科技部補助專題研究計畫報告

五創教育: from Thinker to Doer-新產品開發與創新課程: 設計、教學、評量(第2年)

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本研究具有政策應用參考價值：■否 □是，建議提供機關
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本研究具影響公共利益之重大發現：□否 □是

中 華 民 國 110 年 10 月 06 日

中 文 摘 要 ： 在競爭激烈的環境中，新產品開發無疑是企業謀求生存發展的關鍵能力，然而卻少有研究針對學生的知識背景，探討及分析在商學院開設新產品開發相關課程所應提供的課程內容究竟為何。因此，本研究擬提出一套結構化的課程設計方法，以協助教師在缺乏前導知識下完成新課程的規劃、評估及施教。首先此方法收集與課程主題相關的期刊論文，並應用潛在語意分析法萃取出研究趨勢，以作為課程之教學內容。其次是依據修正布魯姆分類架構發展問卷，以定義出課程的教學目標。最後在使用修正式德菲法及層級分析法將專家意見導入課程設計中，以釐清各項課程元素之適用性。本研究發現，在商學院開設新產品開發課程之教學內容應包含與創新管理、知識管理、專案管理及風險管理等相關的知識技能，並採用體驗式學習及建構式學習等教學法，可培養學生的高階思考能力及提升學習績效。

中 文 關 鍵 詞 ： 層級分析法，商學院，課程設計，潛在語意分析法、修正式德菲法、新產品開發、修正布魯姆分類架構

英 文 摘 要 ： In a dynamic marketplace, new product development (NPD) is considered the pivot of an organization’s competitive strategy. However, little research has been conducted on the teaching material, pedagogical approach, and learning objective that should be part of a course on NPD. The study introduces a methodology for designing a curriculum with limited prior knowledge. First, latent semantic analysis was applied to extract the main research themes from journal articles on the subject, which are considered potential teaching materials. Next, the modified Delphi method was applied to identify their eligibility as teaching materials. Finally, both a revised Bloom’s taxonomy and analytic hierarchy process were applied to establish learning objectives and determine the priorities in teaching materials and pedagogical approaches, respectively. The paper presents a case study to show that the proposed methodology can induce faculty to consider student requirements, evaluate the feasibility of teaching materials and pedagogical approaches, and develop assessments with concrete learning objectives. Moreover, the study found that the pedagogical approaches of experiential learning and constructivist learning were effective for teaching innovation management, knowledge management, project management, and risk management in courses at business schools related to new product development.

英 文 關 鍵 詞 ： Analytical hierarchy analysis; Business school; Curriculum design; Latent semantic analysis; modified Delphi method; new product development; revised Bloom’s taxonomy.

科技部補助專題研究計畫成果報告

（□期中進度報告/■期末報告）

五創教育: from Thinker to Doer -

新產品開發與創新課程: 設計、教學、評量

計畫類別：■個別型計畫　□整合型計畫
計畫編號：MOST 108-2511-H-003-034-MY2
執行期間：108 年 08 月 01 日至 110 年 10 月 31 日

執行機構及系所：

計畫主持人：吳彥濬
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計畫參與人員：博士後研究員：陳正中

本計畫除繳交成果報告外，另含下列出國報告，共 _0_ 份：
□執行國際合作與移地研究心得報告
□出席國際學術會議心得報告

期末報告處理方式：

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中　華　民　國 110 年 10 月 31 日

一、 計畫中英文摘要

中文摘要： 在競爭激烈的環境中，新產品開發無疑是企業謀求生存發展的關鍵能力，然而卻少有研究針對學生的知識背景，探討及分析在商學院開設新產品開發相關課程所應提供的課程內容究竟為何。因此，本研究擬提出一套結構化的課程設計方法，以協助教師在缺乏前導知識下完成新課程的規劃、評估及施教。首先此方法收集與課程主題相關的期刊論文，並應用潛在語意分析法萃取出研究趨勢，以作為課程之教學內容。其次是依據修正布魯姆分類架構發展問卷，以定義出課程的教學目標。最後在使用修正式德菲法及層級分析法將專家意見導入課程設計中，以釐清各項課程元素之適用性。本研究發現，在商學院開設新產品開發課程之教學內容應包含與創新管理、知識管理、專案管理及風險管理等相關的知識技能，並採用體驗式學習及建構式學習等教學法，可培養學生的高階思考能力及提升學習績效。

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英文摘要： In a dynamic marketplace, new product development (NPD) is considered the pivot of an organization’s competitive strategy. However, little research has been conducted on the teaching material, pedagogical approach, and learning objective that should be part of a course on NPD. The study introduces a methodology for designing a curriculum with limited prior knowledge. First, latent semantic analysis was applied to extract the main research themes from journal articles on the subject, which are considered potential teaching materials. Next, the modified Delphi method was applied to identify their eligibility as teaching materials. Finally, both a revised Bloom’s taxonomy and analytic hierarchy process were applied to establish learning objectives and determine the priorities in teaching materials and pedagogical approaches, respectively. The paper presents a case study to show that the proposed methodology can induce faculties to consider student requirements, evaluate the feasibility of teaching materials and pedagogical approaches, and develop assessments with concrete learning objectives. Moreover, the study found that the pedagogical approaches of experiential learning and constructivist learning were effective for teaching innovation management, knowledge management, project management, and risk management in courses at business schools in new product development.

英文關鍵詞： Analytical hierarchy analysis; Business school; Curriculum design; Latent semantic analysis; modified Delphi method; new product development; revised Bloom’s taxonomy.

二、 計畫內容與成果說明

1. INTRODUCTION

The most crucial aspect of survival in a highly dynamic marketplace is the maintenance of a long-term competitive advantage (Purzer, Fila & Nataraja,2016); thus, enterprises must dedicate the majority of their resources and effort to challenges to that advantage by continuously developing and launching new products and services (Purzer et al., 2016). Consequently, the development of new products includes creating new and innovative ideas and successfully developing new products to launch in the market. Although enterprises face pressure to develop innovative products, the process of new product development (Violante & Vezzetti) is even more challenging Wowak et al. (2016). Statistics show that the NPD failure rate established firms is 40% to 65%, but for startup companies it exceeds 90% (Castellion & Markham, 2013). Scholars estimate that approximately 3,000 original ideas are needed to produce a successful new commercial product (Stevens & Burley, 1997).

In entrepreneurship, the commercialization of business ideas has become both a core issue and a major challenge. Although extant literature has generated a variety of knowledge on NPD, prior work generally takes the perspective of the firm level. Fewer studies have been conducted on the design and delivery of courses on NPD than on other subjects in business/management education, such as marketing, entrepreneurship, and social responsibility (Violante & Vezzetti, 2017). NPD has continuously expanded across various fields, including, but not limited to, innovation, product design, finance, teamwork, manufacturing, and marketing (Victor, 2012). According to a survey on technology management courses conducted by Mallick and Chaudhury (2000), scholars and administrators agree that NPD is essential knowledge and a critical skill. In addition, the majority of current NPD textbooks available fail to meet the current requirements of innovation and practical guidance and therefore do not satisfy business demands (Violante & Vezzetti, 2017). Scholars find it difficult to design a NPD course, which involves the determination of goals, activities, content, delivery systems, and assessment techniques, that is suitable for practical purposes (Victor, 2012).

Universities face a salient challenge in demonstrating to key stakeholders, such as accreditors, employers, and government, that their entrepreneurship education (EE) programs are equipping their graduates with the required level of financial skills, entrepreneurial knowledge, tools, and understanding to contribute meaningfully to firms and society (Bertucio, 2017). To that end, the study aims to address the problem of the design and delivery of NPD courses for business students and needs to consider not only learning requirements and objectives (Modo & Kinchin, 2011) but also the views and concerns of different stakeholders for validating innovation and ensuring

broad public support for its implementation (Bertucio, 2017). The study introduces a methodology that integrates latent semantic analysis (LSA), the modified Delphi method (MDM), a revised Bloom's taxonomy (RBT), and the analytic hierarchy process (AHP) to advance curriculum design for courses in NPD. The main strength of our study is the adoption of a structural methodology to offer a comprehensive approach to curriculum design that enables university programs to consider student requirements, evaluate the feasibility of teaching materials and pedagogical approaches, and develop assessments with concrete learning objectives (Al-Awlaqi, Aamer, and Habtoor, 2018)

2. LITERATURE REVIEW

2.1. New Product Development and Entrepreneurship

As defined by Fixson (2009), NPD has nine stages: ascertaining opportunity, investigating market and users, creating ideas and concepts, refining and choosing conception, designing products, building prototypes, testing, evaluating financial capacity, and introducing marketing. Hence, the NPD process is often viewed as a flow that integrates the various phases from conceiving and transforming new ideas to delivering commercializable products (Smulders, 2011) The life cycle of a consumer product generally encompasses four stages: introduction, growth, maturity, and decline. Theoretically, in the final stage of the life cycle, a product's sales volume will decrease gradually, and the product should be terminated when it becomes unprofitable for the company (Tan & Vicente, 2019). To contend with competitors, companies should bring new products to market with high quality and innovativeness within a short timeframe. It cannot be overemphasized that NPD plays a highly important role in innovation, which is the engine of economic growth (Tan & Vicente, 2019). The pressure to innovate is relentless, and highly innovative companies usually make more profit than less innovative companies (Fixson, 2009). Innovation is a value-added process that evolves through the development of novel products, services, manufacturing procedures, and solutions. However, without entrepreneurial activities that exploit opportunities when they emerge in organizations, innovation remains a little more than enthusiasm, rather than an objective goal (McFadzean et al., 2005).

Entrepreneurship is the foundation of innovation and the driving force behind promoting innovation and competitiveness in response to the globalization and rapid development of technology (McFadzean et al., 2005). Entrepreneurship is an effort to promote innovation in an ambiguous situation. It plays a principal role by challenging extant rules and regulations, evaluating new opportunities, allocating and exploiting resources, and promoting progress in innovation (Tan & Vicente, 2019). Therefore, EE in higher education institutions (HEI) has gained increased interest because fostering entrepreneurship among learners is beneficial in enhancing their knowledge and skills

as well as increasing their intention to become entrepreneurs (Nabi et al., 2017). To promote students' competency in the job market, many engineering schools offer NPD capstone courses as an opportunity to synthesize and apply the knowledge acquired by solving real-world engineering problems (Inamdar & Roldan, 2013). By contrast, business schools often focus on the applications of behavioral sciences, mathematics, and economics to manage the production and distribution of goods and services (Inamdar & Roldan, 2013). Therefore, it would be beneficial to enhance students' competency in devising effective teaching plans for imparting the knowledge and skills needed in the management of innovation (Wang & Wang, 2015). However, business students, the next generation of business managers, have to be equipped with underlying knowledge on NPD other than essential management skills during their business education (Wang & Wang, 2015).

2.2 Entrepreneurship Education and Curriculum Design

The goals underlying the establishment of EE are to foster an entrepreneurial attitude and offer entrepreneurial knowledge and skills to potential entrepreneurs in order to create and enhance their entrepreneurial intention (Sekhar et al., 2017). Although some studies assert that entrepreneurship is innate and cannot be taught, many academic articles argue the opposite. Based on both views, later research shows that entrepreneurship is a skill that can be passed on, and creativity and innovation can be encouraged with a suitable education. This claim is echoed by Al-Awlaqi et al. (2018), who stress that three issues must be considered comprehensively in the development of EE programs, including whether the pedagogies selected are the most effective for engaged students, whether the portfolio of teaching materials is appropriate and prescribed, and whether the assessment approaches align with the learning objectives.

Curriculum designers who want to draw up an appropriate teaching plan can choose from among four major approaches to curriculum design in the context of education: an instrumental approach, a communicative approach, an artistic approach, and a pragmatic approach (Visscher-Voerman & Gustafson, 2004). The instrumental approach strongly emphasizes the systemic process; and the objectives of curriculum design are formulated and clarified through a holistic analysis of education-related factors, such as purpose, experiences, organization, and evaluation (Thijs & Van Den Akker, 2009). The communicative approach highlights the importance of relational strategies and considers stakeholder comments the crucial input of curriculum design (Thijs & Van Den Akker, 2009). Consequently, curriculum design is deemed a social process in which stakeholders have their own perspectives on topics and issues, as well as conducting deliberation and negotiation to reach a consensus. The artistic approach stresses the creativity of the designer and assumes that curriculum design is a subjective process that should be guided by designers' personal views and expertise (Thijs & Van

Den Akker, 2009). Hence, teachers act as pivots of curriculum design because they can anticipate a situation as it happens by seizing moments in which students are engaged or express ideas for further learning, such as raising questions. The pragmatic approach emphasizes intensive interaction with local practice and users to promote the practical usability of a proposed curriculum (Thijs & Van Den Akker, 2009). Initially, the curriculum prototype is drawn up after a literature review and brief consultations and then goes through several rounds of redesign, evaluation, and revision before a full version is produced. Table 1 depicts the characteristics of curriculum design approaches.

Over the past few decades, EE has grown and increased in popularity. The emerging challenge in curriculum design is how to provide adequate pedagogy and teaching material to accommodate the learning needs of most or all the students taking the course (Meng et al., 2020). EE programs generally combine regular and business-adjunct instructors to teach students about market research, venture finance, competitive advantage, and the development of business plans, as well as the management of information systems, finance, and marketing (Boyle, 2007). Because of a lack of clarity about the intended outputs, EE programs have a definitional problem: no consensus has been achieved about the contents of the curriculum (Kirby, 2004). A previous study conducted by Rasiah, Somasundram, and Tee (2019) asserts that EE also lacks a consensus on the pedagogic approach, even though it is the most rapidly growing issue in education globally.

To summarize and cluster all the differences that might arise between the different methods for teaching entrepreneurship, Béchard and Grégoire (2005) proposed a taxonomy that comprises three archetypical teaching models in EE: the supply model, the demand model, and the competence model. The supply model is considered a theoretical-orientation teaching model that highlights the behaviorist paradigm (Nabi et al., 2017) and imparts knowledge and skills through lectures, reading, and watching/listening (Béchard & Grégoire, 2005). The other two models, the demand and competence models, are considered practically oriented teaching models (Béchard & Grégoire, 2005). The demand model accentuates the subjectivist paradigm (Nabi et al., 2017); thus, the pedagogical approach equips students with entrepreneurial knowledge and skills through engagement with exploration, discussion, and experimentation (Béchard & Grégoire, 2005). The competence model is similar to the interactionist theoretical paradigm and emphasizes the active learning approach in EE (Nabi et al., 2017); therefore, it considers that instructors should act as coaches and developers to facilitate individual learning through engagement with group members in seeking solution to current, real, and complex problems (Manimala & Thomas, 2017). However, several studies find empirical evidence that practically oriented teaching models are more effective than theoretical models (Pittaway & Edwards, 2012; Rasiah et al., 2019).

Table 1. Summary of curriculum design approaches

Aspects	Instrumental approach	Communicative approach	Artistic approach	Pragmatic approach
Sequence of activities	- Logical sequence	- No strict sequence	- Completely open process	- Cyclical
Characterization of activities	- Rational process	- Intensive deliberation during part of the process	- Creative reflection during the entire process	- Frequent evaluation with users
Feature of the curriculum	- Meeting predetermined requirements	- Meeting requirements on which a broad consensus exists	- Meeting the designer's requirements	- Meeting user requirements
Advantage	- Simplifies a complex design process with a handful of questions	- Obtains broad social support to implement the intended curriculum	- Provide opportunities for constantly fine-tuning the curriculum	- Increasing ownership and practical usability of the proposed curriculum
Disadvantage	- Processes often lack the flexibility for adjustment.	- The processes can be very time consuming and laborious.	- The scope often focuses on specific context of use.	- Results are often determined by the designer's vision.

Source: Thijs and Van Den Akker (2009)

Currently, the literature has produced extensive knowledge and theories about EE, but lacks a straightforward and flexible method of designing curriculum (Bertucio, 2017). This gap is echoed by Sekhar et al. (2017), who argue that curriculum design is an essential aspect of teaching practice, but novice teachers encounter many difficulties. When university faculties lack the knowledge to analyze elements of the curriculum in a productive way, they might make counterproductive changes or fail to make much-needed modifications to lessons (Beyer & Davis, 2012). This paper fills the gap by providing an effective method of curriculum design, proposing a structural methodology that can help instructors design curriculum even if they have limited prior knowledge.

3. METHODOLOGY

In order for the NPD course to proceed efficiently and rapidly, teaching faculties must address several issues involving teaching material, the pedagogical approach, and assessment (Al-Awlaqi et al., 2018). Additionally, NPD courses are expected to offer multidisciplinary knowledge and to share a common vision and message among teachers in various disciplines. Otherwise, the lack of coherence in teaching makes knowledge that students obtain incomplete and has a negative impact on learning motivation (Modo & Kinchin, 2011). Furthermore, the absence of an appropriate framework and prior knowledge are major causes of adverse effects on curriculum design (Beyer & Davis, 2012).

Therefore, the study applied LSA, the MDM, an RBT, and AHP to devise a comprehensive methodology that induces faculties to consider student requirements and educational purpose and to carefully analyze the feasibility of the potential pedagogical approaches. In this methodology (see Figure 1), textual data was retrieved from journal articles related to NPD, and the major themes in the literature were extracted, for consideration as potential teaching material, by using the LSA method in the first phase. Next, this methodology applied MDM to verify the eligibility of teaching materials and pedagogical approaches in the curriculum design project. Lastly, the RBT framework was used to establish learning objectives, which include guidelines on developing assessments. Furthermore, the AHP was used to determine the priorities in teaching materials and pedagogical approaches. The following subsections describe the proposed methodology in a nutshell.

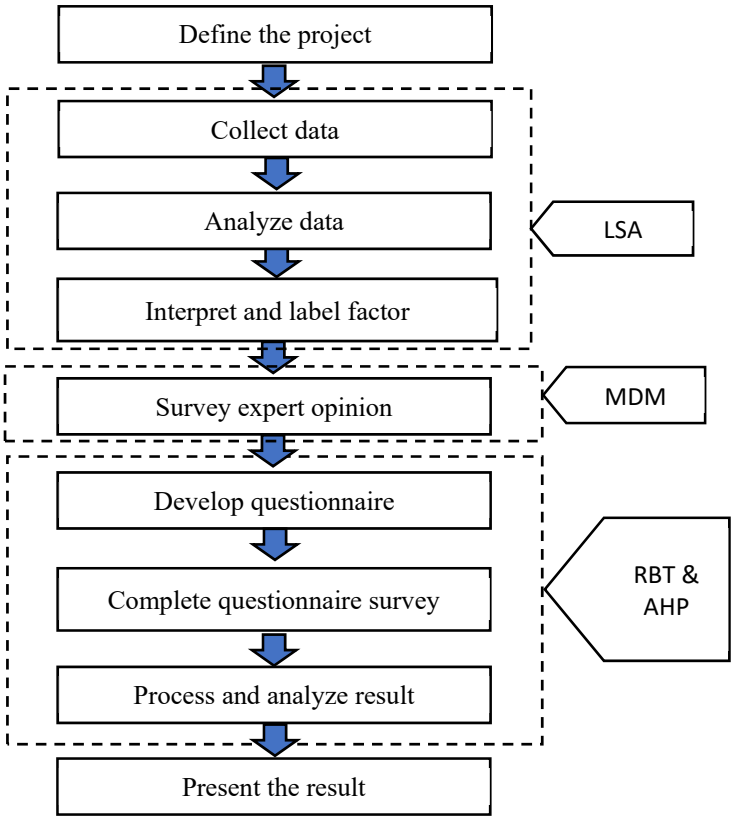


Figure 1. Overview of the proposed methodology.

3.1. Latent Semantic Analysis (LSA)

Text mining in big data analytics is manifesting as a powerful tool for exploiting the power of unstructured textual data by analyzing it to identify significant patterns and elicit new knowledge (Chen, 2019). Latent semantic analysis (LSA), which emerged in the late 1980s, is a prominent method based on theories of mathematics and statistics to extract and represent textual data into a semantic structure (Evangelopoulos et al., 2012). Compared with other semantic models, such as Probabilistic latent

semantic analysis (PLSA) and Latent Dirichlet Allocation (Inamdar & Roldan), it is easier to interpret LSA without prior knowledge of latent topics; thus it is being widely applied in diverse fields (Chen, 2019).

Referring to a previous study, the LSA was initiated with a collection of documents that should comply with the following conditions as far as possible. The collected documents should have a similar writing style, each document should possess only a single topic, and the keyword of a specific topic should be mutually exclusive to each other (Kwon, Kim, & Park, 2017). Thereafter, the latent features of the teaching material were extracted by fulfilling the following steps (Evangelopoulos et al., 2012).

1. Pre-processing: This step involves text cleanup, tokenization, and filtering out low-frequency words to convert raw data into the bag-of-word (BOW), in which the input documents are treated as unordered collections of words.
2. Term frequency matrix transformation and term weighting: In this step, the document set is converted to vectors of term frequency values and exhibited as a term-document matrix (TDM) that presents a co-occurrence matrix of terms and documents. The raw term frequency values are further converted to weighted term vectors and represented as a term frequency-inverse document frequency (TF-IDF) matrix.
3. Singular value decomposition (SVD) and dimensionality reduction: The TF-IDF matrix, denoted as $X_{t\times d}$, is separated into the product of three other matrices: $T_{t\times m}$, a column-orthogonal matrix with m symbolizing dimensionality; $S_{m\times m}$, a diagonal matrix with singular values arranged in decreasing order; $D_{d\times m}$, a transpose of the column-orthogonal matrix, where t indicates the number of terms and d denotes the number of documents (Evangelopoulos et al., 2012).
4. Topic extraction: In this step, the highest "k" singular values are chosen from a diagonal matrix "S" to elicit meaningful latent factors (topics). In general, the number of selected factors depends on the research objectives and is performed by repeating the selection process from two factors and gradually going up to n factors (Kwon et al., 2017). Additionally, the factor rotation is applied on both term loadings (TS) and then on document loadings (SD) to force the term and document loading values to be either very high or very low in furthering the preparation of a cluster of terms and documents for each factor (Evangelopoulos et al., 2012).
5. Topic interpretation: To assist in the interpretation and labeling of latent factors, the tables for each factor solution are generated to contain high-loaded terms and high-loaded documents that are sorted by absolute loadings in descending order. Then, domain experts are invited to interpret and label the factors, and the Delphi method is employed to facilitate attaining the expert consensus (Evangelopoulos et al., 2012).

3.2. Revised Bloom's Taxonomy (RBT)

Bloom's taxonomy was initially proposed by Benjamin Bloom in 1956 for guiding educators to design more appropriate curricula in advancing students' learning performance (Huq & Gilbert, 2017). In the framework, the learning objectives are classified into three domains: affective, psychomotor, and cognitive. The affective domain narrates the interactions between students and teachers who formulate objectives to induce awareness, attitudes, emotions, and feelings. In the psychomotor domain, the learning objectives are identified and categorized about physical manipulation of tools or instruments, and the cognitive domain focuses on the learning outcome of the student's behavior (Anderson et al., 2001).

Although the original Bloom's Taxonomy is a popular framework for formulating teaching plans, it has been criticized for some inherent weaknesses (Anderson et al., 2001). The weakness related to the classification of learning objectives was addressed by Revised Bloom's Taxonomy (RBT), which comprises the dimensions of cognitive process and knowledge. The former is classified into six categories from lower- to higher-order thinking activities, including remembering, understanding, applying, analyzing, evaluating, and creating (Anderson et al., 2001). The category Remembering portrays the capability to recognize or recall relevant knowledge from long-term memory. Understanding describes the capability to classify, interpret, or summarize the meaning of instructional messages. Applying is the capability to implement or execute the known procedure in a given situation. Analyzing encompasses the acts of organizing, differentiating information, and attributing. Evaluating means the acts about making judgments or given information based on criteria. The final category is creating, which means the acts of generating, planning, or producing new information or products.

The other dimension of the RBT framework contains four categories of knowledge arranged from the concrete "factual knowledge" to the abstract "metacognitive knowledge" (Anderson et al., 2001). The first knowledge category is factual knowledge, which refers to the basic elements that students need to know and be well acquainted with the discipline to deal with associated problems. Conceptual knowledge emphasizes the interrelationships among the underlying elements within a larger structure and allows them to work synchronically. Procedural knowledge is concerned with the way things are done and with the criteria to determine the appropriate time to use skills, algorithms, and procedures. The last category of meta-cognitive knowledge corresponds to knowledge regarding cognition itself and understanding one's own cognitive abilities. The RBT is based on enabling the assessment of educational activities, including learning performance, pedagogic strategy, and teaching material, in more detail. Therefore, it has been used to guide curriculum design in various subject

areas, such as business, physical science, social science, and the arts (Anderson et al., 2001).

3.3. Modified Delphi Method (MDM)

The Delphi method was initiated in the early 1960s to attain consensus of opinion among a group of experts through questionnaires and controlled feedback. Subsequently, it was widely applied in diverse fields, for example, program planning, resource utilization, needs assessment, and policy judgment (Vernon & Vernon, 2009). Despite the broad acceptance of the practicality, the Delphi method has some inherent weaknesses, for example, the consensus in forecasting the value requires reiterating surveys that not only waste time but also lead to low cost-effectiveness. The weaknesses were addressed by Mousavi et al. (2013) to propose a more feasible alternative, the MDM. The MDM possesses the essential advantages of the traditional Delphi method, and also efficiently diminishes the effects of bias because of group interaction. However, the following steps can be used to elicit the experts' opinions:

1. Identifying the problem and reviewing relevant literatures;
2. Building an expert panel;
3. Designing the Delphi questionnaire;
4. Delivering the questionnaire on expert opinions;
5. Synthesizing the survey results;
6. Attaining a consensus.

Given that R experts are invited to participate in the round t of a Delphi survey, expert h ranks item j as X_{jht}. The Consensus Deviation Index (CDI) of the survey results are computed with the equation of $CDI_{jt} = S_{jt}/\max_{j}\{\overline{\mathrm{X}}_{jt}\}$, where S_{jt} and $\overline{\mathrm{X}}_{jt}$ are defined as the standard deviation and mean of each item, respectively. Furthermore, a lower CDI reveals that experts' opinions are more likely to reach consensus, and when CDI is zero, which means that expert opinion has attained complete consensus. However, standards for consensus in Delphi research have never been rigorously established. A previous study was referred (Wu & Chen, 2021) to set the threshold for determining consensus dispersion as $\varepsilon \leq 0.3$, which implies that experts' opinion has reached a consensus.

3.4. Analytic Hierarchy Process (AHP)

Based on the characteristics of simplicity, flexibility, and practicality, the AHP technique is widely applied not only to deal with multi-criteria decision-making (MCDM) problems but also in planning and development for various purposes (Suganthi, 2018). In education, the AHP is often combined with the Delphi method to reveal important elements of curriculum design (Suganthi, 2018). Essentially, the AHP

evaluates the priority of the elements considered through a process of pairwise comparison, integrating individual judgments with geometric mean to achieve a unanimous judgment by all participants (Saaty, 2002). The AHP considers the consistency ratio (CR) of survey results as the reliability of the responses; CR≤0.3 implies that the survey result is logically feasible (Saaty, 2002). The essential process in using the AHP method is as follows:

1. Depicting the decision problem.
2. Systematically and carefully considering each element of the decision problem.
3. Differentiating the criteria that affect the decision result.
4. Incorporating all decision elements, including the determined objective, the alternatives for attaining it, and the criteria for evaluating the alternatives, for constructing a hierarchical structure.
5. Assigning priorities to the elements at the corresponding levels by performing a series of judgments with the pairwise comparison method and ranking them numerically.
6. Integrating these judgments to generate a set of global priorities in the hierarchy. Then, calculating the maximum eigenvalue, consistency index, consistency ratio, and normalized values for each criterion.
7. Checking the consistency of the judgments and performing a consequence weight analysis.

4. Empirical Case: Designing a Course in New Product Development (NPD)

To exemplify the application of the proposed methodology, the present study adopted an empirical case of the design and delivery of new product development courses in a Taiwan university, which is often connected with the challenge of compromising the conflicting views from different stakeholders and merging interdisciplinary knowledge (Goldberg, 2012). Currently, there are 16 product-design-related institutes among 14 universities in Taiwan (Ministry of Education, 2020). However, most existing NPD curricula tend to focus on theories and processes, rather than providing systematic methods and resources for the actual commercialization of ideas. This is an important issue that has seriously hindered the development of business management practices resulting in insufficient supply of sought-after talents, as well as a lack of practical methods for enterprises to utilize in business transformation and international competition. The present study, therefore, provides a stepwise depiction of the proposed methodology in promoting the faculties to address this issue in the following subsections.

4.1 Data Collection

In essence, new product development is viewed as a process of continuous integration of large and various disciplinary-bounded knowledge and activities (Smulders, 2011). The required knowledge and skills of new product development are

not well defined to develop the teaching materials for students and assemble the course. Therefore, this study applied bibliometric analysis to elicit the main themes and trends in the literature from published papers on the subject matter, which are deemed as the potential curriculum components of the NPD course.

The study performed a systematic approach to establish a textual dataset (corpus). First, the corpus, including papers published in journals from 2010 to the end of June 2020, were retrieved from the Scopus database, which is one of the most extensive peer-reviewed research repositories in the Social Sciences, by the search queries of "new product development or new product design or new product innovation or new product" and "curriculum design or curriculum development or curriculum approach", which emerged in the article title and/or abstract and/or keyword of research papers. After initial screening, the metadata of 350 documents matched the search strings. After excluding reviews, book chapters, notes, and papers that were repeated or that did not directly deal with the subject of the study, 141 conference papers and 46 research articles were retrieved and exported to SciVal, RIS format (EndNote), and CSV (Excel), respectively, for further processing. As shown in Table 2, the top three sources of collected documents were the Journal of Product Innovation Management (8.1%), International Journal of Innovation Management (2.4%), and Industrial Marketing Management (2.3%). The most prevalent subject areas were business, management, and accounting (46.6%), decision sciences (12.1%), social sciences (10.8%), and economics, econometrics, and finance (7.8%), which is consistent with the focus of the study.

Table 2. Top journals and subject areas in the documents collected

Journal	N (%)	Subject area	N (%)
- *Journal of Product Innovation Management*	184 (8.1)	- Business, management, and accounting	1251 (46.6)
- *International Journal of Innovation Management*	54 (2.4)	- Decision sciences	273 (12.1)
- *Industrial Marketing Management*	52 (2.3)	- Social sciences	243 (10.8)
- *International Journal of Production Research*	46 (2.0)	- Economics, econometrics, and finance	177 (7.8)
- *IEEE Transactions on Engineering Management*	44 (1.9)	- Engineering	175 (7.8)

4.2 Application of LSA to Analyze Textual Data

4.2.1 Analyze Data

After collecting relevant data, the study elicits the potential curriculum components of new product development course by using Latent Semantic Analysis (LSA). However, the original textual dataset is noisy and requires to take a series of

steps for cleaning and pre-processing, which contain normalizing the corpus, removing stop-words, removing low-frequency words, extracting word stemmers, and document matrix transformation.

In this step, the frequency values are converted to weighted term vectors. The study applied the TF-IDF to calculate term weighting, and constructed a matrix of $X_{t\times d}$, and then conducted SVD to decompose such matrix into three different matrices, $T_{t\times m}$ (the term eigenvectors), $S_{m\times m}$ (the diagonal matrix of singular values), and $D_{d\times m}$ (the document eigenvectors).

To extract the latent topics about new product development, both matrix, $T_{t\times m}$ and $S_{m\times m}$, are checked, and also the maximum number of contextual patterns is empirically determined by changing the values of *k*. The study referred previous study (Evangelopoulos et al., 2012) to employ the scree plot in furthering the selection of the appropriate number of dimensions and set k = 4 where the maximum log-likelihood was attained.

Table 3. Topical factors related to new product development

Topic label	Articles	High-loading terms
Knowledge management	42	knowledge, collaborate, innovation, new, manage, product, open, external, share, NPD, transfer, technology, supplier, networks, success
Project management	34	project, new, management, product, plan, infer, information, decision, cost, function, communication, resource, organization, knowledge, limit
Innovation management	31	product, innovation, competitive, manage, knowledge, new, process, development, open, strategy, research, study, market, firm, risk
Risk management	15	uncertain, risk, manage, new, strategy, decision, product, method, knowledge, engineering, evaluate, end, model, QFD, fuzzy

4.2.2 Interpret and Label Topics

The previous step generated four groups of topics with a unique level of prevalence (coherence) rate and fifteen highly loaded terms that denoted the features of the potential teaching materials. Then, we invited three experts (two doctoral-level educators in the entrepreneurship education program and one with graduate background in industrial management) to participate in the study and follow a systematic three-step approach to interpret and label the latent topics independently. The first step was to enter the top four high-loading terms of each group into the EndNote software that already contained the title, abstract, and keywords of the retrieved, relevant literatures. Second, the analysts checked the results of the keyword search and identified the research themes that were considered as the label and the guidance of interpretation of each topic (see Table 3). Third, the analysts inferred the implicit meaning of each topic

according to its label. Referring to a previous study (Kwon et al., 2017), the interpretation process used the high-loading terms to define each topic. Three distinct parts of each term, consisting of nouns, verbs, and adjectives, were displayed and further determined whether they were related either to curriculum or instruction. Terms related to curriculum were deemed as the feature of required knowledge for new product development, whereas the terms about instruction are pedagogies for teaching the required knowledge. Since the components for creating the topics encompass the aforementioned three distinct parts of speech, and the morpho-syntactic feature of term candidates were concatenated to be created as coherent storylines (such as "noun - noun," "noun - verb," "noun - adjective - verb," etc.). When repeatedly interpreting each term corpus, approximately 15 terms were found to be suitable for comprehending the overall picture of the topic for describing one particular teaching material.

4.3 Application of RBT and MDM to determine the curriculum components

4.3.1. Propose curriculum component

Due to the lack of prior knowledge regarding the curriculum design of new product development courses, the present study applied the LSA results as the crucial components of the course, and analysts' interpretation of each topic is described as follows.

- *Knowledge management* (KM): Innovation is a collaborative effort to draw on internal and external knowledge generated by the interaction of implicit and explicit knowledge. Thus, KM is a crucial element in determining the success of NPD, which enables students to leverage intellectual assets by creating, capturing, representing, storing, and reusing knowledge. The topics required for KM include concepts and definitions, intangible assets and intellectual capacity management, and skills related to analyzing, understanding, and implementing KM practices.
- *Project management* (PM): NPD is generally conducted through interorganizational and intersectoral cooperation. Thus, the requirements for managing these projects include allocating limited resources effectively and ensuring that the results are achieved as planned. The NPD courses should equip students with the knowledge and skills required to keep projects under control in terms of time and cost.
- *Innovation management* (IM): Innovation is a significant part of advancing competitiveness. IM in the NPD process focuses on managing product innovation and product development and building competitiveness through innovation. IM comprises introducing basic concepts, for example, front-end innovation and open innovation. It also provides knowledge about strategic innovation management and innovative processes and structures.
- *Risk management* (RM): Many NPD decisions involve ambiguity and further

create risk and uncertainty. RM involves various issues, such as identification of risks and associated potential costs, analysis of the causes and financial losses, and determination of intervention strategies. The NPD course is expected to impart knowledge and skills to students about making adjustments, adapting to external and internal forces, and managing crises or disasters.

Additionally, the study referred to previous studies (Manimala & Thomas, 2017) and adopted four educational theories that are frequently applied to EE as pedagogical approaches of the empirical case.

- *Experiential learning* (EL): The approach highlights that the knowledge and skills of entrepreneurship are created through the transformation of experience. Hence, NPD courses encourage students to apply the theory learned in class to real-life situations and engage in higher-order thinking. The study considers that common teaching activities include creating and running small ventures on campus, interning with startups, and working on small consulting jobs.
- *Constructivist learning* (CL): This approach asserts that students can gain meaning from the various activities in which they participate as part of the curriculum. Additionally, the teachers act as facilitators and coaches to help students obtain the resources they need and to solve problems. The study considers that the available teaching activities in an NPD course include case studies, the development of business plans, and research projects.
- *Socratic method* (SM): This approach is often applied to teach critical thinking through a systematic question-and-answer process guided by the instructor and depends on student involvement. In this context, the study considers that the available teaching activities include discussions, the study of research papers, and the application of information and communication technology (ICT).
- *Lecture-based learning* (LL): This approach involves teacher-centric pedagogy that focuses on memorization of factual knowledge and reinforces lower-level skills. The study considers that the approach is the most commonly used in NPD courses because it offers abundant and straightforward information, allows teacher maximum control over the learning experience, and results in lectures that can be recorded and repeated for different students.

4.3.2. Develop Questionnaires

To evaluate the eligibility of the curriculum components, the study utilized revised Bloom's taxonomy and the results yielded by LSA to develop the measurement items of the questionnaire. The questionnaire encompassed two main parts. The first part of the questionnaire mainly investigated the experts' opinions regarding the learning objective of the course. The items asked participants to select a suitable statement of the learning objective that derived from Revised Bloom's Taxonomy framework. The

second part of the questionnaire was developed following the modified Delphi method and Analytic Hierarchy Process, as well as used the curriculum components mentioned earlier to develop Likert statements and evaluate each statement on a five-point Likert scale ranging from one (very unimportant) to five (very important).

4.3.3. Recruit Domain Experts and Conduct Opinion Survey

The expert survey intended to investigate opinions about the feasibility of the curriculum design. To this end, the study recruited 12 teaching faculties of the entrepreneurship education program to work on the study. Due to the Covid-19 pandemic, the questionnaire was distributed to each panel member in July 2020 by email and asked them to complete and return it within 14 days.

4.3.4. Process and Analyze the Results of Questionnaires

After completing the investigation, we counted the polls in the RBT questionnaire to determine the learning objectives of the course and the result was illustrated in Figure 2. On the other hand, the results of the first round MDM survey (see Table 4) indicated that the CDI of all survey items was less than 0.3, which shows that the survey result attained a consensus. The interquartile range (IQR) of the one item was less than 0.6, which indicates that the result was highly consistent; the other three items were moderately consistent (IQR is between 0.6 and 1). Based on a previous study, the second survey round was suspended (Wu & Chen, 2021).

Table 4. Results of the Delphi survey

	Experts															
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**Mean**	**SD**	**CDI**	**IQR**
Teaching materials																
Knowledge management	5	5	4	5	5	5	5	4	5	5	4	5	4.75	0.45	0.10	0.25
Project management	4	3	5	4	5	4	5	5	5	5	4	5	4.50	0.67	0.14	1.00
Innovation management	5	4	5	5	5	5	5	4	5	5	4	5	4.75	0.45	0.10	0.25
Risk management	4	5	5	3	3	4	5	4	4	5	4	5	4.25	0.75	0.16	1.00
Pedagogical approaches																
Experiential learning	5	4	5	5	4	5	5	5	5	4	5	5	4.75	0.45	0.10	0.25
Constructivist learning	4	5	5	4	4	4	5	4	5	4	5	4	4.42	0.51	0.11	1.00
Socratic method	5	4	5	3	5	5	4	5	4	4	4	3	4.25	0.75	0.16	1.00
Lecture-based learning	5	3	5	4	5	4	3	4	5	4	4	5	4.25	0.75	0.16	1.00

Furthermore, the results of AHP questionnaire was presented in Table 5 to depict the local and global weights of teaching material for each pedagogical approach.

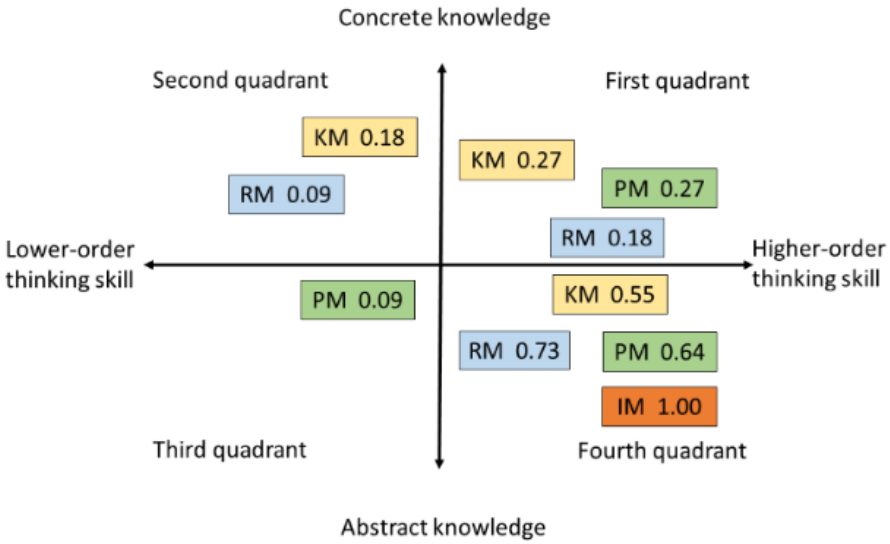
Table 5. Local and global weights of teaching material for each pedagogical approach.

	Teaching materials and local weight (Rank)				
Pedagogical approach	**Knowledge Management 0.302**	**Project Management 0.257 (3)**	**Risk Management 0.123 (4)**	**Innovation Management 0.318 (1)**	**Global weight (Rank)**
Experiential learning	0.194 (3)	0.355 (1)	0.232 (3)	0.439 (1)	0.318 (1)
Constructivist learning	0.268 (2)	0.324 (2)	0.324 (1)	0.287 (2)	0.295 (2)
Socratic method	0.300 (1)	0.175 (3)	0.248 (2)	0.184 (3)	0.224 (3)
Lecture-based learning	0.238 (4)	0.147 (4)	0.196 (4)	0.090 (4)	0.162 (4)

5. DISCUSSION

5.1. Summary

Based on the results of the empirical case, the panel members selected an optimal portfolio that involves teaching materials, pedagogical strategies, and learning objectives regarding the new product development course. Through the application of the latent semantic analysis, the collected literature from the Scopus database was extracted from the main research themes that are considered as the potential curriculum components of the new product development course. Next, revised Bloom's taxonomy was applied to develop questionnaires to establish the learning objectives. Finally, the panel members were invited to verify the eligibility of each teaching material with the modified Delphi method and AHP. To do so, the plight of lack of prior knowledge on the new product development course was addressed, and expert opinions were merged into the curriculum design process.



Note: Teaching materials: KM = knowledge management, PM = project management, RM = risk management, IM = innovation management; the accompanying numbers are for the rate of appearance frequency of the teaching materials in each quadrant.

Figure 2. The framework of learning objectives of teaching materials for a course on new product development.

In accordance with the results of the MDM (Table 4), the panel members agreed that knowledge and skills about knowledge management, project management, risk management, and innovation management are required for business students to manage NPD. However, teaching materials are intertwined with pedagogical approaches; both are crucial and should be addresses simultaneously (Leung et al., 2009). Therefore, the study conducted a further pairwise comparison to evaluate the importance of four pedagogical approaches. The results of the global weight (Table 5) revealed that the approaches of experiential learning and constructivist learning were more important than pedagogical strategies for teaching knowledge and skills in NPD, which is consistent with a previous study (Anderson et al., 2001).

As shown in Figure 2, the learning objectives were organized into four quadrants that are divided in accordance with the dimension of the cognitive process and knowledge in the revised Blooms' taxonomy framework. In terms of the quadrants' definition, the horizontal axis of the first quadrant extends right to the higher-order thinking skill, and its vertical axis extends upward to concrete knowledge. In the second quadrant, the horizontal axis veers towards the lower-order thinking skill, and the vertical axis moves upward towards concrete knowledge. In the third quadrant, the horizontal axis extends left to lower-order thinking skills, and the vertical axis moves downward towards abstract knowledge. Finally, in the fourth quadrant, the horizontal axis stretches right towards the higher-order thinking skill, and the vertical axis heads downward to abstract knowledge. Based on the AHP results (Table 5), the teaching materials selected most were on IM, and the approach of experiential learning was chosen as the most appropriate pedagogical approach for teaching it. Additionally, the framework of learning objectives (Figure 2) reveals that the learning objective of teaching IM is anchored in the fourth quadrant, which means that the panel members were apt to teach abstract knowledge in order to cultivate students' higher-order thinking skills. Such an outcome would echo past empirical evidence that higher-order thinking skills, including critical thinking, reflective thinking, synthesis, and analysis, are important for students in all academic domains. The most desirable teaching plan would be to instruct students in the knowledge and skills for IM, generally involving the topics of opportunity recognition, technology forecasting, business model innovation, and design, in an NPD course through an internship with startups (the experiential learning pedagogy) to offer students opportunities to work on real-life problems and contextualized projects (procedural knowledge in the knowledge dimension) and to enable them to generate new ideas through reflection and inference (category of creating in the higher-order cognitive process dimension).

In the NPD process, KM has the potential to inspire innovativeness, promote organizational learning, and shorten product launch times. Teaching KM generally

focuses on topics related to knowledge discovery, capture, sharing, and application (Bedford, 2013). In the empirical case, some students in the target group possessed insufficient prior knowledge of KM. Thus, the major learning objectives, established by the panel members, are located in the second and fourth quadrants (see Figure 2), in which both concrete and abstract knowledge gained importance in fostering higher-order thinking skills. Likewise, our findings echoed the recommendation of Radmehr and Drake (2017) that prior knowledge and experience both act as a foundation of cognitive processes in students' minds. Based on panel members' opinions, the teaching plan reflects that the theories and principles of KM (factual knowledge) are imparted through the process of posing and answering questions (Socratic pedagogy) to make the student learning interesting. Then, a case study is adopted (constructivist learning) to stimulate their critical thinking (metacognitive knowledge). Thus, the instruction equips students with much-needed competence to organize knowledge in the NPD process.

Moreover, the panel members suggested the pedagogical approaches with the highest priority for enhancing the attainment of the learning objectives of PM and RM, including experiential learning and constructivist learning, respectively. In the NPD context, PM highlights management topics related to the project scope, schedule, and cost (Pons, 2008), whereas RM focuses on identifying, assessing, and planning the uncertainty inherent in NPD processes. Although PM and RM are both prevalent measures for supporting NPD project execution, they are diverse and depend on industry characteristics and the firm's position in the entire value chain). Therefore, the panel members were apt to adopt the pedagogical approach of experiential learning and constructivist learning, including role play, case study, computer simulation, and development of business plans, for teaching PM and RM in the NPD curriculum. The teaching plan has great potential to equip students with the ability to deal with real-world business challenges. After being presented with the study findings, the panel members expressed agreement with the proposed methodology, which is available and effective for faculties at HEIs, and the results of curriculum design are feasible under current conditions.

5.2. Implications for Theory and Practice

Entrepreneurship promotes economic activities by continuously creating new products and services, so it inevitably catalyze economic development and higher-level competition. Therefore, HEIs are aggressively introducing EE programs to equip future graduates with the knowledge and skills necessary for advancing their career development (Rasiah et al., 2019). Because of the lack of clarity about the specified outputs, EE encompasses diverse viewpoints from multiple disciplines and leads to curriculum design within different contexts. The design and delivery of an NPD course

should be based on innovative pedagogies and cross-disciplinary learning activities. However, the extant curriculum design approaches—instrumental, communicative, artistic, and pragmatic approaches—are insufficient and need to be integrated with a structured methodology that merges the stakeholders' concerns, organizational objectives, and resource constraints Inamdar and Roldan (2013).

The study found that the experiences, intention, teacher's passion, mentoring, and practice are key factors in an effective NPD course. Furthermore, knowledge and skills in innovation management, knowledge management, project management, and risk management are highly relevant to NPD. Furthermore, the proposed methodology successfully demonstrated the need for teaching faculties to consider teaching materials, pedagogical approaches, and learning objectives, which are guidelines for developing assessments. The results of the proposed methodology expand on the extant literature on curriculum design for EE by Inamdar and Roldan (2013), Rasiah et al. (2019), and Tan and Vicente (2019).

6. CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

Because of the demands created by constant social change, curriculum design and implementation have also constantly changed over time. Curriculum design is a systematic process that organizes planned learning experiences by defining and connecting the important components that can affect students' learning achievements, including teaching materials, pedagogical approaches, and learning objectives (Al-Awlaqi et al., 2018). Thus, this study introduced a structured methodology, which integrates latent semantic analysis, the modified Delphi method, a revised Bloom's taxonomy, and an analytic hierarchy process, to help faculties in designing an appropriate curriculum with limited prior knowledge.

The study applied AHP to help teaching faculties to determine the priorities among teaching materials and pedagogical approaches. However, answering the AHP questionnaire is a laborious task and it is difficult for experts to ensure the consistency of the pairwise comparisons. Therefore, care must be taken when applying the proposed methodology in related fields, particularly in the choice of domain experts and conducting the survey. The experts need to understand the detailed purpose of the project.

The proposed methodology for curriculum design can be extended and applied to other areas of education, both current and future. For teaching faculty, this methodology can be a dynamic process that solicits required teaching materials and pedagogical approaches. The well-structured process offers an optimal curriculum design that

conforms well to real-world conditions. Nevertheless, the results and findings in the paper are derived from an empirical case of EE programs at a university in Taiwan. Future studies can apply the proposed methodology to other curriculum design projects, and the differences in the learning objectives and the priorities of curriculum elements can then offer a basis for defining effectiveness. Additionally, the proposed methodology can be applied in various fields. We used LSA to extract hidden topics in textual datasets; however, other text-mining techniques, such as Latent Dirichlet Allocation (Inamdar & Roldan), can be applied to create topic models required in these cases. At the same time, linear programming techniques could be added to the proposed methodology when constraints in practice are consider.

7. CONTRIBUTIONS

In this paper, the authors introduced a methodology that integrates a latent semantic analysis, revised Bloom's taxonomy, and the modified Delphi method to carry out curriculum design with limited prior knowledge. The main contributions of the study can be summarized as follows:

- It offers a methodology to assist faculties at HEIs in designing and delivering courses on NPD. The key factors in a successful curriculum design encompass high relevance of the teaching materials, pedagogical approaches, and learning objectives, which are guidelines for developing valid assessments of student learning performance. The study proposed a more structured methodology to address this issue, which often necessitates abundant prior knowledge and experience. The methodology comprises a series of steps that use LSA to extract potential teaching materials, identify the eligibility of curriculum elements with MDM, establish the learning objectives with RBT, and apply the AHP technique to determine the relative priority of each curriculum element. In this way, the curriculum design of a new course is desirable, feasible, and aligns with organizational intentions and expectations.

- It provides insights into the process of curriculum design for developing a valid and feasible NPD course at a business school. Student engagement and learning performance are measures for gauging the quality of HEIs. Tangible factors, such as teaching materials and facilities, and intangible factors, such as teachers and students' interest and ability, learning objectives, communications, and coordination, should be examined and considered as part of the curriculum design to improve education quality.

The results of the study are recognized as the facilitator for improving learning performance of entrepreneurship education. Compared with current entrepreneurship

education program, the study provides systemic curriculum design methodology in which integrates educational theories, artificial intelligence and multi-criterial decision making methods into the curriculum design process. Therefore, the new product development course not only provides students with entrepreneurial knowledge and skill, but also encourages them to practice their capability by experiencing new product development process. This entrepreneurship education program enables learners to deal with problems in real world and enhances their intention to be an entrepreneur. Furthermore, the collected data have been analyzed, organized, reported, submitted, and published in the following journals and conference.

Direct Research Project Outputs

- **Journal papers**

  Wu, Y., & Chen, J. C. (2021). "Stimulating innovation with an innovative curriculum: A curriculum design for a course on new product development". *The International Journal of Management Education*, 19(3), 100561. DOI:10.1016/j.ijme.2021.100561

  Wu, Y., & Chen, J. C. (2021). "Discovering Curriculum Components for a New Product Development Course: A Latent Semantic Approach". *International Journal on Semantic Web and Information Systems (IJSWIS)*, 17(4), 22-36. DOI: 10.4018/IJSWIS.2021100102

- **Conference paper**

  Wu, Y., Chen, J.C., & Tsai, K.M. (2021). "A Curriculum Design Method for New Product Development". *Research and Innovation Forum 2020 (pp. 259-272)*. Springer Proceedings in Complexity. Springer, Cham. DOI:10.1007/978-3-030-62066-0_20

- **Edited Book**

  Wu, Y., Yuan, C.-H., & Chen, M.-Y. (2021). From Thinker to Doer: Creativity, Innovation, Entrepreneurship, Maker, and Venture Capital. *Frontiers in Psychology*. (619 pages). https://doi.org/10.3389/fpsyg.2021.649037 (ISBN 978-2-88966-715-4)

Related Academic Outputs from Project Support

- **Journal papers**

  Wang, W., He, L., Wu*, Y., & Goh, M. (2021). Signaling persuasion in crowdfunding entrepreneurial narratives: The subjectivity vs objectivity debate. *Computers in Human Behavior*, *114*, 106576.

  Yuan, C.-H., & Wu*, Y. (2020). Mobile instant messaging or face-to-face? Group interactions in cooperative simulations. *Computers in Human Behavior*, *113*, 106508.

Wu, W., Wang, H., & Wu*, Y. (2020). Internal and External Networks, and Incubatees' Performance in Dynamic Environments: Entrepreneurial Learning's Mediating Effect. *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-020-09790-w

Wang, W., Zheng, H., & Wu*, Y. (2020). Prediction of fundraising outcomes for crowdfunding projects based on deep learning: a multimodel comparative study. *Soft Computing*, *24*(11), 8323-8341.

Li, H., Wu*, Y., Zhang, S., & Zou, J. (2021). Temporary rules of retail product sales time series based on the matrix profile. *Journal of Retailing and Consumer Services*, *60*, 102431.

Wu, Y., Chen, S.-C., & Pan, C.-I. (2019). Entrepreneurship in the Internet Age: Internet, Entrepreneurs, and Capital Resources. *International Journal on Semantic Web and Information Systems*, *15*(4), 21-30.

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108年度專題研究計畫成果彙整表

計畫主持人：吳彥濬			**計畫編號：**108-2511-H-003-034-MY2		
計畫名稱：新產品開發與創新課程: 設計、教學、評量					
成果項目			量化	單位	質化 （說明：各成果項目請附佐證資料或細項說明，如期刊名稱、年份、卷期、起訖頁數、證號...等）
國內	學術性論文	期刊論文	0	篇	
		研討會論文	0		
		專書	0	本	
		專書論文	0	章	
		技術報告	0	篇	
		其他	0	篇	
國外	學術性論文	期刊論文	2	篇	Wu, Y. J., & Chen, J. C. (2021). “Stimulating innovation with an innovative curriculum: A curriculum design for a course on new product development”. The International Journal of Management Education, 19(3), 100561. DOI:10.1016/j.ijme.2021.100561 Wu, Y. J., & Chen, J. C. (2021). “Discovering Curriculum Components for a New Product Development Course: A Latent Semantic Approach”. International Journal on Semantic Web and Information Systems (IJSWIS), 17(4), 22-36. DOI: 10.4018/IJSWIS.2021100102
		研討會論文	1		Wu, Y., Chen, J.C., & Tsai, K.M. (2021). “A Curriculum Design Method for New Product Development”. Research and Innovation Forum 2020 (pp. 259-272). Springer Proceedings in Complexity. Springer, Cham. DOI:10.1007/978-3-030-62066-0_20
		專書	1	本	Wu, Y. J., Yuan, C.-H., & Chen, M.-Y. (2021). From Thinker to Doer: Creativity, Innovation, Entrepreneurship, Maker, and Venture Capital. Frontiers in Psychology. (619 pages). https://doi.org/10.3389/fpsyg.2021.649037 (ISBN 978-2-88966-715-4)
		專書論文	0	章	

		技術報告	0	篇	
		其他	0	篇	
參與計畫人力	本國籍	大專生	2	人次	協助計畫進行
		碩士生	3		協助新產品之機會辨識、產品點子、產品設計之三個量表之建立
		博士生	0		
		博士級研究人員	1		協助論文分析與撰寫並參與投稿
		專任人員	0		協助計畫執行與資料收集
	非本國籍	大專生	0		
		碩士生	0		
		博士生	0		
		博士級研究人員	0		
		專任人員	0		
其他成果 （無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。）			針對本研究主題獲得一國際期刊SSCI之專刊，今年底前將完成出刊。 Guest Editor, Frontiers in Psychology (SSCI) -2019 - From Thinker to Doer: Creativity, Innovation, Entrepreneurship, Maker, and Venture Capital		