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A Competitive Perspective on Interdisciplinary Education: A Comparative Analysis of Education Programs in Premier Educational Institutions

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Abstract

In the contemporary academic landscape, there is a notable shift from purely information-driven approaches to those emphasizing convergence, creativity, and innovation. This study examines the principles and characteristics of interdisciplinary education in premier educational institutions. Through in-depth interviews, field visits, literature reviews, and case analyses, we analyzed representative interdisciplinary programs. Our findings reveal that successful interdisciplinary education requires: (1) broad disciplinary convergence, (2) the establishment of independent educational institutions and specialized programs, (3) collaboration between faculty and practitioners from diverse academic backgrounds, (4) physical spaces that facilitate active communication and collaboration, and (5) effective operation of workshops and systems that support students' creative ideas. These insights offer fundamental parameters for designing and implementing interdisciplinary education programs and serve as a crucial reference for future academic and pedagogical endeavors.

Keywords: *Interdisciplinary Education, Design-Engineering Convergence Education, Education Model*

1. INTRODUCTION

1.1 Background and Objectives

In today's society, we are transitioning from the information age, where knowledge distribution and utilization were paramount, into an era of convergence, where creativity is a critical source of competitiveness. Advancements in technologies such as Artificial Intelligence, Cloud Computing, Virtual Reality, the Internet of Things, and Big Data are driving the Fourth Industrial Revolution towards a creative economy. In this new landscape, designers are required to adopt convergent thinking, breaking down the boundaries between disciplines like engineering, management, humanities, and sociology to foster collaboration [1]. Design education is evolving to cultivate individuals with deep expertise in specific fields and a broad understanding of multiple disciplines [2]. Historically, design focused on aesthetics and form, but contemporary approaches emphasize creativity, convergence thinking, and collaborative problem-solving skills. As a result, developing

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interdisciplinary education programs has become crucial in design education [3-4].

Internationally, many universities have embraced interdisciplinary education, integrating traditional methods with collaborative approaches. In South Korea, awareness of convergence design education is growing, supported by national initiatives, though it remains less systematic compared to global standards. This study aims to explore the design-centered convergence education model in the creative economy era and identify its characteristics by analyzing leading international interdisciplinary design education programs. Through this research, we aim to propose future directions and needs for interdisciplinary design education.

1.2 Research Framework and Methodology

This study analyzed in-depth the cases of several major international universities to identify global trends in design integration education. We focused on the d. school at Stanford University in the United States, the Innovation Design Engineering (IDE) programs at the Royal College of Art (RCA) and Imperial College London (ICL) in the United Kingdom, and the International Design Business Management (IDBM) program at Aalto University in Northern Europe. By analyzing how these programs operate and their key characteristics, we aimed to draw important insights into current international trends in design interdisciplinary education.

The methodology for this study included an extensive literature review and theoretical analysis of interdisciplinary education and case studies of several design interdisciplinary education programs. In addition to the literature review, the case studies were conducted through fieldwork at institutions such as Stanford, RCA/Imperial College, and Aalto. To do so, the researcher stayed at the institutions for a period of time for research purposes. During this period, the researcher conducted thorough observations and research on program operations, educational environment, curriculum, teaching methods, and evaluation criteria. The researcher also participated in various workshops, seminars, symposia, and other events to gain a deeper understanding of the actual practice of education through conversations and interviews with local education experts. This multifaceted approach added depth to the study and ensured its reliability.

2. INTERDISCIPLINARY EDUCATION

2.1 Primary Principles and Distinctive Features of Interdisciplinary Education

The convergence research is an approach to knowledge production and action that involves diverse teams working together in novel ways—transcending disciplinary and organizational boundaries—to address vexing social, economic, environmental, and technical challenges in an effort to reduce disaster losses and promote collective well-being [5]. In other words, interdisciplinary education is an educational method that creates new knowledge by integrating and linking various disciplines such as humanities, social sciences, business administration, natural sciences, engineering, medicine, design, art, etc. in accordance with the times and social changes [3-4]. This approach stems from the recognition of the limitations of the traditional academic system, which is overly fragmented, and an effort to understand things or phenomena from a holistic perspective instead of looking only at specific fields. It aims to educate students to better respond to the complex challenges of modern society through the acquisition of integrated and comprehensive knowledge.

Convergence research and education are categorized into various categories based on depth and breadth of knowledge and value creation [6] (Figure 1). These include Intradisciplinary, which centers on research in a specific field; Multidisciplinary, which represents the independent combination of multiple disciplines; Crossdisciplinary, which is a collaboration led by one discipline; Interdisciplinary, which aims for equal participation; and Transdisciplinary, which seeks multidimensional collaboration across disciplinary boundaries [7-10]. The depth and scope of disciplinary integration are dependent on mode of convergence.

Modern society is looking for someone who can combine knowledge from multiple fields to come up with creative and convergent solutions, rather than the one with disjoint knowledge in each of the field. Therefore,

interdisciplinary education should aim to break down the boundaries of each discipline, induce creative thinking, and improve practical problem-solving skills through cooperation with companies. This is the essence of interdisciplinary education, where students explore real-world problems together and create innovative results.

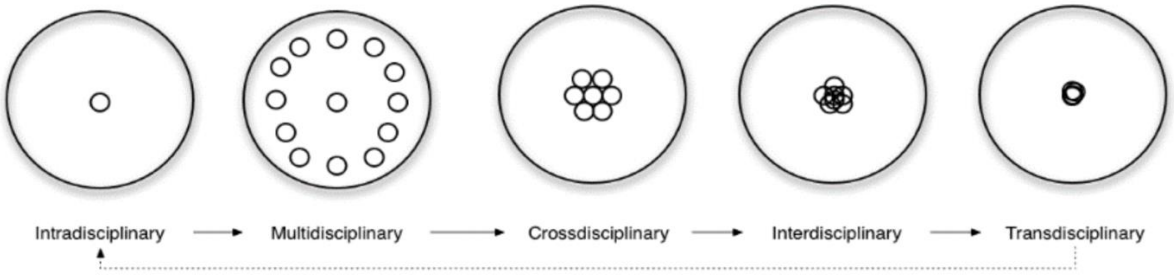

Figure 1. Types of convergence research [6]

2.2 The imperative of interdisciplinary education

At the Davos Forum in January 2016, Klaus Schwab defined the Fourth Industrial Revolution as a time when the boundaries between the digital, physical, and biological domains were blurring and different disciplines were fusing together. He emphasized that this fusion will significantly change the existing industrial structure, blurring the boundaries between industries and disciplines, and creating new markets with new innovative products and opportunities. In this changing environment, interdisciplinary collaboration is becoming increasingly important, as it is the key to unlocking new business opportunities and increasing competitiveness.

In the environment of the Fourth Industrial Revolution, the design field is no longer bounded only to physical or visual changes, but also to convergence with various fields. This means that designers must have creative and interdisciplinary thinking while communicating with various fields such as business, engineering, and humanities. Modern companies are also recognizing design as a pivotal role in corporate management, rather than just a way to decorate the appearance of a product or service. In doing so, design has shifted to focus on the strategic direction and creative innovation of a company. As a result, designers need to be able to communicate and collaborate with a variety of areas to gain an overall understanding, rather than just focusing on their area of expertise, in order to be competitive.

To respond to the demands of the current era, the design industry is seeking new talents with creative and integrative abilities from various academic backgrounds to understand complex and new technologies, products, and services. Edward Osborne Wilson, an advocate in the convergence of disciplines, emphasized that various complex types of problems cannot be effectively solved by one discipline alone. Therefore, there is a very active discussion about a new way of education that breaks down the boundaries between disciplines and organically combines them to solve complex and new problems. The need for an interdisciplinary education model that breaks down the barriers between different disciplines so that they can actively understand and communicate with each other is increasingly recognized.

3. EXPLORATORY CASE STUDIES

3.1 The d. school at Stanford University

Stanford University's d. school stands for Design School, but it's a different approach to design than people might think. When most people think of design, they think of beautifying the physical appearance of furniture, cars, clothes, etc. Contrary to the traditional concept of design, however, d. school focuses on "design thinking". This insinuates that education here is not just about designing objects or forms, but about designing the process

of creation and innovation itself [11-12].

With the growing importance of design around the world, many academics, led by Stanford University professor David Kelly, have begun to emphasize the need for a new way of teaching rooted from the design thinking. This also inspired Hasso Plattner, co-founder of software company SAP. As a result, d. school, a unique educational space centered on design thinking, was established at Stanford in 2005 with a $3.5 million donation from Hasso Plattner. Praterner's decision to make a major gift was based on his belief that innovative problem-solving methods like design thinking should be more widely disseminated; his goal was to make Stanford more than just a place to impart knowledge, but a place to experiment to maximize creativity and innovation [11].

Stanford University's Graduate School of Design is not a specific department or division within the existing school, so it does not offer a separate degree. While Stanford does have an undergraduate program in Product Design and a master's program in Impact Design, they are simply different departments within the School of Engineering. There is no separate application process for admission to the Graduate School; instead, all enrolled bachelor's, master's, and doctoral students at Stanford University can take classes regardless of their major. As a result, the Graduate School attracts students from a wide range of majors, from engineering to the humanities, medicine, law, economics, and education. The school's philosophy is that creative ideas and innovations come from the interaction of people with different backgrounds and experiences. They believe that different perspectives and experiences are essential for problem-solving. Aligned with this philosophy, Classes are made up of students from as many different majors and experiences as possible. For example, a computer science major might be paired with a political science or English literature major, or an education major might work with an industrial engineering major.

Their course offerings vary from semester to semester, with some classes changing significantly from year to year. However, many courses have been offered for over 50 years, such as Global Engineering Design Thinking, Innovation, and Entrepreneurship (ME310). Classes are divided into "Core," "Boost," and "Pop-out" categories based on credit hours and course difficulty, and there are usually more than 10 different classes offered each semester. Boost and Pop-out classes are offered for short periods of time during the semester and may be converted to Core classes if they become popular or if students request them (Figure 2).

The courses at the school are mainly project-based, and based on a convergence teaching methodology. Contrary to the traditional lecture format, the instructor does not ask students to solve a given problem. Instead, d. school challenges students to go beyond the mere absorption of knowledge and develop the ability to formulate solution strategies for complex problem situations in the real world. This approach to education encourages students to focus on "what is the essence of the problem at hand?" rather than looking for a set answer. Therefore, lectures are centered on real-world problem situations that are approached by students rather than problems with known answers. In the process, students with different academic backgrounds and expertise form teams and work together on projects. This approach goes beyond the one-way transmission of knowledge from the professor to a two-way educational model that promotes mutual learning and exchange among students.

The d. school's teaching methodology also has a unique faculty structure. Instead of the traditional lecture style where a single professor leads the entire class, most classes are team-teaching. The teaching team includes professors and researchers from various disciplines, as well as professionals from various fields in Silicon Valley. With such a diverse group of instructors, the course content can be convergence and focus on topics that Silicon Valley companies are facing and need to solve. Some classes are taught by taking on projects from real companies and working with students to solve those problems. This approach exposes students to real-world problems in the field and builds their ability to solve problems from different perspectives. Furthermore, projects that involve close collaboration with real companies give students the opportunity to interact with industry professionals beforehand, which is a huge advantage when it comes to finding a job.

Figure 2. In the d. school, the loft is where the ME310 class takes place

At The School, emphasizing the importance of entrepreneurship education is one of our core educational philosophies. Design-thinking-based entrepreneurship plays a crucial role in modern startup culture. In the school's entrepreneurial atmosphere, classes teach students how to think creatively and innovatively, and how to experiment and validate their ideas. As a result, many of our students now serve as founders or key members of startups at various fields. These successes clearly demonstrate the ripple effect of our educational philosophy in the real world of business.

As the main classroom location for the d. school, building 550 is specifically designed to support a variety of educational activities. The building includes lecture spaces, conference rooms, and rooms of various sizes for team projects. In addition, there are rooms set aside for specific classes. For example, classes in ME310 are held in a space called the Loft. The Loft is a space set aside for students taking the ME310 class, and it's a space that's exclusively for ME310, where students propose ideas, discuss them in-depth, and implement them into practice. To maximize the flexibility of the space while promoting a creative atmosphere, most of the space is partitioned. The partitions allow for different spaces to be transformed at any time to suit different classes or projects. In addition, all the furniture is on wheels for easy mobility to maximize space utilization. There are several wheeled carts with post-it notes, writing utensils, and various prototyping materials so that ideas can be generated and discussed anytime, anywhere.

The Graduate School of Business at Stanford University is more than an institution that transmits knowledge; it is an environment where students learn by doing. A critical aspect of this learning approach is to implement ideas. The prototyping room in Building 550 provides students with the basic tools and materials to bring their ideas to life quickly, but for more specialized and sophisticated work, the Product Realization Lab (PRL) is available. With a variety of metalworking and woodworking machines, as well as specialized equipment such as furnaces and welding facilities, the PRL has everything students need to bring their ideas to life. The PRL is staffed by experienced graduate students and managers who can assist with the use the equipment safely and get hands-on experience implementing your ideas at any time, rather than giving simple instructions or online lectures. They serve as Class Assistants (CAs) and provide students with the support and consultation they need to not only use the equipment but also to implement and validate their ideas. There are more than 20 CAs each semester, and they operate daily from 9 a.m. to 9 p.m. in three shifts: morning, afternoon, and evening, with five CAs assigned to each shift to support students. These CAs receive a full scholarship from the school for the semester. The PRL also offers regular classes to learn how to use the various equipment. These classes are not only designed to teach students how to use the equipment but also to help them acquire the necessary equipment and skills while working on actual design projects. Therefore, students can improve their design and production skills at the same time through these classes. In this way, the d. school and the PRL are closely linked, providing students with an optimal learning environment that fosters both creativity and technical skills.

3.2 The Innovation Design Engineering program at RCA/ICL

Located in London, UK, ICL and RCA offer an MSc in Innovation Design Engineering with a focus on engineering, design, and art. Founded in 1837, the RCA is one of the world's most prestigious art and design universities, with an iconic historic campus in London and a range of postgraduate programs from architecture to fashion, design, and art. Imperial College, on the other hand, specializes in disciplines such as engineering, natural sciences, medicine, and business, and is known as one of the most prestigious engineering schools in the UK. This two-year dual-degree program combines the expertise of both universities and upon graduation, students receive both a Master of Art and a Master of Science degree. The MSc program accepts around 40 students each year, with a total capacity of around 80 students, and students come from a variety of backgrounds including engineering, business, design, chemistry, and many nationalities.

IDE has a history of about 40 years, initially aimed at the convergence of industrial design and engineering. However, over time, the scope of industrial design and engineering was deemed insufficient, and the name was changed from Industrial Design Engineering to Innovation Design Engineering with the intention of expanding into various fields. The main educational objective of IDE is to develop a new generation of designers with innovative thinking in many different fields based on design and engineering. It also attaches great importance to the development of people who have the qualities of independent thinkers. This is because we want our students to identify problems and find solutions on their own, so they can be the change agents of the future. To realize this educational philosophy, IDE's classes are organized so that students can experience the entire process of building a product or service. Classes are primarily project-based, with projects divided into group and individual projects. In particular, group projects emphasize collaboration among students and introduce "Peer Assessment" to evaluate and provide feedback among team members.

Looking at the curriculum in more detail, the IDE program is a two-year course, with the first year designed to give students as much real-world experience as possible. The course emphasizes the experience of actually creating deliverables with their own hands, rather than just learning theory. A variety of training modules, workshops, classes, and research activities are designed to help students improve their overall skills and experience. Among other things, the first-year program is unique in that it has a "module" structure. The module structure breaks down the three semesters of the first year into a series of courses that range from as short as one week to as long as four weeks. This structure allows students to dive deep into different areas without the restrictions of a semester. The 'I'll take 9' module is a prime example of this, where students build nine working products using mass production methods over the course of three weeks. The module brings together students from a variety of backgrounds to work in teams and experience the entire process of creating a product. This is a fresh experience, especially for engineering students without a design background. Throughout the course of these modules, the different approaches are designed to expose students to both the systematic and experimental approaches of science, technology, and engineering, as well as approaches based on creative design insights. Students will also receive expert feedback and assessment at various stages, allowing them to continuously improve their work.

What's interesting about the IDE module is that it teaches two opposing methodologies: Disruptive Market Innovation (DMI) and Experiment (EXP). DMI is a disruptive market innovation approach that puts the market and user needs at the center, breaking down existing boundaries to create new products or services. In other words, DMI creates innovative products and services through a deep understanding of the market and a focus on user needs. EXP, on the other hand, takes the perspective of an engineer or scientist and seeks to generate creative ideas through repeated experimentation and exploration. It aims to innovate at a fundamental level, creating technologies or products that have never existed before. DMI and EXP help students avoid relying solely on traditional research or design approaches. They aim to expand students' creative thinking and develop their ability to generate ideas from different approaches. During the first year, students will experience an even mix of DMI and EXP through several modules. In the second year, they work on a real-world project, deciding in groups or as individuals whether to choose DMI or EXP for each design phase. This structure has the advantage of giving students a balanced experience of both strategic approaches, while further activating their creativity and ability to innovate (Figure 3).

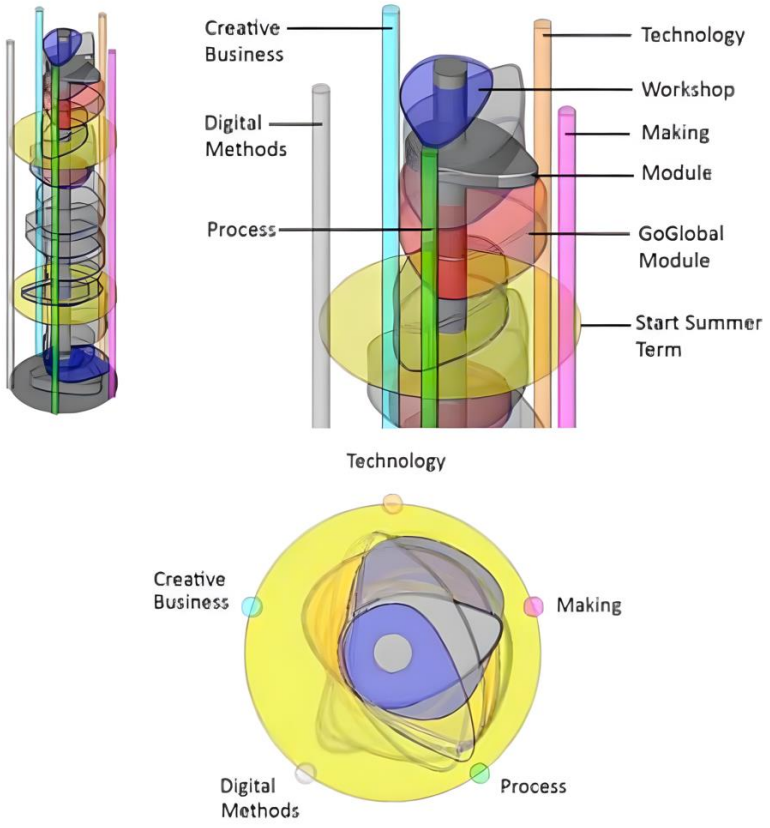

Figure 3. Configuring the IDE's first-year module [13]

The second-year IDE curriculum includes a team-based group project with an individual solo project. Students choose a topic upon their interests and work on a group project in the first semester and a solo project in the second and third semesters. The results of the group projects are presented to the public at the Work in Progress Show, while solo projects are exhibited at the Degree Show at the RCA. Afterward, IDE graduates' work is included in a separate exhibition at the ICL. The report for the Solo Project should be based on in-depth research, similar to a master's thesis, and should present the entire process and results of the project in the form of a thesis.

IDE students are also required to submit a master's thesis before the start of their second year. During the first year, students gain theoretical and practical knowledge in their various areas of interest through the Critical & Historical Studies (CHS) program. This program is compulsory for students, and they spend a year writing a 6,000-10,000 word thesis based on the knowledge they have gained. In addition to hands-on training, CHS offers students a variety of theoretical seminars and lectures to help them develop in-depth research skills.

IDE courses are not taught by a single professor, but by teams. Teaching teams are depending on the module or project, and a team usually consists of three people, including a professor and a tutor. Tutors may also vary depending on the methodology, such as EXP or DMI. Most professors and tutors are either working designers or professionals with their own studios, so students receive practical, hands-on instruction and feedback. During the course of a project or module, specialized tutors may be brought in on an ad hoc basis for specific topics or stages. For instance, in the early stages of a project's research, experts can provide hands-on guidance and feedback. These tutors are often available for short periods of time, such as two or three days. In terms of engineering education, the various types of lectures offered at Imperial also impart practical knowledge to students and are not limited to traditional engineering approaches, but also emphasize a design perspective. To this end, even in modules with an engineering background, it is not uncommon for design majors to be part of the teaching team as well as tutors with an engineering background. In addition, graduates familiar with the IDE program are often used as tutors, further strengthening the links between the different disciplines, and

helping to minimize the gap.

Education at IDE is project-centered, implying that the work students produce is designed to be directly applicable to solving real-world problems. These outputs are often developed into startup ideas, and in fact, several startups have successfully developed from these outputs. Students exhibit their work in the middle and end of the semester, which is open to the public and investors, and can lead to the creation and investment of start-ups. The best project outputs may also be eligible for funding through school programs such as Innovation RCA and the Imperial College Innovation Fund, while also receiving support and advice from professors and experts at the school.

IDE students have full access to the full range of facilities offered by both RCA and ICL, which is a huge advantage for a high-quality prototyping experience. The workshops at both schools are equipped with a wide range of state-of-the-art machinery and equipment, including CNC, lasers, woodworking machines, and castings, allowing students to create finished prototypes that bring their ideas to life. In addition, by prototyping in a variety of materials, including wood, metal, plastic, and composites, students gain a systematic understanding of how products work and how they are manufactured. In addition, each workshop is staffed by professionals with years of experience, so students can not only use the equipment safely under their guidance, but also consult and receive support on how to prototype efficiently at any time. This support gives students the opportunity to not just think about their ideas, but to actually implement them, so that they can identify problems with their ideas and develop them more solidly.

3.3 The International Design Business Management program at Aalto University

Aalto University was founded in 2010 as a result of a government-initiated merger of Helsinki University of Design & Art, Helsinki School of Economics, and Helsinki University of Technology. The university aims for synergy in interdisciplinary education and research based on close cooperation in engineering, science, business, art, and design. Aalto University consists of six schools and is the second largest university in Finland with 17,500 students and 4,000 academic staff.

Launched in 1995., Aalto University's IDBM is a leading interdisciplinary education program in collaboration between the schools of business, art, design, architecture, and engineering. Aalto University believed that a discipline-specific education could not produce innovative and creative people. Under this philosophy, the goal of the program is to develop global talent that drives innovation in new products, services, and businesses through the convergence of design, engineering, and management. This program also encourages business, design, technology, or management majors to study two disciplines outside of their field of study in an interdisciplinary manner to build a well-rounded knowledge and experience.

The IDBM consists of two parts, the Major program, and the Minor program, which allow students to gain both depth and breadth of knowledge (Figure 4). The Major Program is a two-year, 120-credit master's program in which students choose one of three tracks: Arts and Design, Business, and Science and Technology. Depending on the track, students will earn either a Master of Science in Economics and Business Administration, a Master of Science in Technology, or a Master of Arts. Students must take at least 40 credits of required courses, which cover topics such as teamwork, business model design, entrepreneurship, and global virtual teamwork, and require collaboration with students from diverse backgrounds. The Minor program requires a minimum of 20 credits, including the IDBM Challenge and other alternative courses. Aalto University's IDBM program is open to students from other Finnish universities as well as international students, bringing together students with international backgrounds and diverse expertise for an interdisciplinary education.

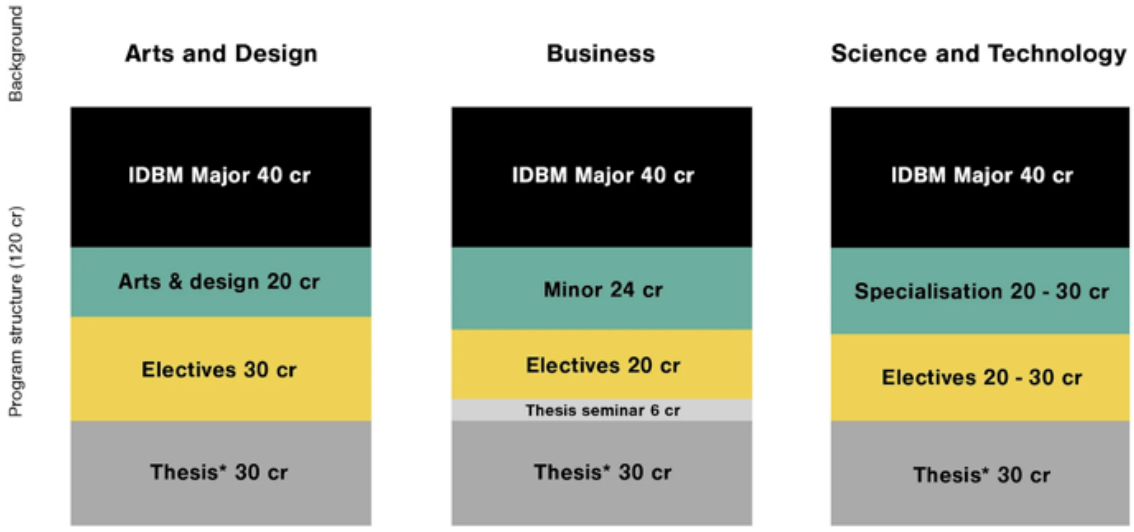

Figure 4. Program design by major in IDBM [14]

At IDBM, the Industry Project for first-year students is one of the mainstays of the program and lasts for six months. In this project, students work with teammates from a variety of majors and backgrounds on real-world project assignments from companies. The assignments cover multiple disciplines such as product development, user research, and business strategy, and the results are often of such high quality that they are incorporated into actual products by companies. Each year, 10 teams participate in the project, which is managed directly by the IDBM department and funded through corporate sponsorship. Faculty members have extensive practical experience, and students work closely with experts from the sponsoring companies. In addition, renowned engineers, researchers, and designers are invited to give feedback and interact with students on their works. This gives students invaluable insight of how to solve problems and practical methodologies that companies face through highly polished project deliverables.

One of Aalto University's signature strengths is the Design Factory, which was launched in 2007. The Design Factory was the first of three Factory programs, along with the Media Factory and Service Factory. It is a space for students to realize their creative ideas and support innovation-driven entrepreneurial activities, and the 1,200-square-meter space is equipped with a variety of equipment for prototyping and testing. The Design Factory is an open space that focuses on interdisciplinary education and provides a practical model of interdisciplinary education through workshops and lectures. Around 40 interdisciplinary courses are taught here every year, and more than 1,200 students study and carry out projects here. More than 20 staff members and 10 doctoral students support the prototyping of student projects at the Design Factory, and their diverse expertise provides the best environment for students to further develop and implement their ideas. In addition, Aalto University's Design Factory's groundbreaking systems and programs have been adopted in many other countries around the world, including Yonsei University in South Korea. As a result, there is a lot of networking with design factories around the world, which helps students to experience and interact with global cultures.

Aalto University's interdisciplinary and convergence education also works in the field of entrepreneurship. As an example, the Aalto Venture Program (AVP), funded by the Finnish government and Aalto University, provides students with the entrepreneurial skills, knowledge, and networking opportunities they need to start their own businesses. AVP is a collaborative effort between faculty and researchers from various disciplines at Aalto University, and its goal is to equip students with a range of innovative and entrepreneurial skills. The program is closely linked to the existing IDBM and Design Factory, which provide students with a wealth of resources and support as they develop their entrepreneurial ideas and turn them into real businesses. Students will receive entrepreneurship training through the program, completing a 'Startup Experience project course' and 'entrepreneurship courses' for a total of 11-16 credits. Upon successful completion of these courses,

students will receive a minor degree called the AVP Startup Minor. This allows students to gain a wide range of experience and knowledge related to entrepreneurship while gaining an academic certification in the field. In the end, by providing students with a variety of experiences and opportunities in the field of entrepreneurship, Aalto University further encourages their entrepreneurial spirit and helps them grow into the innovative entrepreneurs of tomorrow.

4. A COMPARATIVE ANALYSIS AND INTERPRETATIVE EXAMINATION

Based on the characteristics and necessity of interdisciplinary education programs, this paper analyzes the direction and strategy of interdisciplinary education through the cases of world-renowned universities. In particular, we focused on Stanford University's d. school, RCA and ICL's IDE programs, and Alto University's IDBM program. When it comes to interdisciplinary education, the study found that competitive universities around the world share the following common characteristics (Table 1).

First, the range of disciplines collaborating in interdisciplinary education has greatly expanded. The above programs are transdisciplinary, involving not only engineering and design, but also business, humanities, science, and the arts. They based on deep collaboration and mutual understanding between different disciplines.

Secondly, education has been provided through independent organizations to achieve a balanced convergence of various disciplines. Stanford's d. school does not have a degree program but operates as an independent organization that transcends departments. In the case of IDE, a joint program with the RCA and Imperial College, it operates separately from each school's existing departments. In the case of IDBM at Aalto University, it is not part of the existing design department but operates as a separate institution. This allows for better collaboration across disciplines, as they are not part of an existing design department or engineering school.

Third, to maximize the effectiveness of interdisciplinary education, we have innovated teaching methods. When we look at interdisciplinary education cases abroad, we find several professors or experts from different majors teaching together. In particular, there are professors and lecturers with different backgrounds forming teaching teams to provide students with different academic perspectives and approaches. This is considered a highly optimized way of teaching for interdisciplinary education.

Fourth, they had physical convergence spaces to facilitate communication and collaboration between students and faculty. All three of these universities provided special spaces for students to take classes, create, and share ideas. Stanford's d. school offers dedicated spaces for each class, including the Loft, where students in ME310 can freely interact with their teams and turn ideas into reality. Similarly, at IDE, master's students of all grades are assigned individual workspaces in the Studio, where they are constantly interacting with peers from different backgrounds to enhance their learning. Aalto University's Design Factory follows a similar philosophy with a space called the Lounge, where students can easily share ideas and get feedback.

Fifth, we had effective systems and spaces in place to help students turn their creative ideas into reality. Most students are good at generating ideas but struggle with the process of actually implementing them due to a lack of experience. International universities are well-equipped with prototyping labs and workshops to support these students, providing an optimal environment for them to bring their ideas to life. Stanford's PRL offers the help of several CAs, while IDE and Aalto's Design Factory have experts in various fields to help students with their projects.

5. CONCLUSION

This study highlights the importance of interdisciplinary education in the modern world by analyzing the interdisciplinary education programs of world-renowned universities. Interdisciplinary education helps students combine knowledge and skills from multiple disciplines to effectively solve complex problems. The study also identified the key elements and strategies of successful interdisciplinary education programs and their effectiveness.

Table 1. Comparative Analysis of Three Institution

Institution	Program Name	Key Characteristics	Strategies for Success
Stanford University	d. school	- Emphasis on design thinking - Open to all majors - Project-based learning - Collaboration with industry	- Independent operation within the university - Team-teaching approach - Dedicated spaces for interaction and prototyping (Loft, PRL)
RCA/ICL	Innovation Design Engineering (IDE)	- Dual degree in engineering and design - Disruptive Market Innovation (DMI) and Experimental (EXP) methodologies - Project-based curriculum	- Operates separately from existing departments - Collaborative teaching with experts from various fields - Access to advanced prototyping facilities (CNC, lasers, woodworking machines)
Aalto University	International Design Business Management (IDBM)	- Integration of design, business, and engineering disciplines - Industry Project with real-world assignments - Emphasis on entrepreneurship training	- Independent operation within the university - Collaboration with companies through the Industry Project - Dedicated convergence space (Design Factory) for prototyping and innovation

In this study, we visited educational sites to experience and analyze the learning environment, teaching methods, and interactions between students and professors. This type of research can provide much deeper insights than simple data analysis or literature review and can provide a more concrete and practical understanding of the actual effectiveness and importance of interdisciplinary education.

In addition, our finding provide important guidelines and directions for educational institutions and researchers in the design and operation of interdisciplinary education programs. Based on the research, it is expected to contribute significantly to the effective operation and development of interdisciplinary education programs in educational institutions at home and abroad.

The findings from this study offer important guidelines and directions for educational institutions and researchers in designing and operating interdisciplinary education programs. Firstly, institutions should design programs that emphasize broad disciplinary convergence and provide the necessary structures and resources to support interdisciplinary collaboration. Implementing collaborative teaching methods, such as team-teaching models, can enhance the quality of education by incorporating diverse perspectives into the classroom. Additionally, investing in physical spaces that facilitate collaboration can significantly improve the effectiveness of interdisciplinary education. Developing robust support systems, including workshops and prototyping labs, along with providing access to industry resources, is essential for supporting students' creative endeavors. Lastly, integrating real-world projects into the curriculum can help bridge the gap between academic learning and professional practice, providing students with valuable practical experience.

Despite the significant insights gained, this study acknowledges the need for further research and action to advance interdisciplinary education. Future research should examine additional interdisciplinary programs across different cultural and educational contexts to gain a broader understanding of best practices. Evaluating the long-term impact of interdisciplinary education on students' careers and professional success will provide valuable insights into the efficacy of these programs. Conducting comparative studies between interdisciplinary programs in different countries, including South Korea, will help understand regional variations and develop tailored strategies for improvement. As technology continues to evolve, interdisciplinary programs must adapt to incorporate new tools and methodologies, ensuring students are well-equipped for future challenges. Additionally, advocacy for policy support at institutional and governmental levels is crucial to sustain and expand interdisciplinary education initiatives.

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