaries of their respective disciplines, enabling them to think holistically and tackle complex problems. In addition to expertise in their own fields, students must also comprehend and apply theories and methodologies from other disciplines. This interdisciplinary learning and exchange stimulates students' interest in exploring knowledge and promotes interdisciplinary synergy, thereby cultivating a comprehensive and diversified academic vision and mindset. Secondly, multidisciplinary integration

provides a platform for mutual exchange and academic complementarity among the faculty teams involved in mentoring and evaluation. Faculty members can collaborate on researching and discussing issues at the intersection of multiple disciplines, sharing their expertise and experiences. Through collaboration with colleagues from diverse disciplinary backgrounds, faculty gain insights into research frontiers and methodologies of other fields, broadening their academic horizons. This cross-disciplinary interaction not only enhances the academic abilities of faculty members but also promotes innovation and optimization of teaching methods, thereby offering improved support and guidance for students' overall development. Furthermore, the multidisciplinary integrated design competition provides a platform for students and teachers to showcase and communicate, fostering mutual inspiration and facilitating learning from each other's academic achievements. Through presenting their work and results, participating students engage in academic exchanges and encounters of ideas with students and teachers from different disciplinary backgrounds. This academic exchange not only promotes the collision of innovative thinking and stimulation of creativity but also offers students and teachers the opportunity to learn and grow from one another.

2.2 The Integration of Multidisciplinary Approaches Is Crucial for the Development and Advancement of the Discipline

Multidisciplinary integration within innovative design competitions is a critical necessity for advancing disciplinary development. In today's intricate and ever-evolving social landscape, the reliance on a single discipline's research and application can no longer adequately meet society's needs and challenges. The integration of multiple disciplines facilitates cross-collaboration and knowledge sharing, thereby promoting the growth and innovation of individual fields.

First and foremost, multidisciplinary integration broadens the research horizon of disciplines. Each discipline possesses unique theoretical frameworks, methods, and tools. By integrating knowledge and techniques from various disciplines, a more comprehensive and profound research perspective can be achieved. For instance, when designing an urban transportation system, incorporating insights from disciplines such as urban planning, traffic engineering, and social psychology is essential to develop effective and sustainable solutions. Multidisciplinary integration fosters interdisciplinary communication, cooperation, and innovative thinking, thereby propelling the advancement of each discipline.

Secondly, multidisciplinary integration aids in addressing complex problems. Contemporary society faces multifaceted challenges that transcend the boundaries of a single discipline. Through multidisciplinary integration, expertise and methodologies from diverse fields can be synergized to devise integrated and comprehensive solutions. Consider the challenge of climate change, which necessitates the amalgamation of knowledge from disciplines like climate science, environmental science, and economics to formulate adaptive response strategies. Multidisciplinary integration facilitates collaborative interdisciplinary work and furnishes holistic approaches to intricate problems.

Additionally, multidisciplinary integration nurtures innovative crossovers between disciplines. Collaborations across fields often pave the way for new research areas, theoretical models, and

application methods. By fusing expertise and experiences from disparate disciplines, valuable lessons can be gleaned and novel research ideas and methodologies can be sparked. For example, within the realm of biomedical engineering, combining insights from biology, engineering, and medicine has engendered innovative research endeavors in areas such as tissue engineering and biosensors.

In summary, multidisciplinary integration within innovative design competitions plays a vital role in disciplinary development. It widens the research horizon, enables the resolution of complex problems, and fosters innovative cross-pollination between fields. Embracing this integration is imperative to ensure progress and innovation in today's dynamic academic landscape.

3. The Practice of Multidisciplinary Integration in the Urban Water Environment and Water Ecology Creative Competition

3.1 Features and Innovations of the Water Environment and Water Ecology Creative Competition

Under the auspices of General Secretary Xi Jinping's imperative to popularize scientific knowledge, enhance the overall populace's quality, and fully harness "the hidden innovative wisdom among millions of individuals", the Water Environment and Water Ecology Branch of the China Urban Science Research Association has orchestrated the Urban Water Environment and Water Ecology Creative Competition. Its fundamental objective is to foster a scientific environment encompassing water concepts, knowledge, and actionable endeavors throughout society, thereby cultivating a collective water consciousness and forging a consensus on water-related matters. This competition distinguishes itself through its comprehensive, innovative, practical, and multidisciplinary collaborative approach, as well as its emphasis on societal engagement. By adopting this creative competition format, the event serves to advance the development of the water environment and water ecology domain, incentivize the resolution of real-world challenges, and facilitate the application and dissemination of innovative outcomes.

The idea competition encompasses a broad spectrum of aspects within the realm of water environment and water ecology, spanning water resources management, water pollution control, and water ecology preservation. Its objective extends beyond addressing current issues, aiming to inspire participants to propose comprehensive and systemic solutions that foster the sustainable development of the water environment and water ecology. This competition encourages innovative ideas, technologies, and methods to tackle challenges in this field. Innovations can encompass novel water treatment technologies, intelligent monitoring systems, water management models, and various other domains. The format of this competition serves to stimulate participants' creativity and innovation potential. It places a strong emphasis on practical problem-solving, underscoring the feasibility and utility of submissions. Participants are required to consider factors such as technical viability, cost-effectiveness, and ease of implementation, offering concrete and actionable solutions. This practice-oriented characteristic contributes positively to the advancement of the water environment and water ecology domain.

Addressing water environment and water ecology challenges necessitates interdisciplinary collaboration. The competition actively encourages teams comprising participants from diverse disciplines, including

environmental science, computer science, art and design, among others. Through interdisciplinary cooperation, teams can leverage their collective artistic value, environmental protection knowledge, and small-scale program design expertise. Furthermore, the competition welcomes involvement from a wide range of communities, including university students, researchers, businesses, and government agencies. By fostering social participation, the competition brings together the wisdom and resources of all stakeholders, promoting the practical application and dissemination of innovative outcomes. This collaborative approach engenders a win-win situation for all parties involved.

Figure 1. A Multidisciplinary and Collaborative Approach to Design Ideas for Composition

3.2 Academic Allocation and Team Building

The participating teams comprised exceptional students from various colleges, namely the College of Environmental Science and Engineering, the College of Computer Science, and the College of Art, fostering a robust academic environment. Each student assumed a distinct development task and dedicated their efforts to a corresponding technological innovation. These groups engaged in active coordination and communication to foster the amalgamation of creativity and technology, thereby facilitating efficient execution of design and innovation endeavors.

Figure 2. Team Discipline Distribution Construction

3.3 Effects of Multidisciplinary Integration

The team, encompassing three disciplines: environmental engineering, computer science, and art and design, exhibited exceptional performance in the Water Environment and Water Ecology Creative Competition. They skillfully merged their professional knowledge and creative thinking in a multidisciplinary manner, yielding distinct and inventive solutions. Amidst the participation of over 100 universities nationwide, the Hubei Institute of Technology emerged as the national champion, marking the fourth victory for the institute following Huazhong University of Science and Technology, Sichuan University, and Tsinghua University. This competition successfully facilitated the exchange and learning among multidisciplinary talents, accomplishing the objective of cross-pollination across various fields to address engineering application problems. Figure 3 illustrates the flow chart of water reuse treatment. The team's students engaged in spirited idea clashes, resulting in the fusion of multidisciplinary cross-thinking. This achievement serves as a groundwork for tackling more intricate scientific challenges and even broader societal issues in the future. The integration of different disciplines not only enhances the Water Environment and Water Ecology Creative Competition by providing a comprehensive problem-solving perspective, but also introduces a diverse array of innovative approaches and ideas.

Figure 3. A multidisciplinary Approach to Understanding Water Reuse Design Diagrams

4. The Concept of Multidisciplinary Integration in the Realm of Teaching and Research

Disciplinary competitions serve as a significant catalyst for fostering the integration of environmental engineering majors with multiple disciplines in the realms of teaching practice and research. Such competitions provide a platform for environmental engineering students to showcase and apply their comprehensive abilities. By participating in disciplinary competitions, students are tasked with the application of their environmental engineering knowledge, while also incorporating theories and methodologies from other relevant disciplines to tackle intricate problems. This interdisciplinary integration nurtures students' capacity for integrated thinking and innovation, equipping them with the necessary skills to effectively address complex environmental challenges in practical settings.

This multidisciplinary integration aligns with the current training objectives and demands of university education and employers in the field of environmental science and engineering. It also resonates with the

focus of environmental science and engineering disciplinary competitions and practical teaching. Furthermore, the innovative combination of professional competitions, multidisciplinary intersections, and practical teaching in the instruction of environmental science and water treatment design has yielded valuable insights and feedback for teaching practices.

From a theoretical perspective, multidisciplinary integration consolidates and enriches the teaching expertise of environmental science and engineering instructors, thereby advancing their professional growth. Simultaneously, it revolutionizes conventional professional classroom teaching by introducing novel ideas and methodologies, enabling teachers to accumulate and synthesize exemplary experiences and cases. This process enhances their proficiency in both classroom and practical instruction and allows them to effectively transmit these experiences and abilities to students.

In practical terms, the challenges pertaining to industry-education integration and school-enterprise cooperation are addressed through research on multidisciplinary integration. The amalgamation of disciplinary competitions and interdisciplinary integration establishes a link between educational institutions and environmental engineering enterprises, as well as enterprises in other fields, fostering collaborative research and driving industrial development, resulting in a mutually beneficial outcome. Moreover, this teaching practice cultivates students' innovative thinking, collaborative abilities, and practical skills within disciplinary competitions, while also motivating disciplinary teachers to reassess their roles in classroom instruction. The aim of this study is to equip environmental science and engineering educators with the capabilities to serve as practical researchers who can effectively resolve real-world teaching issues in the field of environmental science and engineering.

5. Conclusion

The interdisciplinary integration-oriented Creative Competition on Water Environment and Water Ecology for University Students endeavors to foster innovative talents equipped with comprehensive capabilities and inventive solutions to the challenges of the new era. Centered around the practical application of the 4th Urban Water Environment and Water Ecology Creative Competition, this paper amalgamates theoretical analysis to emphasize the necessity of multidisciplinary integration in creative competitions. It systematically examines the significance of adopting multidisciplinary integration in creative design competitions and outlines strategies for its implementation, along with the implications for curriculum teaching. As such, this study puts forth a novel guiding method and theoretical foundation, with the objective of establishing a creative teaching and research approach characterized by interdisciplinary, intercollegiate, and interprofessional multidisciplinary cross-pollination.

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