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Construction and Effectiveness Analysis of a Virtual YouTuber Innovation and Entrepreneurship Course Based on Effectuation Theory*

This study developed a "Virtual YouTuber (VTuber) Innovation and Entrepreneurship Course" based on Effectuation Theory, aiming to improve the entrepreneurial ability and VTuber skills of students in technical universities. Through experimental teaching and Fuzzy Delphi analysis of expert focus groups, this study not only verified the effectiveness of this course in practical operations but also proposed specific directions for course optimization. The results show that the course has significant effects on improving students' entrepreneurship, teamwork, and VTuber role design capabilities, especially in the effect theory application to the entrepreneurial process. Additionally, this study uses Importance-Performance Analysis to clearly indicate that priority should be given to strengthening entrepreneurial knowledge, content design, and personal brand building and provides specific suggestions for course design. This study's contribution is to combine effect theory with the VTuber industry and innovatively design a set of educational courses that can provide entrepreneurial abilities, which has significant reference value for educational practice in related fields.

1. INTRODUCTION

In the post-pandemic era, alterations in economic conditions increased uncertainty in international competition, and shifts in global demographics and lifestyle habits have posed new challenges to the development, upgrade, and innovation of global industries. Governments worldwide consider promoting industrial innovation and transformation as a top priority, emphasizing efforts in various aspects such as infrastructure, technological innovation, production networks, education, and workforce training [1]. This finding highlights the fact that entrepreneurship and innovation are crucial strategies for driving new economic dynamics, upgrading core industries, and enhancing competition.

Internationally, entrepreneurial education has become a primary educational philosophy for enhancing the knowledge economy [2]. According to the StartupBlink's "2022 Global Startup Ecosystem Report," 257 out of 1,000 global startup ecosystem cities are located in the United States, with over 1,600 universities offering more than 2,200 entrepreneurship courses and having 277 related startup coaching positions [3]. The 2018 Global University Entrepreneurial Spirit Student Survey report indicated that 9% of students aspire to work in their own companies after graduation, and 34.7% wish to start their own ventures within 5 years of graduation [4], indicating that entrepreneurship has become an essential career choice for students' future development [2].

Entrepreneurship is a long-term process that is full of challenges, risks, resource scarcity, unclear goals, and high uncertainty. Numerous studies suggest that entrepreneurs may find it challenging to make decisions based on rational behavior [5-8]. In response to

these challenges, Sarasvathy [9] conducted a study investigating how 27 entrepreneurs made decisions and solved problems when facing the top 10 entrepreneurial challenges. This study's findings present an entrepreneurial decision-making model that differs from the traditional causation model known as Effectuation Theory (ET). In contrast to causation logic, ET is a reasoning model based on control logic. Unlike causation logic, which emphasizes predictive logic, ET requires entrepreneurs to develop potential opportunities based on existing resources and conditions to achieve the desired outcomes [10, 11]. Incorporating ET as the foundation of entrepreneurial education can provide students with practical learning experiences, foster innovative thinking and a practical mindset, and inspire an entrepreneurial spirit. This teaching model not only offers opportunities for reflective learning, but also enables students to cope better with complex and uncertain entrepreneurial environments. Therefore, integrating ET into the development of entrepreneurial education programs not only provides a new perspective on learning but also stimulates students to cultivate entrepreneurial skills.

In recent years, emerging industries have risen in the metaverse era with the rapid development of Internet technology. This not only provides fast, convenient, and cost-effective information and communication channels but also integrates social, entertainment, and business aspects. This integration includes social domains combining "virtual avatars" and "knowledge payment," entertainment domains merging "live platforms" and "audiovisual marketing," and business domains combining "virtual-real integration" and "mobile payments" [12]. Metaverse applications are not limited to social interactions but have expanded to interdisciplinary integration in areas such as healthcare, entertainment, e-commerce, physical retail, and education, representing business opportunities in the metaverse economy [13]. According to Quadintel's current global metaverse market report, this market was valued at approximately $38.88 billion in 2021, with an expected growth rate of over 39.5% from 2022 to 2028. VTuber programs have become crucial social media platforms for youths to gather information, gain related knowledge, and share their experiences.

This study's method is highly innovative and is mainly reflected in the embedding of ET into the design and implementation of VTuber's innovation and entrepreneurship courses. Traditional entrepreneurship education courses rely primarily on causal reasoning to achieve specific entrepreneurial goals through prediction and planning. However, this method cannot cope with ever-changing market demands in a highly uncertain entrepreneurial environment. In contrast, this study introduces ET to encourage students to innovate through existing resources and flexibly respond to market uncertainty, which provides a new thinking framework for entrepreneurship education.

In light of this, this study aims to develop a "VTuber Innovation and Entrepreneurship Course," utilizing ET for instructional design. Thus, we emphasize on integrating emerging technologies into this course, providing hands-on practice and innovative entrepreneurship exercises for university students majoring in technology. Through this course design, we aim to further enhance the VTuber Innovation and Entrepreneurship Course and the "Effectuation-based Innovation Entrepreneurship Instructional Model" to cultivate interdisciplinary talents in the VTuber innovation entrepreneurship industry.

2. LITERATURE REVIEW

2.1 Entrepreneurship Education

Entrepreneurship education aims to cultivate students' entrepreneurial identity, self-awareness, and reflection through the practical experiences of entrepreneurs [14]. This educational approach aims to provide students with practical work and on-site operational experiences, facilitating the development of the psychological qualities and personality traits required for adapting to cultural, economic, and social development. It also aims to nurture entrepreneurial abilities such as entrepreneurial cognition, problem analysis, problem-solving, social communication, teamwork, innovation, opportunity identification, and opportunity creation [15]. Hence, the objective is to equip students with the qualities, skills, professional knowledge, and attitudes necessary to become entrepreneurs and meet the talent requirements of future industries. Furthermore, entrepreneurship education aims to foster students' entrepreneurial traits, skills, professional knowledge, and attitudes, a notion supported by various studies [16-19]. The role of higher education is to provide teaching methods and cultivation processes related to entrepreneurial attitudes and skills, encourage students to develop entrepreneurial concepts and ideas, ignite their entrepreneurial spirit, and ultimately develop entrepreneurial intentions. Numerous studies indicate that entrepreneurship education enhances students' entrepreneurial knowledge, skills, and attitudes, strengthening their professionalism, confidence, and execution, and thereby positively influencing entrepreneurial intentions [20, 21].

2.2 Effectuation Theory

Proposed by Sarasvathy [9], ET is primarily applied to highly uncertain environments to enhance decision-making models that increase entrepreneurial success rates. In contrast to traditional causation reasoning, this theory emphasizes dependence on the situation in entrepreneurial decision-making. Under uncertain conditions, entrepreneurs must navigate changes in consumer needs, preferences, and the dynamic business environment, all of which contribute to increased business risk. Consequently, entrepreneurs face information gaps and cognitive limitations, making it challenging to determine the final outcomes of entrepreneurial decision-making. The decision-making model of effectuation can be considered a method for coping with uncertainty, aiding in elevating entrepreneurs' success rates in complex environments [22].

Sarasvathy's [9, 23] research identified three critical "means" that most entrepreneurs utilize during effectuation, namely, analyzing (1) "Who I am," (2) "What I know," and (3) "Whom I know." As shown in Figure 1, entrepreneurs must first examine the means available to them, including personality traits, experiences, abilities, knowledge reserves, and social relationship networks. Subsequently, they consider the risks or losses they can bear and the utilization of their limited resources. Furthermore, new means and goals can be generated by forging strategic alliances, seeking resource collaboration, and fulfilling commitments to reduce uncertainty, leading to a continuous expansion cycle. Finally, entrepreneurs must handle unforeseen events during the entrepreneurial process and explore various potential paths to successful entrepreneurship [11].

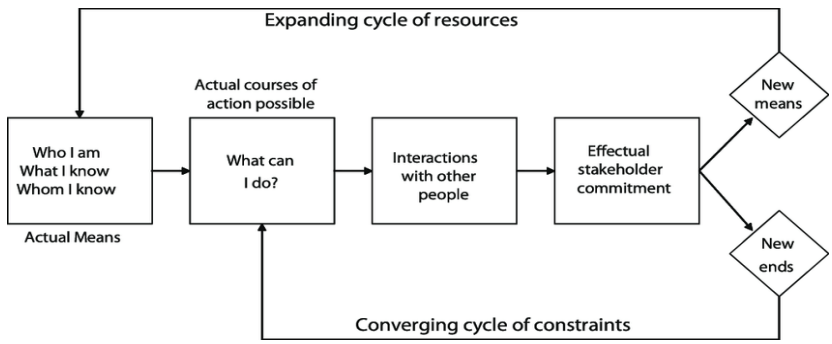

Fig. 1. Effectual process [23]

In summary, this study proposes the application of effect-based reasoning theory in entrepreneurship education, emphasizing that entrepreneurs should act based on existing resources rather than predicting the future or cultivating students' innovation and decision-making abilities. Atrup, et al. [17] found that the effectual reasoning theory can significantly improve students' entrepreneurial decision-making ability in uncertain situations, providing strong theoretical support for this study's hypothesis that "the effectual reasoning theory can improve students' entrepreneurial ability."

2.3 VTuber Concept

Virtual YouTuber primarily consists of a "content creator" (real person) and the virtual 2D representation, the "skin." The virtual avatar's appearance was created using 2D or 3D image creation software, with realistic character movements produced using software such as Live2D or Vroid. Facial tracking tools and body motion capture equipment were employed to merge the performance of the content creator with the actions of the VTuber character engaging in interactions with the audience [24]. In essence, VTubers are akin to theme park performers portraying cartoons but have shifted their work to platforms such as YouTube. Through the creation of virtual avatars, VTubers can embody distinctive characters and express authentic personalities without limitations, which is a key factor that contributes to their rapid popularity. As VTubers gain global traction, the VTuber industry has become an important choice for new-generation entrepreneurs [25]. However, becoming a VTuber requires three essential conditions: (1) hardware equipment including high-quality microphones, cameras, computers, and webcams; (2) digital software proficiency including video editing, live streaming, and animation design software; and (3) creative skills encompassing the ability to design 2D or 3D characters. To summarize, becoming a VTuber is a pertinent consideration in entrepreneurship education curriculum planning.

Therefore, this study integrates ET into entrepreneurship education to help students in the VTuber field learn how to respond flexibly to unknown market changes and use partner networks to expand entrepreneurial opportunities. In the design of this course, students will be able to learn VTuber skills (such as character design and live interaction) and apply ET to make entrepreneurial decisions through practical tasks. Thus, a comprehensive course integrating VTuber skills and entrepreneurial theory provides students with real simulation experience and cultivates their entrepreneurial abilities in the digital innovation industry.

3. RESEARCH DESIGN AND METHODS

3.1 Research Design and Participants

Following a thorough analysis of literature and research team meetings, this study formulated the competency index framework for the VTuber Innovation and Entrepreneurship Course based on ET to align with contemporary needs. The "VTuber Innovative Entrepreneurship Course Competency Index Fuzzy Delphi Expert Questionnaire" was developed, and its research framework is illustrated in Figure 2. Subsequently, 12 experts from relevant fields such as innovation entrepreneurship education, VTuber, virtual reality applications, and ET were invited to participate collaboratively, as shown in Table 1. A Fuzzy Delphi expert questionnaire survey was conducted to confirm the importance and feasibility of the course competency index. Accordingly, the importance and feasibility of course capability indicators were confirmed, which can serve as the basis for curriculum development.

We implemented an 18-week experimental teaching program with 38 second-year students from the general education course "Innovation and Entrepreneurship" at a science and technology university to examine their learning performance. We applied the Importance-Performance Analysis (IPA) method to explore course planning and implementation effectiveness, providing a basis for future curriculum optimization and teaching model construction.

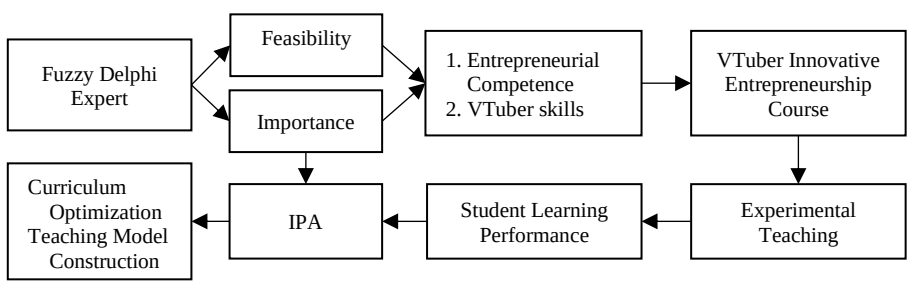

Fig. 2. Research framework (IPA: Importance-Performance Analysis)

Table 1. Overview of Expert Backgrounds.

Expert ID	A	B	C	D	E	F	G	H	I	J	K	L
Title	2	1	1	2	4	6	3	3	3	3	2	1
Years of Experience	15	28	16	18	18	31	13	13	12	12	16	30
Academic Sector	V	V	V	V	V		V	V	V	V	V	V
Industry Sector		V		V	V	V		V	V			
Expertise	4, 5	3, 5	3, 4	1, 2	2, 4	1, 4	1, 5	1, 5	2, 3	2, 4	2, 4	2, 3

Occupation Codes: 1 Professor, 2 Associate Professor, 3 Assistant Professor, 4 Director, 5 Manager, 6 Founder
Expertise: 1_VTuber, 2_Innovation_Entrepreneurship, 3_Curriculum_Design, 4_Marketing_Management, 5_Information_Education

3.2 Research Methods and Tools

The primary research method employed in our study is the "Fuzzy Delphi" approach

to formulate the competency index framework for the VTuber Innovation and Entrepreneurship Course based on ET. Fuzzy Delphi method combines expert questionnaire surveys with focus group interviews to achieve a consensus on issues characterized by uncertainty or complexity [26]. The importance and feasibility of the course competency index were confirmed through expert feedback and discussions.

The self-developed VTuber Innovative Entrepreneurship Course Competency Index Fuzzy Delphi Expert Questionnaire in this study comprises two major constructs: entrepreneurial competence (Cronbach's $\alpha = .789$) and VTuber skills (.763). Each has four sub-constructs: a1-1 entrepreneurial spirit (.816), a1-2 entrepreneurial knowledge (.762), a1-3 application of ET (.797), and a1-4 teamwork (.764); and b2-1 character design (.793), b2-2 content design (.786), b2-3 live-streaming technology (.725), and b2-4 personal brand building (.731)—totaling 28 competency indicators with a total of 107 questions. The questionnaire design considered both professionalism and relevance within the field. Through expert focus group interviews, the Cronbach's α values, indicating the reliability of the questionnaire, were all above 0.7, ensuring high reliability. The questionnaire covered various aspects of the VTuber Innovation and Entrepreneurship Course and, combined with a literature analysis and expert questionnaire results, served as a reference for developing instructional models, course content, competency indicators, teaching activities, and other aspects of the curriculum.

4. RESULTS

Based on this study's design and methods, a Fuzzy Delphi method expert questionnaire survey was conducted to construct the capability indicators, course content, teaching activity design, and analysis results of the "VTuber Innovation and Entrepreneurship" experimental teaching course at a science and technology university. The details are described below:

4.1 Analysis of Fuzzy Delphi Expert Questionnaire Survey

This study assessed the importance and feasibility of competency indicators for the VTuber Innovation and Entrepreneurship Course through a Fuzzy Delphi expert questionnaire survey. The subjective value judgments of the 12 expert scholars are presented in Table 2. As shown in the table, regarding importance, the overall construct of entrepreneurial competence (9.75) was rated higher than VTuber skills (8.63). Within the subconstructs of entrepreneurial competence, teamwork (a1-4) was rated as the most important (9.63), followed by entrepreneurial knowledge (a1-2, 9.50), application of ET (a1-3, 9.25), and entrepreneurial spirit (a1-1, 9.13). Among the subconstructs of VTuber skills, personal brand building (b2-4, 9.38) was rated the most important, followed by content design (b2-2, 9.25), live-streaming technology (b2-3, 9.13), and character design (b2-1, 8.50).

Regarding feasibility, the overall construct of entrepreneurial competence (9.69) was considered more feasible than VTuber skills (9.40). Among the sub-constructs of entrepreneurial competence, teamwork (a1-4, 9.80) was rated as the most feasible, followed by entrepreneurial spirit (a1-1, 9.70), application of ET (a1-3, 9.63), and entrepreneurial knowledge (a1-2, 9.61). Among the subconstructs of VTuber skills, live-

streaming technology (b2-3, 9.67) was considered the most feasible, followed by personal brand building (b2-4, 9.61), content design (b2-2, 9.51), and character design (b2-1, 8.81).

Table 2. Analysis Table of Fuzzy Delphi Expert Questionnaire.

Construct	Importance / Ranking		Feasibility / Ranking		Capability Indicators
a1. Entrepreneurial competence	**9.75**	**1**	**9.69**	**1**	-
a1-1 Entrepreneurial spirit	9.13	4	9.70	2	1-1-1 Innovation, 1-1-2 Risk-taking, 1-1-3 Anticipatory, 1-1-4 Autonomy, 1-1-5 Competitive Aggressiveness
a1-2 Entrepreneurial knowledge	9.50	2	9.61	4	1-2-1 Industry Trends and Market Analysis, 1-2-2 Opportunity Identification and Evaluation, 1-2-3 Goal Setting, 1-2-4 Business Operation
a1-3 Application of effectuation theory	9.25	3	9.63	3	1-3-1 Who I am, 1-3-2 What I know, 1-3-3 Who I know, 1-3-4 Uncertainty Decision-Making
a1-4 Teamwork	9.63	1	9.80	1	1-4-1 Communication and Coordination Skills, 1-4-2 Task Assignment and Problem Solving, 1-4-3 Partner Selection, 1-4-4 Partner Maintenance
b2. VTuber skills	**8.63**	**2**	**9.40**	**2**	-
b2-1 Character design	8.50	4	8.81	4	2-1-1 Character Creation, 2-1-2 Rigging for Characters, 2-1-3 Animation Techniques, 2-1-4 Release Formats
b2-2 Content design	9.25	2	9.51	3	2-2-1 Content Creation, 2-2-2 Audiovisual Production
b2-3 Live-streaming technology	9.13	3	9.67	1	2-3-1 Performing Skills, 2-3-2 Live Interaction
b2-4 Personal brand building	9.38	1	9.61	2	2-4-1 Brand Positioning, 2-4-2 Visual Image, 2-4-3 Self-Marketing

4.2 Integration of ET into VTuber Innovation and Entrepreneurship Course Design

Based on the analysis of the expert questionnaire results, this study serves as the foundation for the instructional content of the VTuber Innovation and Entrepreneurship Course and the design of thematic activities related to “VTuber Entrepreneurship,” as outlined in Table 3. Emphasis is placed on the interactive integrated learning of practical entrepreneurial experience and innovative entrepreneurship courses, aiming to provide students with practical VTuber entrepreneurship experience, construct innovative entrepreneurial knowledge, and cultivate an entrepreneurial spirit. The weekly units of the course are as follows:

(A) Introduction to Innovative Entrepreneurship Course (Week 1)

Explain the teaching objectives, course requirements, and assessment methods of the VTuber Innovation and Entrepreneurship Course. Publicly recruit interested students, have them sign an informed consent form, conduct a pre-course test, and assess their prior

knowledge and starting conditions.

(B) Course Unit Instruction (Weeks 2–17)

Design and implement an innovative entrepreneurship course based on ET. Encourage students to develop active learning abilities, allowing them to autonomously choose entrepreneurial instructional video courses for learning. Guide and assist students in learning, plan teaching materials, provide feedback, and conduct unit course learning, group discussions, and sharing activities. Activity design includes "Who I am? What do I know? Who do I know?" and the "5 Principles of Uncertainty Decision-Making."

(C) Midterm Project Report (Week 9)

Implement midterm project reports based on the progress of entrepreneurial teams involving VTuber entrepreneurship business models. Understand the learning progress and execution status of student entrepreneurial teams, and serve as a basis for course adjustment and improvement.

(D) Final Presentation of Results (Week 18)

Hold the "VTuber Entrepreneurship Final Presentation," providing a platform for students to showcase and exchange ideas. Student teams complete the VTuber entrepreneurship projects, conduct online releases, and present final reports and results through presentations. Additionally, encourage student teams to participate in the "2024 Metaverse Virtual Internet Celebrity Creation and Design Competition" [27]. Conduct post-course assessments to understand the impact of the VTuber Innovation and Entrepreneurship Course under ET on students' learning outcomes.

Table 3. The VTuber Innovation and Entrepreneurship Course Outline and Activity Planning.

Week	Outline	Implementation Emphasis of Effectuation Theory in the Course
1	Introduction to the VTuber Innovation and Entrepreneurship Course VTuber Introduction, Current Trends, and Hardware/Software Equipment	Self-Utilization of Resources Expansion Loop Who I am: Examine personality, interests, and abilities What I know: Examine self-skills, knowledge, and experiences Who I know: Examine personal social relationships and professional networks
2	VTuber Entrepreneurial Self-assessment Virtual Character Construction Techniques Tutorial (2D, 3D)	
3	VTuber Entrepreneurial Team Creative Ideation Virtual Character Costume Design and Material Collection	
4	Creative Tools in Innovative VTuber Character Design Virtual Character Hairstyle Design and Accessory Physics Adjustment	Uncertainty Decision-Making Ability (1) Principle of a Bird in Hand: Start with what you have (2) Principle of Bearable Loss: Set acceptable losses (3) Lemonade Principle: Use emergency measures (4) Crazy Blanket Principle: Build partnerships (5) Pilot in the Plane Principle: Control the controllable
5	VTuber Entrepreneurial Opportunity Identification Introduction to Virtual Character Construction Software Environment and Features	
6	VTuber Entrepreneurial Business Plan Writing Virtual Character Pose Calculation and Export, Platform Integration	
7	VTuber Virtual Character Acceptance Tutorial on Dynamic Capture System Operation	

8	VTuber Entrepreneurial Concept Proposal Integration of Character Platform Actions and Animations	Self-Reflection to Find New Means and Generate New Goals Team Utilization of Resources Expansion Loop Who I am: Examine team material resources What I know: Examine team human resources Who I know: Examine team organizational resources
9	Mid-term Project Presentation	
10	VTuber Entrepreneurial Practice: Prototype Tutorial on Virtual Anchor Program Planning	
11	Lean Entrepreneurship for VTubers Student Motion Capture Practical Production	
12	VTuber Work Online Release (1st Time) Collect Feedback and Revise	
13	VTuber Entrepreneurial Marketing Plan Advancement in Virtual Anchor Program Planning	Uncertainty Decision-Making Ability (1) Principle of a Bird in Hand: Start with what you have (2) Principle of Bearable Loss: Set acceptable losses (3) Lemonade Principle: Use emergency measures (4) Crazy Blanket Principle: Build partnerships (5) Pilot in the Plane Principle: Control the controllable
14		
15	VTuber Work Online Release (2nd Time) Collect Feedback and Revise	
16	VTuber Entrepreneurial Financial Management Completion of VTuber Entrepreneurial Work	
17		
18	Final Presentation Event	Self-Reflection to Find New Means and Generate New Goals

4.3. Analysis of Student Learning Effectiveness in the VTuber Innovation and Entrepreneurship Course

This study conducted a one-sample t-test analysis of the learning effectiveness of "Entrepreneurial Competence and VTuber Skills" among the 38 students participating in the VTuber Innovation and Entrepreneurship Course (Table 4). The findings are as follows:

(A) Learning Effectiveness in Entrepreneurial Competence

The average score for the entrepreneurial skills dimension was 3.59 (standard deviation = .756), with a t-value of 4.807. Each subscale indicates a significant positive difference. This finding suggests that most of the students positively affirmed the effectiveness of learning entrepreneurial skills.

Further analysis of the individual subdimensions indicated that the highest score belonged to a1-3, with a t-value of 5.542. The top three scores were a1-4 (t-value = 4.997), a1-1 (t-value = 4.187), and a1-2 (t-value = 3.952).

(B) Learning Effectiveness in VTuber Skills

The average score for the VTuber skills dimension was 3.58 (standard deviation = .770), with a t-value of 4.661. Each sub-dimension demonstrated a significant positive difference. This finding suggests that most students positively affirmed the learning effectiveness of VTuber skills.

A deeper exploration of the sub-dimensions indicated that the highest score was b2-1, with a t-value of 4.989. The top three scores were b2-2 (t-value = 4.558), b2-3 (t-value = 4.246), and b2-4 (t-value = 4.072).

Table 4. One-Sample T-Test Analysis of Student Learning Effectiveness.

Dimension	Average	Standard deviation	t	Rank
a1 Entrepreneurial competence	**3.59**	**.756**	**4.807*** **	**-**
a1-1 Entrepreneurial spirit	3.60	.881	4.187***	3
a1-2 Entrepreneurial knowledge	3.50	.775	3.952***	4
a1-3 Application of effectuation theory	3.64	.717	5.542***	1
a1-4 Teamwork	3.62	.761	4.997***	2
b1 VTuber skills	**3.58**	**.770**	**4.661*** **	**-**
b2-1 Character design	3.60	.735	4.989***	1
b2-2 Content design	3.57	.771	4.558***	2
b2-3 Live-streaming technology	3.58	.847	4.246***	3
b2-4 Personal brand building	3.58	.876	4.072***	4

4.4 IPA of the VTuber Innovation and Entrepreneurship Course

This study conducted an IPA on the importance of expert questionnaires and student learning effectiveness related to VTuber Innovation and Entrepreneurship Course to verify the effectiveness of its implementation. The details are presented in Table 5 and Figure 3 and explained below.

(A) First Quadrant (Relatively High Importance, Good Student Performance)

The sub-dimensions in the first quadrant included a1-4 and a1-3, indicating that most experts suggest teamwork plays a crucial role in the entrepreneurial process by affecting the overall efficiency and innovation capabilities of teams. ET emphasizes making entrepreneurial decisions in uncertain environments, which is highly relevant to VTuber entrepreneurship. This aspect is a significant consideration in the planning of VTuber innovation and entrepreneurship courses. After the experimental teaching, we observed that most students enhanced their collaborative operational skills through group collaborations and team discussions during the course, leading to a deeper understanding of team operations. Moreover, students learned to respond flexibly to challenging situations with limited resources and used ET for entrepreneurial planning and decision-making. These are the essential items and main features of the VTuber Innovation and Entrepreneurship Course.

(B) Second Quadrant (Relatively High Importance, Relatively Low Student Performance)

The second quadrant comprises sub-dimensions such as a1-2, b2-2, and b2-4. The findings indicated that most experts suggested that entrepreneurial knowledge, content design for VTubers, and personal brand building were essential in the VTuber Innovation and Entrepreneurship Course. Entrepreneurial knowledge served as a foundational capability in the entrepreneurial process. Content design was crucial for creative ideas, story arrangement, and visual design of VTubers. Additionally, personal brand building was critical to VTuber's success and was an essential consideration in course planning.

However, after the experimental teaching, we noticed that most students exhibited relatively poor performance regarding learning effectiveness in the abovementioned sub-dimensions. Therefore, courses must be strengthened to provide fundamental entrepreneurial knowledge and skills. This would provide more practical opportunities and specific guidance for VTuber content design, and prioritize training in brand management

and marketing strategies in course planning.

(C) Third Quadrant (Relatively Low Importance, Poor Student Performance)

In the third quadrant, sub-dimension b2-3 indicates that most experts suggested that the importance of VTuber live-streaming technology was relatively low; most students' performance in this area was also relatively low. Overall, during the students' learning in the VTuber Innovation and Entrepreneurship Course, the demand for VTuber live-streaming technology, hardware, and software equipment was relatively high; however, this was not an essential factor for this course. The key focus was providing students with a VTuber entrepreneurship experience that differs from traditional entrepreneurship.

(D) Fourth Quadrant (Relatively Low Importance, Relatively Good Student Performance)

In the fourth quadrant, sub-dimensions a1-1 and b2-1 indicate that most experts considered cultivating an entrepreneurial spirit and VTuber character design to have relatively low importance in the VTuber Innovation and Entrepreneurship Course. However, after the experimental teaching, we observed that most students displayed relatively high learning effectiveness in cultivating an entrepreneurial spirit and VTuber character design, indicating that the course design and teaching effectiveness in these areas were significant. In the context of limited teaching resources, this finding serves as a direction for future resource redistribution and integrated applications.

Table 5. Importance-Performance Analysis Summary.

Dimension	Sub-dimension	Importance		Performance	
		Score	Z	Score	Z
a1 Entrepreneurial competence	a1-1 Entrepreneurial spirit	9.13	−0.351	3.60	0.330
	a1-2 Entrepreneurial knowledge	9.50	0.468	3.50	−2.067
	a1-3 Application of effectuation theory	9.25	−0.644	3.64	1.288
	a1-4 Teamwork	9.63	1.581	3.62	0.809
b1 VTuber skills	b2-1 Character design	8.50	−1.874	3.60	0.330
	b2-2 Content design	9.25	0.234	3.57	−0.389
	b2-3 Live-streaming technology	9.13	0.234	3.58	−0.150
	b2-4 Personal brand building	9.38	0.351	3.58	−0.150

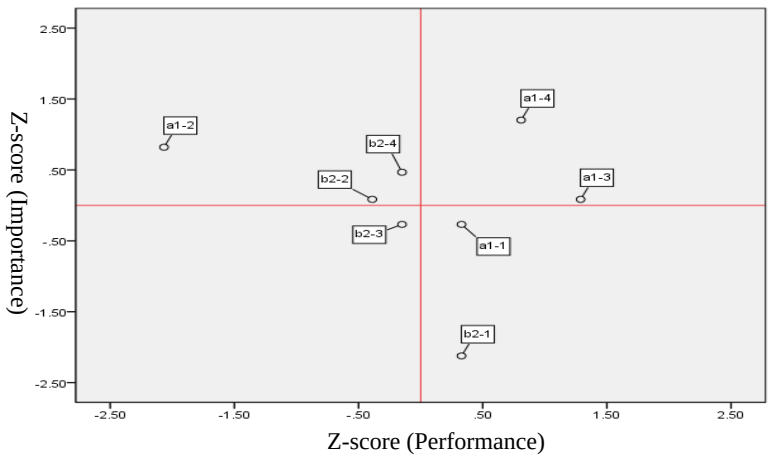

Fig. 3. Importance-Performance Analysis

4.5 Integrated ET in VTuber Innovative Entrepreneurship Education Model

We initially conducted a content analysis of university-level innovation and entrepreneurship and VTuber-related courses. Based on ET, the VTuber Innovation and Entrepreneurship Course was formulated, resulting in the conceptual diagram of entrepreneurial competence development, as depicted in Figure 4 (dashed lines). Unlike traditional entrepreneurship education, this course not only covers essential subject matter but also requires students to self-reflect on existing means, including "Who I am," "What do I know," and "Who do I know" as existing resources. Subsequently, students are encouraged to actively engage in VTuber entrepreneurial practices, iteratively adjusting entrepreneurial goals based on the principles of effectuation, such as "starting with what you have," "setting affordable losses," "leveraging contingencies," "building partnerships," and "controlling the controllable." Through repetitive self-reflection and experiential feedback from VTuber entrepreneurial practices, the course provides students with autonomous, proactive, and continuous support to acquire innovative knowledge and skills.

In comparison, the design of traditional entrepreneurship education, as illustrated in Figure 4 (solid lines), primarily focuses on enhancing students' entrepreneurial attitudes, competencies, and social skills. This includes cultivating students' abilities in various aspects, such as entrepreneurial spirit, marketing, economics, finance, accounting, management, global markets, and law. However, from the perspective of causation reasoning, traditional entrepreneurship education provides students with predetermined entrepreneurial goals and a set of predefined means. After undergoing relevant course instruction, students are expected to identify the optimal, fastest, best, most cost-effective, and most efficient choices to achieve their given entrepreneurial goals.

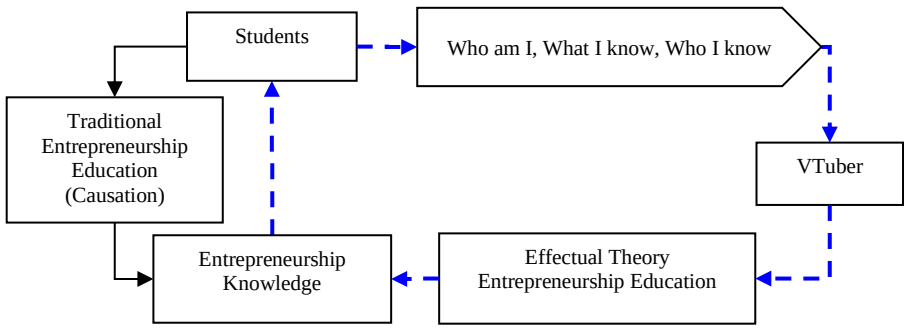

Fig. 4. The conceptual diagram of entrepreneurial competence development

4.6 Recommendations for Implementing the VTuber Innovation and Entrepreneurship Course

This study's findings determine that the VTuber Innovation and Entrepreneurship Course applying ET significantly improves students' entrepreneurial abilities and skills, especially in team collaboration, risk-taking, and content creation. This is consistent with Atrup et al.'s [17, 30] results regarding the application of ET in entrepreneurship education. They reported that effectual reasoning theory can enhance students' entrepreneurial decision-making abilities in uncertain environments. Furthermore, our study determined that students' performance in learning VTuber skills is consistent with Robledo et al.'s [31] research on digital content entrepreneurship, confirming the impact of digital character design and content creation on the entrepreneurial process. Therefore, our study verifies ET and expands the scope of applying these theories to emerging entrepreneurial technologies (such as VTuber).

Building on the VTuber Innovative Entrepreneurship Education Model and course planning, we proposes three major recommendations for instructional implementation. These suggestions are intended for educational institutions and instructors to showcase the course's contribution in meeting the entrepreneurial needs of contemporary university students in the VTuber field.

(A) Effectuation-oriented Entrepreneurial Thinking Cultivation

This course emphasizes the cultivation of entrepreneurial thinking among students in uncertain environments, guiding them to think through the principles of effectuation [11. 28]. Through methods such as case analysis, role-playing, and team discussions, students gain immersive experiences to understand the impact of effectuation on entrepreneurial decision-making. The course aims to make students aware of the uncertainties in the VTuber industry, requiring them to utilize effectuation thinking in business planning with limited resources and to adjust strategies promptly in response to environmental changes [23, 29-31].

(B) Practical-oriented VTuber Entrepreneurial Skill Training

The course strongly emphasizes students' practical operational capabilities, including the creation of VTuber content and multimedia production skills. Concrete examples are provided to develop the technical and professional knowledge that students require in the

VTuber field [24]. Students are guided to use software such as Live2D or Vroid to create life-like motion settings for VTuber characters and engage in actual shooting and production.

(C) Team Collaboration and Partnership Establishment

The course encourages students to engage in team collaborations and highlights the establishment and maintenance of partnerships [29]. By simulating collaboration models in the VTuber industry, students organize themselves into VTuber teams, requiring them to collectively plan and execute content for a VTuber channel. This includes negotiations and consultations with potential partners and fostering communication and collaboration skills.

In summary, by implementing the abovementioned course recommendations, students will not only acquire practical skills related to VTuber but also develop the thinking patterns and teamwork abilities necessary for innovation and entrepreneurship. Additionally, the course's instructional model provides students with a learning experience more closely aligned with real-world job requirements, enhancing their competitiveness and entrepreneurial potential [10, 28].

5. CONCLUSION AND RECOMMENDATIONS

This study combines ET with VTuber entrepreneurial technology to provide a new perspective on entrepreneurship education research. This innovative combination fills the theoretical gap in the application of digital content technology to entrepreneurship education and lays the theoretical foundation for subsequent research. The conclusions and recommendations drawn from the study analysis are summarized below.

5.1 Conclusion

(A) Development of the VTuber Innovation and Entrepreneurship Course based on ET and Competency Indicators

Through a comprehensive literature review, ET was identified as an effective decision-making model for highly uncertain entrepreneurial environments. Building upon this theory, this study innovatively developed the VTuber Innovation and Entrepreneurship Course, encompassing two main constructs: entrepreneurial and VTuber competencies. Each construct consists of four sub-constructs, resulting in 28 competency indicators. The course integrates entrepreneurial knowledge, skills training, and the principles of effectuation. Additionally, it incorporates a VTuber entrepreneurship project to cultivate students' practical skills, entrepreneurial mindsets, and teamwork capabilities.

(B) Emphasis on Entrepreneurial Competency Development in the VTuber Innovation and Entrepreneurship Course

The Fuzzy Delphi expert feedback analysis revealed that the importance and feasibility of the entrepreneurial competency construct in the VTuber Innovation and Entrepreneurship Course were higher than those of VTuber competency. Key indicators, such as entrepreneurial knowledge, application of ET, team collaboration, and personal brand building, emerged as focal points and distinctive features of course design. Moreover,

competency development in VTuber content design was identified as a crucial area requiring prioritized enhancement.

(C) The VTuber Innovation and Entrepreneurship Course Shows Significant Positive Differences in Student Performance

This study utilized experimental teaching to validate the effectiveness of the VTuber Innovation and Entrepreneurship Course. Most of the students demonstrated positive and significant improvements in their learning performance. Regarding entrepreneurial skills, students learned to apply ET to innovative entrepreneurship and employed team collaboration to complete entrepreneurial tasks. Regarding VTuber skills, most students showed great interest in VTuber character design and content creation.

(D) IPA Analysis Provides Specific Recommendations for Optimizing the VTuber Innovation and Entrepreneurship Course

This study employed IPA to identify the strengths and improvement areas of the course, enabling targeted recommendations for enhancement. The IPA results indicate that team collaboration and the application of ET are both essential and highly effective and, thus, should be maintained and strengthened. Entrepreneurial knowledge, content creation, and personal branding were identified as high-importance but low-performance areas that require prioritized improvement. Entrepreneurial spirit and character design performed well, but were of relatively lower importance, suggesting a reassessment of resource allocation. Live-streaming technology was found to have low importance and performance, suggesting a reduction in resource investment. Hence, these findings provide clear directions and specific measures for course optimization.

In summary, the VTuber entrepreneurship course provides an effective entrepreneurship education model for higher education institutions, which can help students acquire practical digital skills during the early entrepreneurship stages. Additionally, business managers can draw inspiration from this study's results and apply ET to the training and management processes of new ventures to improve a team's decision-making ability in the face of uncertainty.

5.2 Recommendations

The results, emphasizing the superiority of entrepreneurial competency regarding importance and feasibility, lead to the following recommendations:

(A) Cultivation of Effectuation-Oriented Entrepreneurial Thinking

Prioritize the development of effectuation-oriented entrepreneurial thinking through case analysis and practical exercises, enabling students to navigate uncertain environments effectively.

(B) Practical-Oriented Training in VTuber Entrepreneurial Skills

Emphasize practical-oriented training in VTuber entrepreneurial skills, including character creation, multimedia production, and hands-on experience. Provide concrete examples to equip students with the necessary technical and professional knowledge of the

VTuber field.

(C) Team Collaboration and Partnership Building

Encourage students to engage in team collaboration and simulate cooperative models within the VTuber industry. Organize students into VTuber teams, which will require them to collectively plan and execute content for a VTuber channel. Emphasize negotiation and communication skills in building and maintaining partnerships.

In summary, the teaching implementation suggestions aim to cultivate students' entrepreneurial thinking, practical skills, and collaborative abilities in the face of uncertainty. At the practical application level, the VTuber entrepreneurship course developed in this study provides students with a platform for transforming their theoretical knowledge into practical entrepreneurial abilities. In future, this course model could be promoted and applied to other digital entrepreneurship fields, thereby promoting the cultivation of more innovative entrepreneurs. Furthermore, the curriculum designed in this study will make entrepreneurship education more attractive to students, potentially attracting more participants. Future research should focus on the ongoing evaluation of the effectiveness of curriculum implementation, so that adjustments can be made.

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