Shaping an Interdisciplinary Curriculum Design Framework

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Abstract

Globally, the world has faced with successive waves of disruption from Industry 4.0 to COVID-19 pandemic and more recently, the pervasion of artificial intelligence. These disruptions necessitate higher education institutions to rethink their educational policies and curricula to enhance their students and graduates' competencies and in preparing them for the world of the future. Higher education institutions have taken the bold step to experiment with interdisciplinary curricula in offering study programs that cut across related and unrelated disciplines. Interdisciplinary curriculum is designed with real-life experiences and actual context where students can gain a deeper understanding of the world as well as to create connection between their learning with a meaningful and higher purpose. This paper attempts to investigate how interdisciplinary programs transform students' learning and experience through analyzing the critical theories and good practices. It aims to recommend a framework to aid Vietnamese institutions and teachers in their professional development.

1 Introduction

The successive waves of disruption from industry 4.0 to COVID-19 followed by artificial intelligence have changed the landscape of current and future skills demanded by industries, businesses and enterprises for their survival as well as to mitigate and to overcome the impacts arising from the waves of disruption.

The World Economic Forum: Future of Jobs Reports (2023) revealed that more than 85% of organizations surveyed have identified increased adoption of new and frontier technologies, and more than 75% are looking to adopt these technologies including big data, cloud computing and artificial intelligence in the next 5 years to drive transformation in their organizations [1]. In the report, employers estimated that 44% of workers' skills will be disrupted in the next five years with growing importance and demand for complex problem-solving skills. They have identified two key barriers to organization transformation as skills gaps and an inability to attract talent with the expected skill set.

In a separate report by Economist Impact (2023) - Bridging the skills gap: Fueling careers and the economy in Vietnam mentioned 62% of employees have identified analytical skills, critical thinking and problem solving as the most important skills to have [2]. Besides, it is said that the ramifications of the waves of disruption have resulted in the rise of wicked problems, and to solve them would require the integration of disciplines. The need for higher education institutions to produce students and graduates that demonstrate higher cognitive ability to solve multi-dimensional issues and challenges and to close the skill gap demanded by employers and the human resource produced by the higher education institutions have become increasing importance in the disruptive world of today and the future. The skills-based hiring movement is an example of employers hiring a candidate's skill rather than his or her graduate degree due to unmatched skills of graduates from higher education institutions.

In this context, many universities worldwide are exploring, developing and offering interdisciplinary curricula such as STEAM (science, technology, engineering, arts, and mathematics) education by integrating STEM (science, technology, engineering, and mathematics) with humanities and social sciences and other non-STEM disciplines, which emphasizes more on unifying concepts and engaging students, partners, and stakeholders in meaningful activities connected to the real world [3,4]. In line with the changing and development landscape, Vietnam in particular is predicted to become the cradle providing technology talent and qualified graduates for the country and the world [5]. Although higher education in Vietnam has achieved significant achievements, there are still limitations and shortcomings. Therefore, innovation in the higher education system, such as quality training, curriculum change are priority areas to contribute to the implementation of the country's development and international integration goals [6].

From this perspective, the paper aims to investigate and analyze relevant critical theories and good practices of interdisciplinary curricula implemented by higher education institutions around the region and to recommend an interdisciplinary curriculum design framework to aid Vietnamese higher education institutions and teachers in designing interdisciplinary programs and in preparing their curricula, students and graduates that are future ready.

2 Methods

The review analyzes and synthesizes previous theories and research on interdisciplinary curricula to develop a multidisciplinary curriculum framework. As described below, the review process includes three stages.

2.1 Setting up the criteria for literature review

All the publications should be relevant to the study's topic, which focuses on Interdisciplinary Curriculum Design, Practice, and Results. These articles are all peer-reviewed and written in Vietnamese and English. The literature review spans from the beginning of the 19th century to 2024 to provide critical information for interdisciplinary curriculum development and practices.

2.2 Developing the strategies for searching the information

The keywords identified before searching are interdisciplinary theories, interdisciplinary curriculum, interdisciplinary approach, interdisciplinary practices, interdisciplinary research, teaching and learning in higher education, and good practices in the international and Vietnamese universities. The search strategies start with reading the book/article titles, authors/ abstracts, and the publishers to find the rates of citations and impact of the articles and authors in this field. In this way, the study can summarize the common points of view and issues of the interdisciplinary curriculum models. Databases are used from prestigious sources, including the Educational Resources Information Centre (ERIC) catalog, the Science Citation Index Expanded (SCI-EXPANDED), the Web of Science®, Academia, and Google Scholars. The relevant abstracts and full papers are scanned and read carefully to find the critical patterns and ideas. Good practices from other universities are synthesized from the universitie's websites and articles.

2.3 Formulating the conceptual framework of the interdisciplinary curriculum

Critical analysis is carried out based on the literature review. The key elements are explored and evaluated through good practices and the needs of society and the job market. A proposed framework is formulated to assist educators, managers, and teachers in having an overview of the interdisciplinary curriculum design

and instructions.

3 Results

3.1 Previous research on interdisciplinary curriculum

Across theories and previous research, there is a consensus that interdisciplinary curriculum frameworks are valuable for developing holistic, flexible educational models. Scholars generally agree that implementing such interdisciplinary curricula requires multiple sources and more collaboration among educators, students, and industry practitioners from diverse backgrounds and disciplines [7,8]. According to Gouvea et al. (2013), interdisciplinary courses require teachers "to go beyond" their own single discipline [9]. Deeper levels of conceptual coherence between the disciplines are considered as one of the good methods to help students increase their integrated knowledge and relationships among different disciplines. The authors also recommend the importance of the connections between task levels and intended learning objectives of interdisciplinary education. Jacobs (1989) describes the need for the growth of knowledge in our society and students should have a larger range of experience that reflects "both a discipline field and interdisciplinary orientation" [10.] To do this, teachers should play a very active role in curriculum design and determine the degree and nature of integration of the knowledge, the scope, and the sequences of their teaching. Also, he recommends that an interdisciplinary curriculum be only used when the problems reflect the need to overcome the fragmentation, relevance, and growth of knowledge. To foster the curriculum design, he offers the continuum of options for content design, which focuses on many levels of options such as discipline-based, paralleled disciplines, multi-disciplinary, interdisciplinary units/courses, integrated content, and lastly, the complete program.

In the study conducted by Spelt et al. (2009), the scholars emphasize that students will work during

their careers in interdisciplinary teams on complex societal problems; they need to be able to think critically and interdisciplinary [11]. This thinking ability helps them to achieve a deeper understanding of the problems and propose more advanced solutions. Besides implementing the principles of the constructive alignment theory, teamwork ability and the prior experience of individual team members play an essential role in successfully facilitating interdisciplinary courses or tasks. Additionally, the authors suggest more empirical research on relationships between the analysis of interdisciplinary learning processes and interdisciplinary learning outcomes, and the student's attitudes towards the other disciplines. Relating to students assessment, Boix Mansilla and Duraisingh (2007) created the Targeted Assessment Framework from the analysis of various student learning outcomes and assignments such as written papers, presentations, and works [12]. According to the scholars, it is necessary to design clear indicators of quality interdisciplinary student learning. By proposing a theoretically grounded and empirically tested rubric to assess student interdisciplinary, the scholars also focus on four fundamental aspects: purposefulness, disciplinary grounding, integration, and critical awareness. In each dimension, the rubrics must reflect the quality of student's performance and the learning challenges that might happen to them. Generally, the authors suggest that interdisciplinary curricula should include competency-based assessments to evaluate students' understanding of complex, cross-disciplinary topics. This is supported by the workplace interpersonal skills framework proposed by Klein (2006), who argues that such competencies are essential for addressing real-world problems [7]. However, to teach and measure these soft skills are not easy in reality because the interpersonal effectiveness requires students learn from their experience, instinct, in specific contexts or cases.

While interdisciplinary curricula are beneficial, researchers frequently discuss challenges, such as institutional constraints and resource limitations [10,11]. Integrating disciplines often requires new curriculum structures, increased teaching resources, and administrative support, which can be barriers for some institutions. Studies, including those by Ashby and Exter (2019), argue that overcoming these challenges often requires institutional changes, such as updated accreditation policies, expanded budgets for interdisciplinary initiatives, and new models for stakeholder collaboration [13]. To understand complex societal issues through an interdisciplinary approach, Luhmann (1970) provides a sophisticated framework emphasizing communication, operational closure, and functional differentiation, which can be a powerful tool for interdisciplinary analysis and application [14]. Besides, Weber (1920) provides the systematic institutions and organizations framework that inspires the later interdisciplinary approach [15]. That is to understanding the complex societal issues, we need to consider or integrate perspectives from various disciplines from social, economic, political, and cultural factors because they are infact interact or influence each other. This concept helps to illuminate the multifaceted nature of developing the approach in interdisciplinary curricula.

Table S1 summarizes the comparative key interdisciplinary curriculum frameworks by different authors and researchers, along with their approaches and focal points.

In summary, interdisciplinarity relates to understanding the purviews of the natural sciences, social sciences, and humanities, and it is indeed necessitated for complexity, specifically by the structure and behavior of complex systems [16]. Hence, it is necessary to include systematic strategies with multi-faceted in the design and practice. Eagleman's (2010) possibilianism emphasizes to

explore new, unconsidered notions, the participants need to hold multiple ideas in mind rather than being driven by a single idea or story [17]. More interesting, the open-mindedness to actively explore new ideas, which is considered the foundation of an interdisciplinary curriculum development and practice.

3.2 Transformative learning in interdisciplinary curriculum

Spelt et al. (2009) proposed a list of subskills relating to interdisciplinary thinking and learning [11]. Transformative learning facilitates these skills to help learners obtain knowledge of disciplines, knowledge of disciplinary paradigms, knowledge of interdisciplinarity, and higher-order cognitive skills in the interdisciplinary curriculum [18]. In fact, transformative learning is a paradigm-shifting approach to learning and teaching that enables learners to critically reflect on their existing knowledge and experience [19]. Mezirow (1978) advocates transformative learning as an approach to understanding the world and the self in a new way [20]. Mezirow (1991) claims that transformative learning helps the learners transform their beliefs, attitudes, opinions, and emotional reactions that constitute their meaning schemes" [21]. Like this concept, Cranton and Kasl (2012), and Taylor (2007) find that people can change their habits or actions through experience and critical reflection [22,23]. As a result, transformative pedagogical approaches can create opportunities for students to challenge and renew their beliefs and behaviors. Other scholars suggested transforming the learning from faculty to student [24]. Supported by Freire (1970), students need to be change agents rather than passive receivers of the teacher's knowledge or attitudes [25]. Students should take ownership of their educational process through "self-directed learning" and "self-directed inquiry" [26]. The idea of self-directed learning by Cunningham (2010) focuses on the motivation and self-discipline needed to be successful

[27]. Kolb (1984) states that knowledge is created through experience [28], while Dewey (1938) writes that experiential learning transforms impulses and feelings into purposeful action [29]. Another kind of transformative learning relates to experiential education and service learning, which have fundamentally changed the ways of learning and teaching [30]. According to Eyler (2009), there is a strong need to take students into the community to help them "bridge classroom study and life" [31]. Rone (2008) asserts that experiential education is a kind of informal learning embedded within the processes to encourage interactive encounters [32]. Other interesting points from Freire (1998, 2000) and Dewey (1998) view that experience should be the key criterion in education that influences the curriculum and educational training process [29,33,34]. Wyk (2008) asserts that to have meaningful experience, students must be immersed in enhancing their personal experience in their learning [35]. In a survey by White and Nitkin (2014) on Simmons World Challenge, which is an interdisciplinary experiential-based program offered by Simmons College, found that most of the students who had enrolled in the world challenge have a deep sense of engagement in the self-directed learning experience and 100% of the students reported that they have a shift in their view of the world than before – a premise of transformative learning [36].

3.3 Future jobs related to interdisciplinary studies

As the world keeps changing in an unexpected way, interdisciplinary studies have become increasingly important in the modern age. The respondents from the World Economic Forum: Future of Jobs Reports 2023 predicted that 42% of business tasks will be automated by 2027 which vary from 35% of reasoning and decision-making to 65% of information and data processing [1]. About 75% of them are expected to adopt artificial intelligence with 50% of the

respondents expecting it to create job growth while the other 25% expecting job losses.

They estimated that 44% of workers' skills will be disrupted in the next five years and 60% of the workers would require training before 2027 with only half of them having adequate training opportunities today. Analytical and creative thinking skills are the two top core skills prioritized by employers from 2023 to 2027. These two skills are also valued by Vietnamese employees in the report by Economist Impact (2023) - Bridging the skills gap: Fueling careers and the economy in Vietnam [2].

These future skills demanded by employers coupled with the twenty-first-century knowledge-based society have influenced higher education policies and curriculum design. Harvard and Melbourne (2007) and Japanese Council for Education (2008), address the importance of curriculum change or learning outcomes to include logical thinking skills, problem-solving skills, working in teams, ethical development, and multicultural literacy. According to Sangra (2011), knowledge today is created by flexible, collaborative networks in dynamic and at times unstable environments in which interdisciplinary curricula could provide opportunities to train and to engage learners in multiple perspectives and experiences [37]. Gaining multiple perspectives requires learners to be aware of changes in the strategies and construction of knowledge [38]. Keeling's study (2009) stresses that learning is a dynamic process and there is an intensified need to consider that learners today can learn anywhere, anytime on any device [39]. This leads to a debate about the transformation of learning, inquiry and teaching. Open education calls into question changes in learning and teaching processes, while also providing learners with the confidence to construct their own knowledge as culled from a wide range of perspectives that enable learning experiences [40]. In

this respect, the transformation of learning and teaching processes offers advantages for equity, confidence and transparency to attain alternative resources and socially constructed meaning, both of which help tap into human potential.

Interdisciplinary curriculum can be described as one that connects different areas of study by cutting across disciplines which unifies and integrates concepts and theories to engage students in relevant, meaningful learning experiences connected to the real world. The Institute of Arts Integration and STEAM describes STEAM curriculum as having the four following features: (a) an integrated approach to learning connecting standards, assessments, and lesson design and implementation; (b) experiences and assessment involving two or more standards from STEAM; (c) active learning approaches such as inquiry, collaboration, and process-based learning; and (d) utilizing and leveraging the integrity of the arts [4].

A group investigation project of interdisciplinary curriculum found that interdisciplinary curriculum embraces higher-order thinking and deeper understanding of content, cultivating lifelong learning, learning around themes, big ideas, and meaningful concepts, connecting various curricular disciplines, providing opportunities for skills application and small group activities, active participation in relevant real-life experiences, captivating, motivating, and challenging learners, and accommodating different learning styles and multiple intelligences.

According to the findings from a 2012 study of Lesley University, Voices from the field: Teachers' views on the relevance of arts integration, teachers reported that integrated STEAM education stimulates "deep learning, creates increased student engagement, and cultivates students' investment in learning" [41]. Besides, educational experts mentioned that the combination of STEM with the art approach encourages students to think creatively and engage

them in STEM subjects using skills learned from arts. In addition, STEAM education approach can help students learn skills relevant to the 21st-century, including innovation and cultural sensitivity. The study also reports that a well-rounded approach enables teachers to use differentiated instruction more effectively to meet the needs of diverse learners. Moreover, according to a study by Dr. Robert Root-Bernstein, scientists that were more successful than others are more likely to engage in some form of arts and crafts avocations [42,43]. It is this integration of sciences with arts that produces more successful scientists.

In another case, a paper by Nelson Laird and colleagues found that STEM faculty generally uses pedagogies that encourage higher-order, integrative, and reflective learning significantly less than faculty in non-STEM fields [44]. They also found that STEM students fall behind non-STEM students in integrative

and reflective learning. In short, one of STEAM's major benefits is that it provides multiple teaching and learning approaches, giving students opportunities to learn with different learning styles, competencies, and backgrounds that fit their learning needs best.

3.4 Good practices in interdisciplinary curriculum

Theories and best practices for interdisciplinary curriculum development center on integrating multiple fields to foster deep learning, critical thinking, and real-world problem-solving skills.

In complementing the theoretical frameworks, a study of good practices in interdisciplinary curriculum among higher education institutions in Indonesia, Singapore, Thailand and the United Kingdom was held to conceptualize interdisciplinary curriculum design framework. The types of interdisciplinary programs offered by the higher education institutions in the research are illustrated in Table 1.

Table 1 Types of interdisciplinary programs.

Number	Interdisciplinary Curriculum Type	Higher Education Institutions	Country
1	Customizable Curriculum	Singapore University of Technology and Design (SUTD)	Singapore
2	Design Thinking	National University of Singapore	Singapore
3	Integrative Studies	Singapore Management University	Singapore
4	Phenomenon-Based Research	University College London	United Kingdom
5	Service Learning	Universitas Gadjah Mada	Indonesia
6	Social Innovation	Chulalongkorn University	Thailand
7	Stackable Curriculum	Nanyang Technological University	Singapore
8	Teaching Enterprise	Nanyang Polytechnic	Singapore
9	Work-Study Integration	Nanyang Technological University	Singapore
10	X-Curriculum	Singapore Management University	Singapore

A brief description of each type of the interdisciplinary programs researched is given below.

3.4.1 Customizable curriculum

Education at the Singapore University of Technology and Design is customized based on three building blocks: core curriculum, variable curriculum and outside the classroom. The core curriculum provides students with a broad and strong in their major of choice including a capstone project collaborating with students from different majors to solve real-world challenges from industry partners. Minors and specializations are offered in the variable curriculum and the outside the classroom activities include internship, global exposure and research. The three building blocks are supported by courses in innovation/entrepreneurship, data science/artificial intelligence as well as humanities, arts and social sciences.

3.4.2 Design thinking

Design thinking is an iterative process of seeking customers' insights, challenging assumptions, and redefining problems to identify alternative solutions to resolve customers' pain. Design Thinking helps tackle ill-defined or unknown problems by re-framing the problem in human-centric ways, generating ideas, and adopting a hands-on approach in prototyping and testing. The engineering students at the National University of Singapore are offered a second major in design thinking, embracing entrepreneurship and innovation in addition to their primary major [45].

3.4.3 Integrative studies

The integrative studies at the Singapore Management University offers a unique Deferred Declaration of Degree (D3) program that allows students to explore and take up courses in the interdisciplinary core curriculum and disciplinary courses from other SMU Schools without pre-committing to any specific degree program in the first year of study [46]. Students are allowed to select courses across SMU's six schools in accountancy, business, economics, computing and information systems, law and social sciences. They will graduate with a bachelor's degree in integrative studies with their chosen major after 4 years [47].

3.4.4 Phenomenon-based research

The University College London (UCL) offers students phenomenon-based learning through the connected curriculum focusing on research and inquiry [48]. It consists of five dimensions: holistic, authenticity, contextuality, problem-based inquiry learning, and learning process. Its uniqueness lies in the multi-stakeholder's collaboration in conducting the research with researchers, alumni and others within and outside the institution. For example, the UCL Integrated Engineering Program is an interdisciplinary framework which allows specialized and interdisciplinary engineering education to be delivered across different engineering disciplines. It creates programs that teach fundamental technical knowledge of a core discipline coupled with interdisciplinary, research-based projects and nurturing professional skills. At regular intervals throughout the study, students come together from across the faculty to collaboratively work on interdisciplinary research and design projects.

3.4.5 Service learning

Service learning or community service is a community engagement that integrates learning and community service to enrich students' learning experience. At Universitas Gadjah Mada (UGM), community service is mandatory for every UGM undergraduate student. Students work in groups and spend around two weeks living with the community and are involved with the community to face and solve their problems. The community service provides students with excellent grassroots understanding, which enriches their perspectives and competencies.

3.4.6 Social innovation

The CU social Innovation Hub at Chulalongkorn University is a center for researchers and students from all disciplines to exchange knowledge and to invent social innovations with the aim of improving the community's quality of life and to meet the country's sustainable development goals [49]. The center also incubates social enterprises by coaching researchers to transform their social innovation into viable businesses.

3.4.7 Stackable curriculum

The stackable curriculum known as Flex Masters is a flexible program leading to a master's degree that gives students the flexibility of stacking credits (micro-credential) earned in modular courses towards a full master's degree of various specializations offered by various schools in Nanyang Technological University [50]. A key feature of the Flex Master's program is the involvement of industry practitioners in designing the curricula and providing their valuable industry-relevant expertise in the course content and mode of delivery, thereby bringing in industry/market perspectives to the learners.

3.4.8 Teaching enterprise

Teaching enterprise is a concept to incorporate the real-world environment into higher education institutions. At Nanyang Polytechnic, the School of Business Management adapted business centers such as retail banking, human resource management, call center, tourism, convenience store, IT outlet and event management as platforms for students to apply their knowledge and deepen their skills through a learn-apply - learn - apply cycle in these business centers located within the campus [51]. Each business center has a different operational focus catered to providing specific training for students in different programs. Each cycle of attachment takes up to 21 weeks.

3.4.9 Work-study integration

The work-study integration scheme enhances students' readiness for the workplace by integrating institution-based learning with structured on-the-job (OJT), which exposes them to the real-world environment. The scheme allows them to learn on the job, develops soft skills, and cultivates an understanding of real-world practices through multiple internships. At the Nanyang Technological University (NTU), a work-study scheme is available for engineering and science undergraduate programs [52].

3.4.10 X-Curriculum

X-curriculum is another interdisciplinary program pioneered by the Singapore Management University which is a flexible curriculum that allows students to pursue their interests and passion across different fields outside their faculty. The university offers more than 300 combinations of 43 majors and tracks in a single degree program, and 15 double degree combinations. The x-curriculum collaborative approach involves industry practitioners, students and faculty members across different faculties and industries.

4 A proposed framewok for interdisciplinary curriculum

The design of the interdisciplinary programs offered by higher education institutions is aligned to the key theories mentioned in the research and the programs focus on real world learning and future skills demanded as listed below.

(1) Holistic and Connected Knowledge: Interdisciplinary study involves integrating knowledge from various related and unrelated disciplines. By connecting concepts across various subjects, students gain a holistic understanding of complex issues.

(2) Critical and Creative Thinking: Interdisciplinary

learning encourages critical and creative thinking in problem solving. When students from various disciplines come together to analyze problems, they derive a diverse view of issues and solutions. This collaboration fosters creativity and problem-solving abilities and develops their cognitive ability and flexibility in developing creative solutions to resolve real-world challenges.

(3) Transferable Skills: Interdisciplinary study addresses students' differences and helps develop transferable skills like multi-cultural skills, communication skills, and data analysis. These skills are essential throughout life, both personally and professionally.

(4) Holistic Worldview: By exploring diverse topics, students gain a broader perspective on the world. They learn to appreciate cultural differences, historical contexts, and interconnectedness among disciplines.

Through synthesizing the key theories and good practices of interdisciplinary programs, an interdisciplinary curriculum design framework was conceived as illustrated in Figure 1.
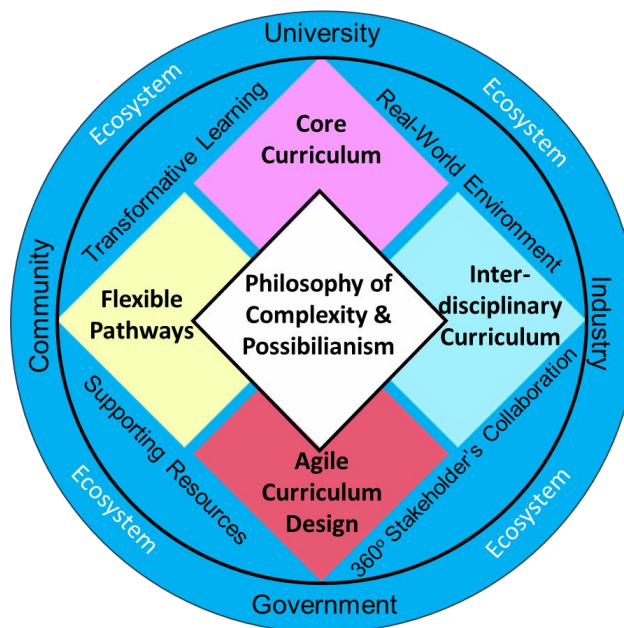

Figure 1 Interdisciplinary curriculum design framework.

The framework reflects the evolving landscape of education in the modern world and espouses the philosophy of complexity of the real world and possibilianism of interdisciplinary education. By integrating knowledge from diverse fields, students are trained to think critically, work collaboratively, and address the complexities of contemporary life where challenges often transcend beyond a single discipline.

The interdisciplinary curriculum design framework encapsulates the collaborative network of the university with the industry, government and community. The interdisciplinary program consists of core curriculum (i.e. Major) and interdisciplinary curriculum which is a related or unrelated discipline to the core curriculum. The curriculum design process should be agile in responding to the changes needs of the ecosystem and based on the principles of flexibility and empowerment that allow students to customize their curriculum based on their aspirations as well as in fulfilling the institutional ambitions, stakeholders' needs and contextual factors. A cafeteria approach to curriculum design would allow students to choose courses from baskets of different course categories. The courses in each course category are like the dishes on the menu of a cafeteria that can be changed very quickly to meet the changing tastes and preferences of the consumers (i.e. stakeholders). The cafeteria

approach to curriculum design is non-linear, agile and can respond to the changing needs of the ecosystem rapidly without compromising the quality of education. It overcomes the limitation of the traditional curriculum design approach, which is rigid, linear, and unresponsive in responding to the needs of the labor markets and employability skills of the graduates.

The curriculum design should consider various pathways to cater to diverse needs of the varied students. Pathways may include but are not limited to recognition of prior learning, micro-credentials, double majors, major-minor, joint-degree, dual degree and concurrent degree.

The interdisciplinary curriculum offers experiential education by integrating transformative learning and real-world environment to bridge formal learning with real-life experience. Experiential approaches may include but are not limited to real-world projects, capstone projects, action research, interdisciplinary research, internships, on-the-job training etc. The interdisciplinary curriculum should involve 360o stakeholder's collaboration from diverse students, faculty, alumni, industry, government, NGOs, the community and fully supported with resources to facilitate effective implementation such as interdisciplinary center/institute, innovation and entrepreneurship pipelines such as incubation, test bed, marker space, social innovation lab, start-up ecosystem etc.

5 Conclusion and Considerations

The research presents a systematic review of interdisciplinary programs and practices, which can serve as potential sources for other empirical studies relating to this field. The literature review shows that interdisciplinary curricula foster students' lifelong learning skills and increase their abilities to solve complex problems in the real world, which is very important for the future job of each graduate. Klein (2006) and Repko and Szostak (2021) stated that

interdisciplinary education equips students to synthesize knowledge across domains, which is crucial for their personal and professional lives [7,8]. Experiential learning opportunities are considered one of the good teaching methods to help students transform their learning and apply interdisciplinary knowledge to real-world scenarios; this also helps to enhance their preparedness for complex, multi-faceted problems in the workforce.

Based on the analysis of the relevant publications and good practices from different international universities and programs, a framework is developed that could be considered a suitable source, encouraging others to explore the field of interdisciplinary curriculum teaching and learning. The interdisciplinary curriculum design framework should integrate knowledge from diverse fields, pay attention to the collaborative network of the university with the industry, government, and community, respond to the changes and needs of the ecosystem, and based on the principles of flexibility, stakeholders feedback, cater to diverse needs, and more critically being supported with resources to facilitate effective implementation such as interdisciplinary center/institute, innovation, and entrepreneurship. Some challenges that relate to the development and implementation of the interdisciplinary curriculum could be the shortage of resources such as disciplines experts, institutional changes, budgets for interdisciplinary initiatives, and new models for stakeholder collaboration [10,11,13]. According to Vietnamese education experts, in the technology era, and the digital economy, the "single – disciplinary" curriculum or training at universities will gradually be replaced by multidisciplinary and interdisciplinary [53]. Training in interdisciplinary or multidisciplinary will equip learners with more specialized, and inter-field knowledge and comprehensive professional skills, helping them quickly adapt to the rapid changes in the labor market [54]. At present, many universities have applied

interdisciplinary majors, such as Digital Business and Artificial Intelligence, Applied Mathematics in Economics, Management, and Finance. However, there is a strong need to rearrange and invest more on the lecturer's quality, the infracstructure and facilities, resources in curriculum revision and development.

In conclusion, interdisciplinary curriculum is a significant trend and a good choice in this uncertain era because of the rapid pace of innovation and the changing nature of the job market in the disruptive world, particular in Vietnam higher education context. It can be implemented in various ways to suit the institution's needs and contexts. An authentic, interdisciplinary curriculum incorporating the real-world context is critical in enhancing students' competencies, learning and experience and in preparing them to be future-ready. The good practices of universities and institutions in Indonesia, Singapore, Thailand and the United Kingdom have proven that interdisciplinary curriculum education can spark students' imagination, improve their skills, and enhance their adaptive capabilities in the constantly changing globalized and digitized world and to prepare them well for a dynamic, disruptive world of today and the future.

Acknowledgements

Conflicts of Interest
The authors declare no conflicts of interest.

Author Contributions
Conceptualization: N.T.M.N.; Data curation: N.T.M.N.; Formal analysis: J.O.C.B.; Methodology: J.O.C.B.; Writing–original draft: N.T.M.N.; Writing–review and editing: N.T.M.N.

Ethics Approval and Consent to Participate
No ethical approval was required for this article.

Funding

Availability of Data and Materials
The data presented in this study are available on request from the corresponding author.

Supplementary Materials
The following supporting information can be downloaded at: https://ojs.exploverpub.com/index .php/jerr/article/view/290/sup. Table S1: Comparative of key interdisciplinary curriculum framework/approach.

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