



Article Remodeling the STEM Curriculum for Future Engineers

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Abstract: Higher education is facing low enrollment, and fewer students are motivated to select STEM majors. This paper reports the results from one university that recently experimentally reformed its undergraduate curriculum to a "theme-based curricula", the New Engineering Curriculum Program (NECP). The subjects in this study were 127 engineering students who applied for the NECP at a university in northern Taiwan. An experimental design using the pre- and post-test measurements of the experimental and control groups was applied in this study. The results revealed a significant effect among those who participated as second- and third-year undergraduates in terms of their subject-specific performances and attitudes of learning in various courses. Furthermore, the results showed that students in the NECP showed better learning performance and higher learning motivation than students in the traditional course module. The outcomes and analyses are discussed.

Keywords: STEM; undergraduate engineering; curriculum reform; New Engineering Curriculum Program (NECP)

1. Introduction

1.1. The Current Reality

Due to the low birth rate, the amount of students enrolled in higher education in Taiwan has been decreasing since 2009 [1]. This year, the Central Intelligence Agency (CIA) of the US reported that Taiwan has a total fertility rate (TFR) of 1.07 (i.e., the number of children born per woman), which is ranked last among 227 countries [2]. The condition results in fewer students enrolled at all levels of education, and this has recently begun to impact higher education. While a lower birth rate resulting in lower student enrollment is a difficult challenge for higher education, the current COVID-19 outbreak is another. It is forcing the formats of hybrid, asynchronized, and synchronized online learning to take over from the traditional face-to-face learning setting. However, research has found that higher education students are generally dissatisfied with their online learning experiences [3]; as such, this could further deter them from enrolling in classes [4].

STEM majors (i.e., science, technology, engineering, and mathematics-emphasized majors) in higher education in Taiwan have experienced lower student enrollment and low student interest (or motivation) in their educational paths, and learning ineffectiveness has become a common issue discussed among professors [5,6]. Ultimately, the goal of promoting STEM for student careers and fostering educational effectiveness in science, technology, engineering, and mathematics-related majors for the next generation of society seems to be facing a dilemma. STEM-related subjects have been regarded as challenging to learn for young people [7]. Most of the core coursework requires the learning of extensive theoretical foundations (e.g., scientific concepts, engineering mathematics, calculation, and computer programming). While the training of STEM majors is naturally challenging, stimulating students' learning interest, especially for those with lower academic achievement, can be difficult, leading to a vicious cycle [8].



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Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). In traditional curricular design, one or a few summative courses in the senior year (e.g., a capstone course or project) are normally arranged for students to demonstrate how they may integrate the professional knowledge and skills that they have learned. It is the final test before the undergraduates launch their careers, and verification of the departments' course effectiveness and curricular design. However, the problem with the traditional method may be the lack of real-world connections. A capstone course or project may reflect whether students have obtained a comprehensive understanding of the skills being taught. However, if the curricular design is not relevant to some authentic scenarios or does not fit into the mainstream, such that the curriculum is lacking (hands-on) interdisciplinary connections (e.g., humanities and arts) or practice-driven understanding and skills (i.e., real-world problems in workspaces), we may be less likely to find students motivated to learn [9].

In this vein, a common need arises for universities to re-consider how the current STEM curriculum can be reformed [10–14]. Immense strategic teaching and learning methods have been proposed, practiced, and documented; furthermore, a reformation has been led by the teachers [15] (i.e., teachers' collective or individual responses to the curriculum reform). A consistent suggestion from the current literature is that a localized curriculum reformation is needed [13], instead of a top-down reformation led by governments [16]. Although there have been related studies associated with the movement in higher education, research data collected associated with institutional-wide curricular reformation are lacking. Therefore, the current study was an exploration aiming to understand a reformed STEM curriculum while caring for student performance and motivational effects.

1.2. The Role of STEM Education in Higher Education

In most cases, STEM education has been practiced for non-engineering majors, such as integrating STEM elements in general education courses for non-engineering students [17] or interdisciplinary learning objectives that seek a cross-dimensional solution for larger scales (e.g., environmental issues) [18]. For cultivating future engineers, STEM education delivers not only professional knowledge but also new ways of thinking and the ability to think ahead of new problems in a technology-enriched future society [19]. "New thinking and problems" refer to the ability to recognize new needs to be foreseen and solved with known techniques and technology. The ability requires immense expertise from different areas and creative collaboration in an interdisciplinary setting [20].

Meanwhile, sustainable STEM education echoes the aforementioned needs. Today, the movement in higher education integrates reformed knowledge, innovation, and practice while considering the humanities, ethical issues, social learning, and civic engagement with a learning process that is exploratory, action-oriented, reflective, and transformative [21]. While the curriculum has been rapidly reformed at the primary and middle school levels toward STEM, the movement has prompted higher education to change and make their ways of teaching more multifaceted [22].

However, how STEM can be remodeled for engineering majors is still unclear [23]. In response to the changing learning needs in higher education, to invest actively in online education by trying out various possible delivery models to continue to provide adaptive and dynamic teaching seems insufficient; it may be more important to consider possible changes to the internal system, curriculum, and teaching for engineering education.

Among several approaches that are generally focused per course on teachers' unconventional strategies of teaching (e.g., problem-based learning and online/flipped instruction) or students' constructive ways of responding to/exploring/learning the course materials (e.g., inquiry-based learning and collaborative group settings), a curriculumbased reformation (or the New Engineering Curriculum Program approach (NECP)) has been proposed in Taiwan in some universities to reorganize the curriculum aimed to reconcile students' interest to the STEM learning experience.

1.3. The Proposed Goal

While STEM education in primary and middle schools has been re-introduced recently with an interdisciplinary emphasis, we argue that STEM for higher education may be reformed with a theme-based curriculum within/among STEM majors' curricula. The rationale of the NECP is to synthesize the goals to foster STEM needs in higher education by consolidating a certain number of the core courses with a series of themes of authentic and practical scenarios that students may encounter in their future vocational spaces into certain consecutive semesters (e.g., in the 2nd to 4th years of undergraduate study). Among these semesters, the theme-based curriculum involves theories and methods, tools or applications for design and analysis, hands-on techniques for processing and manufacturing, and methods for experimental measurement and validation, which are remodeled with a group of courses surrounding some professional themes. The curriculum proposes to integrate the core theories, instruments, and practices throughout the program efficiently and systematically by shortening the original core coursework (i.e., 80% of the normal semester schedule is redesigned and fitted with condensed and remodeled contents of the original courses, and a new theme-based capstone-like course is introduced for each of the thematic course groups by utilizing the 20% of time saved from the original courses (Figure 1).



Figure 1. An example of the theme-based STEM curriculum redesign (Mechanical Engineering).

1.4. The Purpose of the Study and Research Questions

With the aforementioned remodeled series' theme-based STEM curriculum for the undergraduate level, the current study sought to present an exploration of the treatment

effect and student learning motivation in an experimental curriculum. Therefore, understanding their learning performance and feedback revealed after the courses would better assist us in knowing whether the reformation of the NECP approach for STEM education had an effect. The following research questions were set to assist us in approaching the goal of the current study.

- 1. Do students in the NECP show better learning performance than students in conventional engineering courses?
- 2. Do students in the NECP show a different level of learning motivation than students in conventional engineering courses?

2. Materials and Methods

2.1. Participants

The subjects in this study were 127 engineering students who applied for the New Engineering Curriculum Program (NECP) at a university in northern Taiwan. In terms of gender distribution, 102 students were male, and 25 students were female. In terms of grade distribution, 65 students were second graders (Sophomore), and 62 students were third graders (Junior). In addition, we interviewed two of the faculty who were willing to be part of the NECP. Their answers served as anecdotal data to assist the understanding of the process of the NECP under implementation.

2.2. New Engineering Curriculum Program (NECP)

We were able to collect two years' worth of data (i.e., students enrolled in the themes of "Smart Automation" and "Smart Mold") since the first launch of the NECP in 2019 (see Figure 2). To illustrate this, in the fall semester of 2019, students who were entering their Sophomore and Junior years had the opportunity to apply for the NECP in the current Department of Mechanical Engineering. More than 127 students applied for the program.



Figure 2. Comparison of the old and new curriculum designs associated with terms and academic years in the STEM curriculum (Mechanical Engineering in the current study).

2.2.1. Smart Automation

In response to the wave and impact of Industry 4.0, the traditional machinery industry has to be upgraded towards intelligence. Therefore, the Department of Mechanical Engineering cooperating with the current study has planned a thematic course group of "Smart Automation and Mechatronics Integration" to adjust the contents of (1) Engineering Mathematics and (2) Mechanism in the first semester of the sophomore year. In addition, (3) a special topics course was offered, in which the structural dynamic simulation of Solid-Works, the basics of automatic control, the Arduino microprocessor and motor control and sensor technology, and the operation of instruments for automatic control experiments was incorporated. This course is designed to provide students with the opportunity to work on a variety of topics, such as the simulation of a solid works structure, the fundamentals of automatic control, Arduino microprocessor and motor control, sensing component technology, and the operation of an automatic control experiment. Students who take this course would learn the theories and technologies related to the integration of automation and electromechanics systematically in the first semester of their sophomore year, which is of great benefit to their subsequent studies and internships in the industry in their senior year.

2.2.2. Smart Mold

To make the connection between mold and molding-related courses more systematic, the related courses originally scattered over three years are reorganized in the first semester of the junior year so that students can work towards clearer objectives through the planned theme guide. These objectives include learning basic knowledge, the operation and simulation of related engineering analysis software, and experimental practical tools, as well as completing the theme set by the course group. Students would practice what they have learned and accept the challenge of working together in a team to solve practical problems in mold design and manufacturing. The course is planned to be implemented in the first semester of the junior year, and the two required courses, "Fluid Mechanics" and "Mechanical Design, and the new elective course" "Special Topics on Smart Mold and Manufacturing", are selected as the core courses.

2.3. Experimental Design

The study was designed using an NECP group and a conventional group with a preand post-measurement experimental design. The NECP group was of students enrolled in the New Engineering Curriculum Program (NECP), and the conventional group was of students enrolled in the traditional engineering course. Approximately 1/3 of the students in the department applied for the NECP.

2.4. Instrument

2.4.1. Learning Motivation Scale

The learning questionnaire for this study was adapted from the IMMS (Instructional Material Motivational Survey) questionnaire developed by Keller [24] (2010) to assess students' motivational performance. This questionnaire contained four dimensions: attention (12 items), relevance (9 items), confidence (9 items), and satisfaction (6 items). The scale was developed using Likert's 5-point style. Five meant strongly agree, and one meant strongly disagree. The higher the score that the students obtained was, the higher their learning motivation was.

2.4.2. Learning Performance Test

To understand the learning status of students in each module of the curriculum, a test was designed according to the content of each course to check students' learning performance. The question items of the tests were all multiple-choice items. These question items created by the instructors were mainly designed with factual knowledge associated with key concepts for the basic comprehension of the subjects. Participants in both the NECP and the traditional conditions took the same learning performance tests according to their treatment groups. Some question items were as follows:

Fluid Mechanics:

 "The force acting over the surface per unit length of the surface perpendicular to the force" is the definition of which term? (A) specific gravity, (B) surface buoyancy, (C) specific weight, (D) surface tension. What is "the ratio between its density and the density of a reference substance, usually water at 4 °C"? (A) specific gravity, (B) surface buoyancy, (C) specific weight, (D) surface tension.

Engineering Mathematics:

- The learning objectives of engineering mathematics were (A) calculate arithmetic problems in various types of engineering, (B) solve geometric problems in the design phase of engineering, (C) derive mathematical equations for engineering problems, and (D) model and solve engineering problems as mathematical equations.
- Which of the following description is wrong about the "solution of an ordinary differential equation (ODE)"? (A) The solutions of ordinary differential equations are functional, (B) the general solution of ordinary differential equations of order N has N independent constants, (C) most of the ordinary differential equations can be found as analytic solutions or closed-form solutions, (D) the solutions of ordinary differential equations.

3. Results

3.1. Student Learning Performance in the New Engineering Curriculum Program (NECP)

From the results of the repeated-measures *t*-test, it was found that the students in the Smart Automation module showed significant improvement in the post-test scores of the Engineering Mathematics, Mechanical Dynamics, and Smart Automation topics. Students who took the Smart Mold module also showed significantly higher post-test scores than pretest scores in the Fluid Mechanics, Mechanical Design, and Smart Mold topics. The results of this study showed that the students' learning outcomes were significantly improved after taking the new engineering course modules (Table 1).

Table 1. Students' learning performance in the New Engineering Curriculum Program (NECP).

	N -	Pre-Test		Post-Test		DE	T X 1
Course		М	SD	Μ	SD	DF	1 value
Smart Automation							
Engineering Mathematics	58	28.62	11.69	43.53	18.19	57	5.81 ***
Mechanism	62	31.85	11.92	58.31	16.02	61	10.34 ***
Special Topics on Automation	60	49.92	13.51	59.17	12.96	59	6.16 ***
Smart Mold							
Fluid Mechanics	63	28.49	10.65	42.86	12.72	62	7.50 ***
Mechanical Design	61	47.13	10.90	58.11	12.08	60	5.99 ***
Special Topics on Smart Mold and Manufacturing	63	46.48	10.09	59.43	10.31	62	8.60 ***

*** p < 0.001.

3.2. Differences in Learning Outcomes between the Students Taking the NECP and the Students in the Conventional Engineering Course

In this study, an analysis of covariance (ANCOVA) was used to compare the performance of students taking the NECP courses with that of students taking the conventional engineering courses. The independent variable was the type of course, the dependent variable was the post-test measurements, and the covariate was the pre-test measurements.

The results of ANCOVA revealed that except for Fluid Mechanics, in the three courses (Engineering Mathematics, Mechanical Dynamics, and Mechanical Design), the students who participated in the NECP condition performed significantly better on the paper-based exams than the students in the conventional condition. The results indicated that the training in the new engineering courses helped to enhance the students' learning in the core courses (Table 2). However, when comparing the performances of the NECP students and the general students in the Fluid Mechanics courses, it was found that the performance of the NECP students was not better than that of the students in the conventional setting.

Course –	NECP			Conventional			16	-	
	Ν	Μ	SD	Ν	Μ	SD	đf	F	
Engineering Mathematics	58	43.53	18.19	69	36.23	13.43	1	8.19 **	
Mechanism	62	58.3	16.02	35	30.00	11.05	1	79.32 ***	
Fluid Mechanics	63	42.86	12.72	67	44.18	18.44	1	0.36	
Mechanical Design	61	58.11	12.08	51	43.92	14.40	1	26.87 ***	

Table 2. Comparison of students' learning performance between the NECP and conventional groups.

** *p* < 0.01, *** *p* < 0.001.

Fluid mechanics is relatively a more abstract subject area. Fluid Mechanics is a complex course that includes concepts related to both chemistry and physics. The difficult part of fluid dynamics is that it is not only fluid dynamics that need to be learned, but also the mechanical engineering process of condensing the fluid that has been melted in the mold, which requires more complex calculations. There is still a follow-up course called Mold Fluid Dynamics. The fluid mechanics taught in the conventional setting, in contrast to the NECP curriculum, contains more paper-based practice activities (e.g., paper-based quizzes and exams). The NCEP fluid dynamics curriculum contains more hands-on and practice-driven activities (e.g., unit operation and simulation) to lead students to discuss the relationships between the theory and practice of fluid dynamics. The course spends more time on these activities to lead students to discuss the theoretical and practical relationships with fluid mechanics and less time on paper and pencil test exercises. These differences in course activities have caused a significant improvement, evident when comparing the pre-test and post-test Fluid Mechanics scores of the NECP students (see Table 2), but no significant differences in scores when the results were compared with those of the students in the traditional Fluid Mechanics.

3.3. Differences in Learning Motivation between the Students Taking the NECP and the Students in Conventional Engineering Courses

In this study, an analysis of covariance (ANCOVA) was used to compare the learning motivation of students taking the NECP courses with that of students taking the conventional engineering courses. The independent variable was the type of course, the dependent variable was the post-test measurement, and the covariate was the pre-test measurement.

From the results of the study, it was found that the students who participated in the NECP showed significantly higher motivation in both the Engineering Mathematics and the Mechanical Design courses than those who took the conventional courses. The results of this study indicated that this thematic curriculum structure was helpful in increasing students' motivation, especially in the Engineering Mathematics course and in the Mechanical Design course (Table 3). In the Mechanism course and Fluid Mechanics course, the study found no significant differences in learning motivation between the NECP group and the conventional group (Table 3). The results showed that the design and planning of the theme-based curriculum can stimulate students' interest in and enthusiasm toward engineering and then motivate them to learn related knowledge and skills in an active search for answers.

Table 3. Differences in learning motivation for Engineering Mathematics between the NECP and conventional groups.

Course	NECP			Conventional			- D(66		Sia
	Ν	Μ	SD	Ν	Μ	SD	Df	55	F	51g.
Engineering Mathematics	47	3.47	0.52	34	3.16	0.45	1	1.49	9.13 **	0.003
Mechanism	43	3.32	0.60	11	3.34	0.41	1	0.00	0.00	0.993
Fluid Mechanics	62	3.75	0.51	16	3.58	0.58	1	0.070	0.38	0.538
Mechanical Design	69	3.75	0.47	21	3.05	0.49	1	3.80	23.30 ***	0.000

p < 0.01, *p < 0.001.

3.4. Students' Learning Performance in Capstone Courses

To understand students' performance in the capstone courses (1) Special Topics on Automation and (2) Special Topics on Smart Mold and Manufacturing), the study analyzed the students' scores along five different emphases: (a) Integration (ability to design and conduct experiments, as well as to analyze and interpret data; ability to design an engineering system, component, or process); (b) Professionality (ability to apply knowledge of mathematics, science, and engineering); (c) Innovation (ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantial conclusions); (d) Practicality (ability to apply techniques, skills, and modern tools necessary for engineering practice); (e) Communication and Care (ability to manage projects (including budgeting), communicate effectively, work in a multi-disciplinary environment, and function on teams; ability to apply ethical principles and commit to professional ethics and the responsibilities and norms of engineering practice, and have a sense of respect for diversity). These five emphases were determined by faculty who agreed to teach in the NECP program. These five emphases were then turned into a set of grading rubric. At the end of the semester, the instructors invited professionals and experts from the industry to attend the final student exhibition held by the NECP program. Not only did the students have to collaborate well to complete prototypes or artifacts from the capstone projects, but they needed to practice their communication skills and demonstrate well during the presentation for better grades (see Figure 3).



Figure 3. NECP students were presenting their capstone projects in the final exhibition. Professionals and experts from the industry invited by the NECP program were giving grades and comments.

There were several topics that NECP students chose for the capstone project, including fluid-line design, programming design, and analysis of fluid path. In the capstone courses of Special Topics on Smart Mold and Manufacturing; in the Special Topics on Automation, students worked on robotic arms design-related topics and automatic transportation line design-related topics. All topics were determined by the students based on a full semester (i.e., 18 weeks) of discussions and collaboration among an average of 5–6 team members. At the end, 12 groups were formed, consisting of 71 NECP students.

From the results of the data analysis, we could see that the students who took both the Smart Automation module and the Smart Mold module scored well in the performance of the project outcomes in terms of integration, professionality, innovation, practicality, and communication and care (Table 4).

Course Module	Dimensions	No. Of Groups	М	SD
	Integration	12	88.22	1.31
Special Topics on Automation	Professionality	12	88.11	1.18
	Innovation	12	87.17	1.30
	Practicality	12	88.56	2.26
	Communication and Care	12	89.00	0.88
	Integration	12	83.39	3.94
	Professionality	12	83.56	3.51
Special Topics on Smart Mold and Manufacturing	Innovation	12	82.72	4.33
	Practicality	12	83.61	3.51
	Communication and Care	12	83.06	2.72

Table 4. Student's learning performance in Special Topics courses.

4. Discussion

Learning Motivation and Performance

The core of STEM education is to provide learners with a cross-disciplinary learning context and learning environment [25]. The development of students' problem-solving skills has been a critical competency in the past few years. In developing students' practical problem-solving skills, STEM education is one of the educational pathways to help students gain a more comprehensive understanding of their learning goals by integrating curricula from different fields. For STEM education, in addition to teaching the core knowledge of the curriculum, it is also necessary to emphasize interdisciplinary integration [26]. The topic-oriented approach provides more explicit learning goals, from basic knowledge to the operation and simulation of relevant engineering analysis software, to the learning of experimental tools, and finally to the completion of the topics set by the class.

In this study, the NECP courses helped students put into practice what they had learned in the courses and to be able to accept challenges and work together as a team to solve practical problems. In general, the traditional university curriculum planning would arrange a summative course in the senior year, such as a final project, to verify the effectiveness of students' learning by integrating the knowledge of related courses into the problem solving of the final project after two to three years of study. In this study, the traditional approach indeed showed some drawbacks, such as the overly broad content of introductory theory without the guidance of themes and the failure to link learning topics effectively horizontally or vertically. It showed that the traditional curriculum arrangement had a specific difficulty in facilitating systematic learning.

In addition, this study found that students' motivation was significantly enhanced in this thematically integrated curriculum module learning environment. Students' attention, relevance, self-confidence, and satisfaction were all significantly improved. Such results are similar to those of Wang's study [27]. The thematic design of the curriculum provided students with a more precise direction for their learning. It helped them achieve a more specific understanding of the application of the content to different aspects of the curriculum. This phenomenon could be seen in this study.

Capstone Project

The purpose of curriculum planning for the special topics course was to provide students with the opportunity to integrate professional knowledge and skills from related courses and to present further project proposals and outcomes [28]. As for the students in the control group, the capstone project in the traditional setting was not available to them until their last year of the program (i.e., the senior year). Students' performance in the capstone project revealed their learning outcomes. The special topics course was a

very effective way to integrate students' knowledge in related courses. Although there was no comparison between the experimental and control groups due to the nature of the design of the curriculum in this study, the learning performance in the capstone projects showed a generally positive outcome among the NECP students. Moreover, the scores that the students achieved might also have been linked to their significant improvements in the other courses, "Smart Mold" and "Smart Automation". Increasingly more studies have shown that this type of project-based curriculum design and planning is beneficial to student learning [14].

In response to the innovative development of engineering education, the NECP consists of two thematic clusters, "Smart Mold Design and Manufacturing" and "Smart Automation". This project emphasizes a theme-oriented curriculum design. In particular, the content planning of the required courses must be adjusted according to the topics of the clusters, because topic-oriented learning can better stimulate students' learning interests, further enhance their independent learning ability, and effectively improve their learning performance. In addition, because the process requires group learning, it also helps students enter the community with the concepts, wisdom, and attitudes that they have gained from the program's practical courses.

5. Limitations and Suggestions for Future Research

Some insights on the limitations of this study and suggestions for future research are described.

First, while the university in the current study has invested in remodeling some portions of their curriculum in one certain department (Mechanical Engineering) as part of the STEM curricula reformation, many other subject areas have not begun this kind of experimental reformation. It is unclear whether the results of the current study may or may not be generalized to other subject areas.

Second, it is well-known that "artificial intelligence" (AI) has taken over many of the "automatic" parts of factory production and calculation lines (e.g., the so-called "smart" sections replaced by AI). It is unclear how schools would teach these subjects. Students may not take the initiative to learn while facing the reality that many of the difficult subjects involve work that would be replaced by AI. Similarly, the attitudes possessed by the instructors are unknown but worthwhile for future exploration.

Lastly, one finding was unclear. While students revealed a significantly positive learning motivation toward the NECP condition, their learning outcome was similar to that in the conventional condition. It was conjectured that when the subject was too hard to learn (such as "fluid mechanics" in the current study), learners might have performed a "perceived learning motivation". The data in the current study were not able to address this phenomenon. This can be a suggested area for further investigation.

6. Conclusions

While higher education has been facing the consequences of low fertility, remodeling it from the inside out has seemed inevitable. The current study sought to apply the concept of theme-based STEM curriculum design to the new engineering education program by planning several thematic clusters during the university period, covering various professional fields within the department.

First, learning performance was found to be significantly improved compared to that in the conventional setting. The study proposed a thematic curriculum module design concept and examined students' learning performance in such a curriculum program. The results showed that the thematic curriculum planning and design had a significant impact on the learning performance of the students compared to those who took the conventional curriculum. Compared with the conventional curriculum planning approach discussed above, the NECP course was more responsive to technological development and met the industry's need for future talents, such as problem-solving ability, cross-disciplinary innovation ability, and communication about cooperation ability. Second, learning motivation was found to be significantly improved compared to that in the conventional setting. Most importantly, in the purpose-driven learning context of thematic clusters, students' learning motivation was enhanced, and learning effectiveness was improved. While facing the reality of the number of fewer students in our next generation, it is hoped that a long-lasting effect of the curriculum reform is that both the teachers and students will be more invested. With the results observed from the participants, the current study suggests a process of theme-based curricular reform within one specific discipline of mechanical engineering as part of the STEM majors in higher education.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by Chair of Department of Mechanical Engineering, Chung Yuan Christian University, Taiwan. The research data collected and related research procedure conducted regarding the New Engineering Curriculum Program at our department has met the following codes: (1) Research is conducted in a commonly accepted educational setting. (2) The research involves normal educational practices (e.g., comparison of instructional techniques). (3) The study procedures do not represent a significant deviation in time or effort requirements from those educational practices already existent at the study site. (4) The study procedures involve no increase in the level of risk or discomfort associated with normal, routine educational practices. (5) The study procedures do not involve sensitive subjects. (6) Provisions are made to ensure the existence of a non-coercive environment for those students who choose not to participate.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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