Engineering Curriculum Reform Based on Outcome-Based Education and Five-Color Psychology Theory

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Abstract: Innovation in curriculum design at the system level is crucial for nurturing students’ sustainability skills. This study focuses on the teaching reform of a hydraulic engineering construction and management course, taking a sustainable development perspective and achieving a harmonious integration of knowledge acquisition and skill development. A “One Center, Two Platforms, and Three Education” teaching model is devised, incorporating outcome-based education and five-color psychological theory. This model encompasses a student-centered approach, leveraging the Chaoxing platform and a virtual simulation experiment platform while addressing theoretical, practical, and ideological-political education. The study participants consisted of water and hydropower engineering students at the School of Energy and Power Engineering, Xihua University. This teaching model not only enhances students’ learning motivation but also elevates their academic performance. Moreover, the model has yielded notable improvements in students’ overall quality, independent learning abilities, and innovation aptitude. The effectiveness of this teaching model in engineering courses has garnered positive feedback from both graduates and employers, who acknowledge its contribution to enhancing teaching quality and promoting sustainable development in engineering education. Furthermore, this model can serve as a reference for enhancing college education and fostering students’ abilities and ethical standards.

Keywords: engineering education for sustainability; five-color theoretical psychology; outcome-based education; sustainable development; hydraulic engineering

1. Introduction

The future development of global civilization faces numerous significant challenges, such as energy depletion, environmental degradation, and biodiversity loss [1]. In response, sustainable development has emerged as a paramount concern since the 20th century [2]. The 1980 outline on world natural resource protection emphasized the interconnectedness of nature, society, and the economy in sustainable development [3]. The 2015 Paris Accord solidified a consensus on addressing the impacts of climate change [4]. The UN Sustainable Development Goals (SDGs) represent a comprehensive social transformation agenda [5], with a focus on social-ecological systems. The concept of sustainability was originally proposed by Hans Carl von Carlowitz in the 18th century [6], and the Brundtland Report defined it as meeting the needs of present and future generations. Although sustainability has multiple definitions, they all share the common objective of achieving the SDGs [7]. The SDGs encompass 17 goals centered around people, prosperity, peace, partnership, and the planet, aiming to eradicate poverty, protect the environment, and ensure shared prosperity [8]. This vision entails economic prosperity combined with equity and justice, serving as both a roadmap and a transformative process toward a sustainable world. Education is recognized as a crucial element for effectively implementing the SDGs [9,10]. The reform of
higher education reflects the collective understanding that sustainable development should be integrated across all fields of study [11–13].

The UN conference on the Human Environment held in 1972 marked a significant milestone in promoting education for sustainable development [14]. This was followed by the Talloires Declaration, which elevated the importance of sustainability in universities. The United Nations Decade of Education for Sustainable Development (DESD) further emphasized the integration of sustainable development principles into learning and teaching [15]. Matthias Barth and colleagues have critically examined teaching practices related to sustainable development and highlighted the need for evolving teaching requirements [16]. They have also explored the concept of sustainable development capabilities in higher education and proposed approaches to incorporate competencies into teaching practices [17,18].

Traditional engineering education has traditionally focused on theoretical knowledge and practical applications [9]. However, the challenge in integrating sustainability into engineering education lies in the need for innovative teaching methods [19]. Numerous studies have highlighted the importance of incorporating sustainability into the curriculum as a crucial step in effective sustainable development education. This trend has been gaining momentum since 2015 [20,21], although the integration of sustainable development goals into university curricula is still in its early stages. Scholars have explored various approaches to introducing sustainable development into university courses [22]. Active learning techniques [23–25] and other tools and methods have been identified as valuable resources for enhancing teaching effectiveness. Additionally, the development of sustainable development competencies should be integrated into university curricula. The United Nations recommends the inclusion of critical thinking, self-awareness, and problem-solving skills [26]. Furthermore, multidimensional thinking, diverse approaches, and the ability to learn independently should be considered [27].

Curriculum reform plays a crucial role in enhancing the sustainability of education. In China, with the implementation of the professional certification system for engineering education, there has been increased attention on reforming engineering education. The Washington Accord, an agreement on the mutual recognition of undergraduate degrees in engineering education, has further emphasized student-centered and outcome-oriented approaches. Student-centered teaching methods have been widely adopted in Western countries. For instance, Portugal has implemented peer learning as part of higher education reform [28]. In Brazil, project-based learning (PBL) and cooperative learning have been applied to curriculum reform in geotechnical engineering at the Technical University of Valencia [29]. In Dublin, PBL has been utilized in the teaching of civil engineering at University College Dublin (UCD) [30]. PBL, a teaching method commonly employed in higher education [31], involves the teacher acting as a facilitator [32], placing the student at the center of the learning process, and enhancing learning efficiency [33] while improving soft skills [34]. By mapping student learning outcomes to the learning objectives of the course, projects can be constructed to improve students’ soft skills [35]. PBL was used in chemical engineering education, electrical engineering, and so on [36,37]. Uziak has demonstrated the ability to use PBL methods in engineering courses [38]. Noordin reports on the benefit of PBL methods in improving the non-technical skills of engineering students [39]. In Japan, person-centered approaches have been utilized in STEM education [40]. In Ghana, the flipped classroom approach has been employed to integrate the curriculum and enhance students’ learning outcomes and self-efficacy [41].

The implementation of the student-centered teaching method has been proven to greatly enhance the effectiveness of teaching. Drawing upon the principles of outcome-based education (OBE) theory and five-color psychology theory, this study focuses on the curriculum reform of water resources engineering management in the engineering field. The study develops a teaching model called “One Center, Two Platforms, and Three Education” and explores the integration of sustainable development into engineering
education. This research presents a novel approach to fostering students’ learning abilities and nurturing their innovation mindset.

2. Basic Information of the Hydraulic Engineering Construction and Management Course

2.1. Main Content

Xihua University, located in Sichuan province, is a prominent comprehensive university committed to making significant contributions to education. In accordance with the university’s mission and the objectives of major training, the hydraulic engineering construction and management course is a fundamental course for students majoring in water conservancy and hydropower engineering. This major was recognized as a school-level key major and a university-level special major in 2019 and 2011, respectively. In 2014, it was selected as an “Excellent Engineer Education and Training Program” in Sichuan Province, and in 2015, it became an important talent training base. Currently, 530 students are enrolled in this major, with an annual intake of approximately 120 students, and the employment rate has consistently exceeded 91%.

Hydraulic engineering construction and management involves the systematic management process of planning, organizing, coordinating, and controlling water conservancy projects. It is an interdisciplinary subject that intersects management knowledge and engineering technology [42]. The course is characterized by its strong comprehensiveness and practicality [43]. It consists of 56 h of instruction and carries 3.5 credits. The course focuses on the construction of hydraulic structures in water conservancy projects and provides a systematic exploration of the fundamental concepts, principles, and methods of construction technology and organizational management in water conservancy projects. The course is divided into eight chapters, covering topics such as water flow control, blasting technology, foundation treatment technology, the construction of earth and rock dams, concrete dam construction, underground construction, construction organization, and construction management.

2.2. Main Objectives

The main goals of this course are as follows:

(1) Develop an understanding of the advantages, disadvantages, and accomplishments in the field of hydraulic engineering. Conduct scientific experiments and research related to water conservancy engineering to instill students with engineering professional ethics, social responsibility, and scientific literacy.

(2) Acquire a comprehensive knowledge base and technical skills in water conservancy and hydropower engineering construction. This includes proficiency in blasting technology, foundation treatment, and dam and underground engineering construction principles, methods, and procedures. Develop the ability to apply engineering knowledge in practical scenarios and make informed decisions regarding construction methods and strategies. Enable students to independently tackle various challenges in water conservancy and hydropower engineering.

(3) Foster design consciousness and teamwork skills. Enhance proficiency in hydraulic engineering design, ensuring that designed structures meet construction technology requirements and facilitate smooth construction processes. Engage in collaborative teamwork activities to develop effective communication and interpersonal skills.

(4) Gain an understanding of the fundamental principles, methodologies, and case studies in modern hydraulic engineering construction management. Cultivate strong engineering practice and project management abilities.

(5) Familiarize students with relevant national standards, laws, and regulations governing hydraulic engineering. Expand their knowledge beyond the major, covering social, economic, and other interdisciplinary subjects. Develop independent learning capabilities.
2.3. Urgency of the Course Teaching Reform

Currently, the course is taught in a traditional manner, with teachers utilizing PowerPoint presentations [44] to facilitate student learning and understanding of key course concepts. Students’ performance is primarily assessed through final exam scores. However, this traditional teaching approach often results in students struggling to apply theoretical knowledge to practical problem solving [45]. Many students possess strong theoretical knowledge but lack practical skills, making it challenging for them to transition smoothly into professional practice after graduation. In today’s society, there is an increasing demand for students to possess a broader range of abilities.

To address these challenges, it is crucial to implement student-centered teaching methodologies that prioritize stimulating students’ interest in learning and fostering their independent learning and innovation skills. The teaching approach for the water construction and management course requires urgent reform to cultivate graduates who possess practical talents that are in high demand within society.

3. Design of the Curriculum Reform

This study employs a systematic top-level design approach to accomplish the objectives of the course across five key areas: teaching goals, teaching activities, teaching strategies, teaching resources, and teaching philosophy. These components work together to create an effective framework for the course, as illustrated in Figure 1.

Figure 1. Systematic top-level design of curriculum reform.

Building upon the five dimensions mentioned earlier, the study has developed a “One Center, Two Platforms, and Three Education” teaching model, as depicted in Figure 2. The model revolves around a student-centered approach, with a focus on fostering ideolog-
itical and political thinking and practical skills and stimulating students’ enthusiasm for learning. It incorporates a hybrid teaching environment that combines both online and offline elements, aligning with the teaching ecology of engineering education professional certification. In the online teaching environment, teachers assign tasks, schedule exams, and keep track of students’ progress as they study online, participate in discussions, and take exams. In the offline teaching environment, teachers guide students to develop a variety of activities, including oral presentations, thematic debates, practical activities, academic research reports, and virtual simulation experiments, to stimulate learning interest and improve comprehensive ability. The two platforms encompass the utilization of the Chaoxing platform and a virtual simulation experiment platform. The three aspects of education encompass theoretical learning, practical application, and ideological and political education. This comprehensive teaching model aims to create an engaging and effective learning environment that caters to the needs of students while promoting their holistic development.

![Diagram: New teaching mode of water conservancy project management](image)

**Figure 2.** New teaching mode of water conservancy project management.

### 3.1. One Center

In 1994, American scholar William G. Spady introduced a systematic explanation of OBE. OBE focuses on defining specific learning goals that students are expected to achieve upon completing the educational process [46]. This model gained significant traction in the United States and Australia during the late 20th century [47]. OBE involves designing educational plans, teaching content, and evaluation systems with a predetermined focus on the desired learning outcomes. By adopting this approach, teaching quality can be enhanced. The core principle of OBE is that the student becomes the central figure in the educational process (as depicted in Figure 3). Educational methods, processes, structures, and courses are seen as means to facilitate student success, not just in terms of grades but also in terms of enhancing students’ abilities for life and work. Teachers play a crucial role by prioritizing student-centered instruction and emphasizing the development of stu-
Students’ comprehensive qualities and abilities to achieve effective teaching outcomes [48, 49]. Figure 4 provides a visual representation of the OBE model.

Figure 3. Student-centered teaching mode.

Figure 4. OBE model.

3.2. Two Platforms
3.2.1. Chaoxing Online Learning Platform

The complex and abstract nature of course content often diminishes students’ interest and enthusiasm for learning while simultaneously making it challenging for teachers to gauge students’ learning progress and provide timely feedback. To address these issues, the reform initiative incorporates the Chaoxing online learning platform.

With the rapid development of the Internet, online learning has gained widespread popularity in higher education [50]. Many universities in China have implemented massive open online courses (MOOCs) or small online courses [51]. This educational model offers a wealth of resources and overcomes geographical and social limitations [52]. In this reform, teachers record video lectures explaining the fundamental concepts of the course, which are then uploaded to the online learning platform for students to access. Online courses effectively optimize teaching time by focusing on delivering basic knowledge. Figure 5 illustrates the flow chart of the online learning process.
The Chaoxing online platform is a dedicated online learning platform accessible through smartphones, computers, and other mobile devices. It offers a wide range of learning resources to support students’ online learning experience. Through this platform, students can engage in online study, participate in discussions, and take exams, taking full advantage of the information technology provided by the teaching website. Figure 6 depicts the user interface of the online system operation, showcasing the functionalities and features of the Chaoxing online platform.

![Online teaching flow chart.](chart1.png)

**Figure 5.** Online teaching flow chart.

Within this system, teachers have the capability to assign tasks, conduct section tests and exams, and monitor students’ learning progress. They can gather and upload various learning resources, such as documents, videos, animations, and pictures, onto the platform, enabling students to study independently. Table 1 presents the learning resources available in this study. Furthermore, teachers can access statistics on students’ learning time, providing insights into their learning progress (Figure 7).

![Online system operation interface.](chart2.png)

**Figure 6.** Online system operation interface.

**Table 1.** Teaching resource statistics.

<table>
<thead>
<tr>
<th>Type</th>
<th>Video</th>
<th>Document</th>
<th>Animation</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>78</td>
<td>98</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>Proportion</td>
<td>28.26%</td>
<td>35.51%</td>
<td>10.87%</td>
<td>25.36%</td>
</tr>
</tbody>
</table>
In OBE teaching, the focus is on the learning outcomes achieved by students, and traditional examinations remain the primary method of evaluating these outcomes, usually in paper-based format rather than online exams [53].

On the Chaoxing platform, teachers organize various types of questions aligned with the course objectives. The examinations consist of multiple choice, true/false, short answer, and calculation questions. The weightage assigned to each section is 30%, 10%, 20%, and 40%. The total score for each student is calculated based on their performance in these four sections. Students access the exams using their unique identification numbers and passwords. The system randomly selects a set of test papers for each student. Students are required to complete the exam online within a designated time frame, and their scores are automatically calculated. The average score across all test papers is used to evaluate students’ academic achievements. Measures are implemented to prevent cheating [54]. To discourage searching for questions online or using multiple devices, certain precautions are taken. First, although the content of the questions in the exam may be similar to those found online, the data or answers are different. Second, students are restricted to logging in from a single device. Additionally, the position of question types within each set of test papers is randomized. Finally, students are required to use webcams throughout the exam for monitoring purposes [55]. These measures aim to ensure the integrity and authenticity of the assessment process.

3.2.2. Virtual Simulation Experiment Platform

In addition to theoretical instruction, experimental teaching is an essential component of this course. Virtual simulation technology enhances the practicality of course experiments by making them more intuitive, repeatable, and interactive [56]. This technology offers a promising avenue for teaching reform. Considering the complexity, hazards, and time-consuming nature of water conservancy construction, conducting physical experiments becomes challenging. To address this, this study introduces a virtual simulation experimental platform at Xihua University. This platform allows students to engage in highly realistic and interactive simulations of the entire water conservancy construction process. Within this virtual environment, students can design and operate within a simulated scene, enabling them to gain a comprehensive understanding of the theory, techniques, and methods involved in constructing typical hydraulic structures. The virtual simulation
center at the university has undergone its initial construction phase, as depicted in Figure 8, providing a dedicated facility for this purpose.

![Virtual simulation experiment](image_url)

**Figure 8.** Virtual simulation experiment: (a) classroom of virtual simulation experiment; (b) virtual simulation experiment system.

The virtual simulation platform offers various features, including guidance mode, experimental equipment introduction, and voice broadcasting. These functions provide students with comprehensive guidance and facilitate their exploration and innovative design within the virtual environment. The platform offers a wealth of experimental modules, including diversion construction, concrete dam construction, underground construction, and construction organization and management. Upon the completion of each experiment, the system automatically evaluates students’ knowledge assessment and operational processes, assigning a total score of 100 for each part. Furthermore, the system generates an experiment report in Word format automatically. The students’ study outcomes are evaluated based on the quality and content of their experimental reports. These reports serve as an essential assessment tool for evaluating students’ understanding and application of experimental concepts and techniques.

### 3.3. Three Education

#### 3.3.1. Theoretical Education

Theoretical knowledge is of great importance for students in this major, and this study integrates outcome-based education (OBE) and five-color psychology theory into the entire teaching process. Students are encouraged to develop five types of thinking: life, critical, logical, economic, and aesthetic thinking.

Color plays a significant role in our perception of the world and can independently impact our thoughts, actions, health, and happiness [57–59]. Drawing upon color psychology principles, color can enhance and motivate our learning experiences [60]. The five-color theoretical psychology represents a foundation for innovative thinking, encompassing five fundamental types of thinking: green life, red critical, purple logical, golden economic, and blue aesthetic thinking. It is shown in Figure 9.

Online self-study incorporates golden economic thinking, which focuses on students achieving their goals under optimal conditions. Students can adjust their learning progress according to their individual needs and participate in online tests to facilitate efficient learning. The grades obtained in these online tests evaluate this section of the course.
Life thinking serves as the foundation for innovation and breakthroughs. By realizing their independence, students can unleash their creativity. Oral and PowerPoint presentations are encouraged, in which students choose a research problem aligned with their interests and review relevant literature within the context of the course. This culminates in a 20–30 min presentation, which is evaluated by the teacher based on content, timing, interaction, and fluency of speech.

Red critical thinking guides students in identifying and asking questions, solving problems through reasoning and judgment, and developing their analytical and problem-solving abilities. Thematic debates are conducted during teaching on topics such as engineering ethics, the advantages and disadvantages of engineering, and environmental impact. Both teachers and students participate in the grading process for this section.

Logical thinking is essential for understanding innovative concepts and realizing reform. Through purple logical thinking, teachers explain frontier theories in the classroom to help students memorize and grasp knowledge more effectively while stimulating their curiosity and interest in research. Students demonstrate their understanding by completing research reports, combining their expertise, literature reviews, and exploration of cutting-edge technologies.

To make originally abstract and tedious learning content more intuitive, virtual experiment technology is introduced, incorporating relevant graphics, animations, and videos. With the aesthetic thinking of blue, which captures students’ attention, their learning mode transitions from passive acceptance to active engagement. The evaluation for this section is based on the experiment report.

By integrating these different types of thinking and incorporating engaging teaching methods, the study aims to enhance students’ learning experiences and promote their active participation and understanding of the course material.

3.3.2. Practice Education

To further enhance their understanding of engineering sites and develop their ability to integrate theory and practice, students are provided with opportunities to visit project sites. This allows them to gain first-hand experience and practical knowledge. Table 2 illustrates the practice locations and the corresponding learning content, providing a comprehensive understanding of the engineering field. Additionally, the college organizes on-campus lectures and invites industry experts to share insights into cutting-edge research developments and engineering technologies. These lectures offer students a clear
understanding of the industry’s development prospects. Moreover, by establishing partnerships with 20 enterprises, including China Yangtze River Three Gorges Co., Ltd. (Beijing, China), National Energy Group, Yalong River Basin Hydropower Development Co., Ltd. (Chengdu, China), China Energy Construction Gezhouba Group, and China Electric Power Construction Capital Survey and Design Research Institute Co. (Beijing, China), students have opportunities to connect with industry professionals. These partnerships effectively contribute to their sustainable career development and employment prospects.

Table 2. Practice location and learning content.

<table>
<thead>
<tr>
<th>Number</th>
<th>Practice Location</th>
<th>Learning Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sichuan Zipingpu Development Co., Ltd. (Chengdu, China)</td>
<td>Understand the current status of the major and its development trends</td>
</tr>
<tr>
<td>2</td>
<td>Qingfengling teaching power plant</td>
<td>Understand the problems and solutions in the construction of hydraulic structures</td>
</tr>
<tr>
<td>3</td>
<td>Sichuan Wudu water diversion project</td>
<td>Learn the methods and principles of hydraulic devices’ layout</td>
</tr>
<tr>
<td>4</td>
<td>Guolangqiao hydropower station of Datang</td>
<td>Learn the design, construction, and procedures of hydraulic engineering</td>
</tr>
<tr>
<td>5</td>
<td>Dujiangyan water conservancy project</td>
<td>Learn about the positive and negative effects of hydraulic engineering</td>
</tr>
</tbody>
</table>

3.3.3. Ideological Politics Education

In June 2020, the Ministry of Education issued a document emphasizing the importance of ideological and political education throughout the teaching process. This education aims to assist students in developing sound value judgments and making ethical choices [61]. The document highlights the integration of ideology and politics, which helps students cultivate moral character, personal qualities, abilities, and initiative. Ideological and political education is considered a fundamental task within the field of education [62].

As part of the comprehensive reform of the new education mode, efforts are being made to identify and incorporate curriculum elements that contain ideological and political components. The objective is to achieve the goal of “mining and integrating the fusion point of ideological and political knowledge and theoretical knowledge”. Within the classroom, teachers consciously engage in discussions related to topics such as “science and technology innovation” and “ecological sustainability” [63]. Students are encouraged to undertake research studies that align with their professional interests, stimulating their motivation to learn. This approach leads to comprehensive improvements in teaching quality. It also guides students in establishing a correct worldview, values, and outlook on life. Ultimately, it cultivates outstanding engineering talents with an international perspective, a sense of national pride, and strong professional ethics.

4. Evaluation and Effect of the Curriculum Reform

4.1. Evaluation of the Implementation Process

The evaluation of the curriculum reform implementation process involves conducting interviews with experts, universities, and students to gather comprehensive feedback (summative evaluation). This feedback serves to improve the curriculum reform system and make it more effective and rational.

Expert evaluation: Professors Jin from Tsinghua University, Zhang from Fuzhou University, Guo from the China Institute of Water Resources and Hydropower Research, and Cui from Xi’an University of Electronic Science and Technology provided positive reviews of the course. They recognized it as a distinctive course aligned with the principles of outcome-based education (OBE) theory. They acknowledged its innovative curriculum design and its successful achievement of the curriculum training objectives.

University evaluation: The university regards the performance of the course team as excellent, with commendable classroom teaching interactions. The integration of theory and practice has effectively realized the intended curriculum objectives.

Student evaluation: This course is highly regarded by students and consistently ranked among their favorite courses. The teaching performance of the course team consistently received the highest assessment ratings over the years. Students appreciate that while mastering knowledge, they also experience a significant improvement in their practical
abilities. Furthermore, teachers demonstrate timely attention to students’ psychological well-being and effectively guide them in developing healthy values.

These evaluations from experts, universities, and students collectively demonstrate the success and positive impact of the curriculum reform, highlighting its effectiveness in achieving the desired outcomes and creating a favorable learning environment.

4.2. Evaluation of the Effect of Curriculum Reform

4.2.1. Evaluation of Student Exam Grades

The evaluation of students’ exam grades encompasses both online tests and regular performance assessments, as illustrated in Figure 10. The details of the evaluation process are as follows:

1. Online test part (summative evaluation):

   Students’ test results from online exams are considered part of the summative evaluation. The final online test grade contributes to the assessment of students’ performance in this section.

2. Regular performance (formative and summative evaluation):

   Regular performance evaluation comprises several components:
   (a) Experimental report parts: Each part of the experimental report is evaluated formatively.
   (b) Whole experimental report: The complete experimental report is assessed as part of the summative evaluation (20% weightage).
   (c) Oral presentations: The quality of students’ oral presentations carries a weightage of 40% in the assessment.
   (d) Thematic debates: Students’ participation and performance in thematic debates contribute to 10% of the evaluation.
   (e) Research report: The research report submitted by students accounts for 10% of the assessment.
   (f) Practice study report: The evaluation includes students’ performance in the practice study report, with a weightage of 20%.

3. Overall evaluation (summative evaluation):

   The overall evaluation combines the online test scores (70% weightage) and the regular performance assessment (30% weightage), resulting in a comprehensive summative evaluation.

   This evaluation framework ensures a comprehensive assessment of students’ knowledge, skills, and performance, incorporating both formative and summative evaluation methods. The distribution of weightage among the different assessment components is depicted in Figure 10.

   A total of 410 students from the School of Energy and Power Engineering at Xihua University participated in a comparative study of academic performance. All participants were pursuing bachelor’s degrees, and no postgraduate students were included in the survey. Table 3 provides an overview of the participants.

Table 3. Statistics of participants.

<table>
<thead>
<tr>
<th>Year</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>82 (27.2%)</td>
<td>27 (24.8%)</td>
<td>109 (26.6%)</td>
</tr>
<tr>
<td>2020</td>
<td>80 (26.6%)</td>
<td>25 (22.9%)</td>
<td>105 (25.6%)</td>
</tr>
<tr>
<td>2021</td>
<td>69 (22.9%)</td>
<td>28 (25.7%)</td>
<td>97 (23.7%)</td>
</tr>
<tr>
<td>2022</td>
<td>70 (23.3%)</td>
<td>29 (26.6%)</td>
<td>99 (24.1%)</td>
</tr>
<tr>
<td>Total</td>
<td>301 (75.6%)</td>
<td>109 (26.6%)</td>
<td>410 (100%)</td>
</tr>
</tbody>
</table>
The results of an independent samples t test comparing scores between 2019 and 2022 revealed a significant difference, with an average score increase of 3.4 points (M = 74.32, SD = 10.82). The t-value was −2.348 with 208 degrees of freedom, and the p-value was 0.02, which is less than the significance level of 0.05. The Shapiro–Wilk test was used to assess the normal distribution of grade distribution (Figure 11b), and the p-values for the four years were 0.115, 0.623, 0.09, and 0.08, respectively, indicating that the grade distribution follows a normal distribution.

It is noteworthy that students’ interest in learning increased during the pandemic lockdown period in 2020 and 2021. The transition to online exams and the introduction of virtual experiments allowed students to study theoretical knowledge and laboratory courses online from home. The feasibility and effectiveness of the reform plan were thus validated. Figure 11 presents the average grade results, demonstrating the positive impact of the implemented reforms.

As shown in Table 4, there has been a consistent increase in the number of excellent students and a decrease in the number of unqualified students over the years. The percentage of students achieving excellent grades rose from 2.7% in 2019 to 9% in 2022, representing a
significant increase of 6.3%. Furthermore, the rate of unqualified students dropped from 12% to 7%, reflecting a noteworthy reduction of 5%.

It is noteworthy that students’ interest in learning increased during the pandemic lockdown period in 2020 and 2021. The transition to online exams and the introduction of virtual experiments allowed students to study theoretical knowledge and laboratory courses online from home. The feasibility and effectiveness of the reform plan were thus validated. Figure 11 presents the average grade results, demonstrating the positive impact of the implemented reforms.

Figure 11. Statistics of average score from 2019 to 2022: (a) comparison of average grades from 2019 to 2022; (b) a normal distribution curve of score.

Table 4. Final grade level distribution of four years.

<table>
<thead>
<tr>
<th>Year</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unqualified (&lt;60)</td>
<td>13</td>
<td>14</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Qualified (60–70)</td>
<td>25</td>
<td>19</td>
<td>18</td>
<td>27</td>
</tr>
<tr>
<td>Medium (70–80)</td>
<td>48</td>
<td>40</td>
<td>41</td>
<td>31</td>
</tr>
<tr>
<td>Good (80–90)</td>
<td>20</td>
<td>26</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Excellent (90–100)</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>109</td>
<td>105</td>
<td>97</td>
<td>99</td>
</tr>
</tbody>
</table>

4.2.2. Evaluation of Course and Course Objective Achievement Degree

The evaluation of the curriculum reform’s effectiveness involves assessing the degree of curriculum achievement. To align with the requirements of engineering education certification, the teaching syllabus is modified to redefine the weight assigned to each course objective. The weights for the five curriculum objectives are set as follows: 0.1, 0.3, 0.2, 0.15, and 0.25. The assessment of each course objective is divided into two parts: the online exam part (weighted at 0.7) and the regular performance part (weighted at 0.3). This weight distribution reflects the importance of both summative and formative evaluations in measuring students’ achievement of each curriculum objective. Figure 12 provides a visual representation of the weight assigned to each curriculum goal, reflecting the prioritization and emphasis placed on different aspects of the curriculum.

The achievement degree of course objectives $D_m$ is obtained as:

$$D_m = \sum_{n=1}^{Max_m} \frac{w_{mn} A_n}{S_n}$$

where $Max_m$ is the total number of evaluation parts for the $m$-th curriculum goal. $S_n$ is the full score of the $n$-th part under the curriculum goal, and $w_{mn}$ is the weight of the $n$-th part under the $m$-th curriculum goal. $A_n$ is the average score of the $n$-th part.
The achievement degree of the course OA is calculated as follows:

\[ \text{OA} = \sum_{m=1}^{5} D_m \times w_m \] (2)

where \( D_m \) and \( w_m \) are the achievement degree and weight of the \( m \)-th curriculum goal, respectively.

Tables 5 and 6 show the course achievement degree from 2019 to 2020 and 2021 to 2022, respectively.

![Figure 12. The weight of each goal.](image)

<table>
<thead>
<tr>
<th>Year</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course objective achievement degree</strong></td>
<td>D₁</td>
<td>D₂</td>
</tr>
<tr>
<td>2019</td>
<td>0.738</td>
<td>0.658</td>
</tr>
<tr>
<td>2020</td>
<td>0.7101</td>
<td>0.72975</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course objective achievement degree</strong></td>
<td>D₁</td>
<td>D₂</td>
</tr>
<tr>
<td>2021</td>
<td>0.745</td>
<td>0.815</td>
</tr>
<tr>
<td>2022</td>
<td>0.7485</td>
<td>0.75175</td>
</tr>
</tbody>
</table>

4.3. Achievements and Application of the Reform Course

Over the past six years, the teaching team of this course has received recognition and support for their efforts in curriculum reform. They have been granted two provincial and ministerial teaching reform projects, two school-level teaching reform projects, and two school-level “first-class” curriculum construction projects. Additionally, they have published seven papers on teaching reform, showcasing their commitment to advancing teaching practices.

Furthermore, the major successfully obtained the China Engineering Education Professional Certification and international accreditation Washington Accord in 2022, further validating the effectiveness of the curriculum reform. This means that engineering graduates with professional certificates will have their degrees recognized by other members of the Washington Accord and will also be treated in the same way as local graduates when applying for postgraduate degrees in countries and regions participating in the Washington Accord.
The curriculum teachers actively engage in professional exchanges and continuously strive to stay at the forefront of teaching innovation and reform. They actively promote curriculum reform initiatives and share their experiences with other courses such as “Water Conservancy Engineering Management”, “Modern Hydraulic Structure Design”, “Water Resources Planning and Utilization”, and “Hydraulic Buildings.”

The efforts put into curriculum reform and teaching innovation have yielded positive results. Over the past six years, students’ abilities have improved significantly. This improvement is evident through their achievements in discipline competition awards, scientific papers, invention patents, and participation in scientific projects, as summarized in Table 7. The students’ notable accomplishments highlight the positive impact of the implemented reforms on their academic and professional development.

Table 7. Achievements of course reform from 2016 to 2021.

<table>
<thead>
<tr>
<th>Year</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition award</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>15</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Scientific paper</td>
<td>7</td>
<td>11</td>
<td>13</td>
<td>18</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>Invention patent</td>
<td>28</td>
<td>21</td>
<td>20</td>
<td>24</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Scientific project</td>
<td>37</td>
<td>44</td>
<td>52</td>
<td>54</td>
<td>61</td>
<td>60</td>
</tr>
<tr>
<td>Outstanding graduates</td>
<td>11</td>
<td>13</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>20</td>
</tr>
</tbody>
</table>

In addition, the employment rate of students has improved. Figure 13 shows a profile of graduate students.

![Figure 13](image-url)

Figure 13. Employment rate and distribution: (a) employment rate of students; (b) the distribution of graduate students.

Based on the survey conducted, the results indicate that 80% of graduates and employers believe that all course objectives have been achieved (refer to Figure 14). Specifically, 89% of the respondents felt that goal 5 had been completely or largely achieved, and 89% and 87% believed that goals 1 and 3 had been fully or significantly reached, respectively. These findings suggest that the students have acquired a strong grasp of engineering theories and professional knowledge, demonstrating high vocational literacy and adaptability to the evolving demands of society and industry.
First, the student-centered teaching model shifts the focus from teachers to students, leading to improved teaching methods and strategies that align with the requirements of engineering education accreditation. This model has received positive feedback from experts, schools, and students, resulting in the course being recognized as a first-class key construction course at Xihua University. Furthermore, the major successfully obtained the China Engineering Education Professional Certification and international accreditation Washington Accord in 2022, solidifying its credibility and effectiveness.

Second, the teaching model has demonstrated improvements in student achievement, indicating that it has enhanced students’ independent learning abilities and practical skills. The model also fosters students’ innovative thinking, resulting in fruitful outcomes across various aspects. Over time, the degree of course achievement has increased steadily. Moreover, the evaluation of graduating students and the rate of goal achievement have both exceeded 80%. Employers have praised the students for their sustainability-related competencies.

Last, this teaching model emphasizes student-centered teaching and integrates theoretical education, practical education, and ideological and political education throughout the entire teaching process. By doing so, it provides a valuable reference for curriculum construction and lays a strong foundation for achieving the goal of sustainable development.

Overall, the implementation of the teaching model based on OBE and five-color psychological theory has yielded positive results, benefitting both students and the broader educational community. It not only enhances students’ learning outcomes but also contributes to the cultivation of their practical skills and innovative thinking, ultimately supporting the realization of sustainable development objectives.

Figure 14. Graduate and employer satisfaction with the achievement of course objectives: (a) survey results of graduates; (b) survey results of employers.

When considering the responses from employers, 89% of them felt that goal 3 had been completely or largely achieved, followed by 88% for goal 5 and 87% for goal 1. This indicates that employers are highly satisfied with the engineering theory and professional knowledge, as well as the professional quality, learning, and development ability of graduates from this major.

5. Conclusions

This study proposes a teaching reform for a hydraulic engineering construction and management course based on OBE and five-color psychological theory. In line with the principles of sustainable development, a “One Center, Two Platforms, and Three Education” teaching model is constructed. The impact of this model extends beyond this particular course, as it has been successfully applied to other courses, yielding positive outcomes.

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Author Contributions: Conceptualization, A.H. and X.M.; formal analysis, M.W. and S.Z.; investigation, C.F.; writing—original draft preparation, A.H. and X.M.; writing—review and editing, A.H., X.M. and C.F. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

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