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Research on the Improvement of Vocational College Student's Learning Input Under the "Three Education" Reform: Taking the Chemical Engineering Course as an Example

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Abstract: Taking the chemical engineering course as an example, this paper discusses the path to improving the learning input of higher vocational students under the background of "three education" reform. Through the in-depth analysis of teachers, teaching materials, and teaching methods, a series of concrete reform measures are put forward, including the change of teachers' roles, the update of teaching materials, and the innovation of teaching methods. Practice has proved that these measures can effectively improve the learning input of higher vocational students, improve the teaching quality, and provide strong support for training high-quality chemical technical personnel.

Keywords: "Three education" reform; Higher vocational students; Study commitment; Chemical unit operation technology course

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1. Current situation of vocational students' learning input under the background of the "three education" reform

Under the background of implementing the "National Vocational Education Reformation Plan", the reform of teachers, teaching materials, and teaching methods in higher vocational colleges is collectively called the "three education" reform [1]. The "three education" reform was initiated through the "20 Measures for Vocational Education" plan. In the same year, the Ministry of Education launched the "Double High Plan." Aligned with the new talent concept, teaching, and quality standards, the reform of the "three education" has emerged as a crucial strategy for advancing the establishment of the "Double High Plan" technical skill talent training hub [2].

China's higher vocational education is transitioning into a phase of high-quality development, with chemical engineering majors in higher vocational colleges shouldering the critical responsibility of producing skilled professionals for society. The quality of talent training has increasingly become a public concern. In recent years, there has been a growing emphasis on evaluating learning quality, with learning input serving as the focal point of assessment in higher vocational education [3,4]. According to a 2020 report from the Vocational and Technical Education Center Research Institute of the Ministry of Education, the overall level of learning investment among vocational college students is only 61% [5]. Additionally, students in vocational colleges commonly encounter issues such as low enthusiasm for learning both inside and outside the classroom, limited depth of understanding, insufficient practical learning time, and inadequate post-class self-study time. In response to this situation, higher vocational colleges need to conduct thorough self-analysis and devise practical measures to address these challenges [6-8].

2. Background and concept of design

2.1. Background of design

The theoretical foundation of learning design is rooted in the constructivist theories of Piaget and Vygotsky, representing an effective reform of classroom teaching methods [9]. The constructivist teaching approach places students at the center, viewing them as active participants in the construction of knowledge and meaning. In this framework, teachers serve primarily as facilitators and guides, assisting students in the process of knowledge construction. Unlike the traditional teacher-centered "instructional design," "learning design" is aimed at guiding students toward achieving specific learning objectives. It leverages learning activities as the vehicle and students' individual learning contexts as the foundation, tailoring learning tasks, environments, and organizational structures to accommodate varying levels of student proficiency. Moreover, it emphasizes the ongoing feedback and adjustment of teaching methods or plans based on the actual learning experiences of students [10,11].

2.2. Principles of learning design

According to constructivist learning theory, students are the center and are active creators of their own learning experiences. In this model, teachers primarily serve as facilitators, aiding and encouraging students in constructing meaning, rather than simply imparting knowledge directly.

2.2.1. Highlighting the centrality of students

Clarifying the importance of a "student-centered" approach holds significant guiding value for teaching design. Firstly, it is essential to fully stimulate students' initiative and cultivate their thinking skills throughout the learning process. Secondly, students should be provided with multiple opportunities to apply their knowledge in various real-world situations. Lastly, students should be encouraged to develop their own understanding of objective concepts and devise solutions to practical problems based on the feedback they receive. These three points — empowering initiative, facilitating knowledge application, and fostering self-feedback — are the fundamental elements that epitomize a student-centered approach.

2.2.2. Constructivism holds that learning is closely related to a certain socio-cultural context

When learners engage in learning within their real-life situations, they are able to assimilate and internalize new knowledge by integrating it with relevant experiences within their existing cognitive framework. This process enables learners to assign specific meaning to the new knowledge.

2.2.3. Emphasizing "collaborative learning" in meaning construction

The interaction between learners and their environment is fundamental to understanding learning content, representing a core tenet of constructivism. Facilitated by teachers, students engage in discussions and communication to establish learning communities. Within these groups, students collectively explore diverse theories, ideas, and hypotheses, initially consulting among themselves before engaging in broader discussions. Through this collaborative learning environment, the collective thinking and wisdom of the learners are shared, allowing for the co-construction of meaning from the acquired knowledge [9,10].

2.2.4. Focusing on designing the learning environment rather than the teaching environment

The learning environment is a place where learners can explore freely and learn independently. In this environment, students can use a variety of tools and information resources to achieve their learning goals. Students can not only get help and support from teachers but also work with and support each other. According to this idea, learning should be promoted and supported rather than strictly controlled and dominated. The learning environment should be a place that supports and promotes learning [11,12].

2.2.5. Emphasizing the use of various information resources to support learning rather than teaching

In order to support learners' active exploration and meaning construction, they need to be provided with various information resources (including various types of educational media and materials) during the learning process. It should be made clear that the purpose of these media and materials is to support students' independent learning and collaborative exploration, rather than to assist the explanation and demonstration by teachers.

2.2.6. Emphasizing that the ultimate goal of learning is the realization of meaning construction rather than the achievement of teaching objectives

In traditional instructional design, teaching objectives are of paramount importance, as they are both the beginning and the end of the teaching process. The content and order of teaching content can be determined based on the teaching objectives, and they form the basis for assessing teaching effectiveness and conducting evaluations. In a constructivist learning environment, however, students are viewed as active participants in knowledge construction, with their meaning-making processes representing the ultimate goal of learning. Therefore, instructional design in such an environment should focus on creating situations conducive to students' construction of meaning. The entire instructional design process centers around facilitating meaning construction, whether through independent exploration by students, collaborative learning activities, or guidance provided by teachers [13,14].

2.3. Methods of learning design

Teachers can approach learning design from three key aspects. Firstly, they can design learning tasks, where learners are responsible for completing tasks while teachers offer support to facilitate task completion. Secondly, teachers can design the learning environment, including physical and digital tools, resources, and space arrangements, to provide learners with the necessary resources for engagement. Thirdly, teachers can design a social framework to foster effective learning groups through both face-to-face and remote interactions, enabling flexible and efficient teamwork learning. Research indicates that learning design positively impacts students' self-efficacy in learning [5]. By leveraging concepts, principles, and methods of learning design, teachers can effectively design courses to enhance student learning. This, in turn, can improve students' learning engagement across behavioral, emotional, and cognitive dimensions, thereby fostering greater participation in learning activities.

3. Approach to improving the learning input of vocational college students with the chemical engineering major as an example

The Unit Operations of Chemical Engineering course of chemical engineering majors was taken as the study subject to carry out case analysis of learning design:

3.1. Pre-class

Unit Operations of Chemical Engineering serves as a foundational professional course offered during the second semester of freshman year and the first semester of sophomore year. It represents the initial practical course for students in the field. At this stage, students typically lack a clear understanding of chemical production processes. To address this, the teaching team has developed a project library focusing on the production of nylon material intermediates. Students have the option to select topics directly from the project library or choose topics independently. Regardless of the method chosen, students are required to adhere to the following principles when selecting their topics: (1) Adoption of a reasonable process route for the chemical production process to construct a complete production process. (2) Inclusion of at least four unit operations, such as fluid transport, heat transfer, rectification or absorption, and drying, within the production process. (3) Completion of selection and calculation tasks related to conveying equipment, heat transfer equipment, or separation equipment, as applicable.

3.2. Task allocation and project implementation

After selecting their topics, the teacher guides students to consult literature, determine the process flow, identify the chemical production equipment involved, and delineate the unit operations necessary for completing the process design. Each project is then decomposed into the following six sub-projects:

(1) Production process determination

Students define the production process, create a process flowchart, and specify the typical equipment for each operational unit.

(2) Fluid conveying unit design

Students determine the length and diameter of conveying pipelines, select appropriate conveying equipment, and conduct installation and calculation tasks for the chosen equipment.

(3) Heat transfer unit design

Students select heating or cooling mediums, establish inlet and outlet temperatures for these mediums, calculate their consumption, determine the system’s heat transfer rate, complete heat exchange area calculations, equipment process size calculations, and select suitable heat exchangers.

(4) Separation unit design

Students select separation units for material and heat balance, perform typical equipment size calculations (e.g., theoretical plate number, tower height), and complete related tasks.

(5) Drying unit design

Students conduct material and heat balance for the drying system, select drying mediums, determine their consumption, specify final product quality requirements and required drying time, and complete calculations for drying equipment selection.

Students should complete the above five sub-projects sequentially according to the project order.

3.3. Project evaluation

The project evaluation includes the design process (20%), the design description (50%), and the defense (30%). After the completion of the project, the project team is required to submit a project design statement. The evaluation of the design process involves intra-group mutual evaluation (60%) and student self-evaluation (40%). Evaluation criteria include individual task completion (20%), task quality (60%), and individual contribution to the project (20%). Intra-group mutual evaluation employs an online anonymous scoring method, with the arithmetic average serving as the score. The weighted average of intra-group and individual self-evaluations determines the individual design process score. For the design description, students work in groups to submit a design specification. Evaluation is based on teacher assessment (70%) and inter-group evaluation (30%), utilizing anonymous online evaluation. Group leaders act as judges, and the weighted average determines the group score. During the defense, each team member is responsible for a portion, with judges posing questions to the group or individual members. The defense team assesses group performance in terms of collaboration, logical expression, principle application, design process, and response to questions. Each stage of the defense is completed by the team members, with a student in charge of a different stage. The judges may ask questions to the whole group or a member of the group. The defense team evaluates the defense performance of the whole group in terms of group collaboration, logical expression, principle application and design process, and answering questions.

4. Path of learning input improvement for chemical engineering students in higher vocational colleges

Firstly, it is essential to conduct a thorough analysis of the learning situation, creating a detailed "student profile" to enhance emotional engagement. This involves deeply understanding students, including their interests, habits, methods of learning, past experiences, and potential challenges. By crafting personalized learning goals and tasks tailored to different student profiles, valuable learning activities can be implemented. Individualized teaching strategies are then applied to cater to learners' diverse needs, providing various platforms for student expression.

Secondly, forming learning groups fosters collaborative learning, thereby increasing students' behavioral engagement. Collaborative learning entails students coming together as a learning community to tackle complex tasks collectively. This approach reduces cognitive burden and cultivates an atmosphere of inquiry and participation in the classroom.

Thirdly, innovating learning activities and integrating tools and resources can enhance students' cognitive engagement. Learning design revolves around learners' needs, with teachers developing activities that resonate with students' experiences. This approach nurtures students' autonomy and facilitates the attainment of learning objectives. The aim of learning design extends beyond knowledge acquisition and exam success; it aims to foster knowledge construction. Teachers should innovate both the format and content of learning activities, leaving room for student individuality and autonomy. Encouraging students to generate knowledge and actively participate in diverse learning activities is key.

5. Summary and prospect

Learning design embodies a learner-centered approach, focusing on student development and individual differences, while emphasizing the pivotal role of students in the learning process. Recognizing the prevailing issue of low learning engagement among vocational college students, the author proposes leveraging learning design principles alongside three dimensions of learning engagement to enhance student involvement. Firstly, a thorough analysis of the learning environment and crafting a detailed "student portrait" are crucial to boosting emotional engagement. Secondly, establishing learning groups for collaborative learning fosters behavioral input. Lastly, innovating learning activities, integrating tools and resources, and enhancing cognitive input contribute to student engagement. Teachers in higher vocational colleges can revolutionize their teaching methodologies through the lens of learning design. By adopting the foundational model of learning design and exploring various methods and technologies, educators can accumulate effective practice cases and integrate the concept into daily curriculum teaching. Strengthening guidance and support for students' learning input will ultimately facilitate their growth and talent development.

Disclosure statement

The author declares no conflict of interest.

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