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Exploration of Process-oriented Assessment Based on the Course of Tolerance Detection and Technical Measurement

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Abstract: Based on the concept of output orientation and integration of course politics, learning effect is the evaluation standard of course with the purpose of promoting the development of students. For course Tolerance Detection and Technical Measurement, that 20 times of usual process-based assessment and 6 types of assessments are set up based on teaching plan of all chapters of the course contents under the process-oriented assessment. With the analysis and comparison of the learning effect, students can score more examination points and perform more satisfaction with the integration of theory, practice and the training of ability to analyse and solve problems.

1. Introduction

The "40 Guidelines for Higher Education in the New Era" is issued by China's Ministry of Education in 2018. It gives further emphasis that academic assessments of college students should have rich content, diverse forms, and a multi-dimensional evaluation system [1]. Final exam scores should not be the primary measure of learning progress of students. Different from the single assessment mode of traditional teaching, the most significant feature of process-oriented assessment under blended teaching mode is that the assessment process no longer focuses on the final result of learning, but divides the learning result into different stages [2]. In every stage and chapter of course learning, there are corresponding quiz, which will combine online with offline, theory with practice, individual presentation with group cooperation, independent learning with collective learning and students' self-study with teachers' guidance, so that students can enjoy the joy of learning during the process [3]. At the same time, feedback of learning effect can be received in time during the process-oriented assessment. The students also can find the joy of the study and enjoy the sense of gain and achievement during study. And the personality of students can be explored instead of only focusing on the final examination. Furthermore, process-oriented assessment indirectly reduces the pressure of the final exam and avoid problems such as poor grades caused by low test-taking abilities under the traditional results-oriented assessment mode. Therefore, the confidence and motivation of students will be enhanced, and their learning ability will be further cultivated. The traditional relationships will be changed by designing goals, content, learning material, joint planning of assessment and program evaluation, the use of holistic approaches between teaching and assessment procedures and their agreement with the participants of the learning process to create new ones, then expanding functions, which takes the process to a completely different height [4].

2. Course description

"Tolerance Testing and Technical Measurement" is taught as a core compulsory course for the major of Mechanical Design, Manufacturing, and Automation. Fundamental knowledge and basic skills in tolerances and testing for mechanical products are primarily provided in this course. Learning effect of Students is the evaluation standard of this course, based on the concept of output orientation and integration of course politics, in order to promote the development of students. The content of the course consists of two parts: geometrical tolerance (including the basic concepts and methods of dimensional tolerance, geometrical tolerance, surface roughness, etc.) and geometrical inspection (including the basic knowledge of technical measurement, the principles of common measurement methods and the operation of measuring instruments). Therefore, in the curriculum, this course serves as a link between design courses and process courses, acting as a bridge from foundational courses to specialized courses.

3. Process-oriented assessment of course

3.1. Implementation process of process-oriented assessment

There are a total of 20 times of usual process-based assessment for course of Tolerance Detection and Technical Measurement. (a total of 6 types of assessments), covering all chapters of the course contents, and the specific implementations are shown in Table 1.

Table 1: Implementations of course assessments.

Number	Task	Form	Proportion	The average	The highest	The lowest	Attendance	The pass rate
1	Quiz	Online test	8%	89.89	100	50	72	94.5%
2	Homework	Written homework	7%	89.15	100	60	73	93.2%
3	Performance	Oral answer Attendance	6%	89.71	100	30	73	97.3%
4	Mid-term examination	Written test	1%	72.70	96.5	38.5	68	86.3%
5	Tolerance design of the axis	Drawing design	8%	73.30	95	30	72	95.9%
6	Experiment	Skill Operation	20%	82.81	92	50	71	95.9%
7	Final exam	Written test	50%	66.18	94	22	73	72.6%
Overall			100%					

The overall evaluation grade of the course consists of two parts: regular assessments (including process and mid-term assessments) and the final grade, with each accounting for 50 percent. In view of learning attitudes, behaviors and outcomes observed by students, diversified assessment methods are adopted, including classroom performance (attendance and participation in discussions), eight in-class quizzes, eight homework assignments, one mid-term test, one large assignment (axial tolerance design), and eight experimental operations, providing a comprehensive evaluation for competencies of students. The integration of theory with practice encourages students to actively engage in the entire learning process. The specific assessment methods designed in combination with the curriculum objectives and their proportional distribution are shown in Table 2. The theoretical teaching hours are primarily conducted through in-person instruction, employing a combination of classroom lectures and heuristic questioning/discussion methods. This approach is centered around ideological and political education cases to effectively link knowledge points of tolerances and measurement, forming a knowledge system. The experimental teaching hours use a demonstration-based teaching approach.

Table 2: The components of the score and their proportion.

Target	**Main points**	**The components of the score and their proportion(%)**						**Proportion (%)**
		Components					**Final examination**	
		Performance	**Quiz**	**Exercise**	**Homework**	**Experiment**		
1	Geometric precision design, the basic principle and method of geometric measurement	2	3	3	0	2	26	36
2	Geometric measurement experiment, measuring instruments and testing methods	2	3	2	0	15	0	22
3	Tolerance standards checking, tolerance and fittings marking	2	2	3	8	3	24	42
Total		6	8	8	8	20	50	100

3.2. Evaluation of process-oriented assessment

The design and evaluation of the process-oriented assessment are based on the undergraduate cultivating program and the course syllabus. The evaluation standard of the assessment content is based on learning effects of students with the aim of promoting student development. The assessment covers the entire course. The questions and formats are set and adjusted according to the key and difficult points of the course content. There are scientific assessment methods, diversified assessment forms, widely covered content. And the assessment process can be traced back. The assessment results are fair and the assessment results can comprehensively and accurately reflect the learning situation of students. Besides, the academic records leaf a mark throughout the whole course, and the assessment records of ordinary grades are shown in Table 3.

There are five scoring gradients for each assessment session according to students' performance and degree of completion, of which 100-90 points are fully mastered, 80-90 points are well mastered, 70-80 points are generally mastered, 60-70 points are basically mastered and less than 60 points are not mastered. In order to evaluate the learning effectiveness of students accurately and comprehensively, the course has developed different evaluation criteria for each of the three course objectives. Details are shown as follows:

Scoring criteria for target 1: Master the basic principles and methods of geometric precision design and detection of mechanical parts, and design the rationality of geometric precision of mechanical parts according to the requirements of use, accuracy of identification and judgment of tolerance standards involved in testing items.

Scoring criteria for target 2: The ability to formulate an experimental plan for the testing items involved in the geometric testing of mechanical parts and the ability to reasonably select and design measuring instruments and testing methods based on the basic principles of geometric testing.

Scoring criteria for target 3: The familiarity with basic knowledge of tolerance testing and technical measurement and various national standards should be improved. It is essential to learn the development, current status and trends of national standards and relevant standards of the International Organization for Standardization (ISO). And the understanding and analysis of the geometric accuracy of parts in mechanical drawings, as well as the lookup and application of tolerance standards should be obtained.

Table 3: Examples of full records under process-based assessment

		Example No.	**1**	**2**	**3**	**4**	**5**
		Name	**One Zhang**	**Two Zhang**	**Three Zhang**	**Four Zhang**	**Five Zhang**
Classroom Performance	6%		95	94	93	86	84
In-Class quiz	1.00%	Quiz1	91	68	100	91	90
	1.00%	Quiz2	81	80	82	100	98
	1.00%	Quiz3	100	82	80	100	98
	1.00%	Quiz4	100	82	100	100	98
	1.00%	Quiz5	72	52	100	100	98
	1.00%	Quiz6	0	50	100	98	82
	1.00%	Quiz7	90	0	100	98	70
	1.00%	Quiz8	82	0	100	100	98
	Test summary		77	52	95	98	92
After-Class assignment	0.50%	Homework 1	80	100	100	100	100
	0.50%	Homework 2	85	75	95	90	90
	1.00%	Homework 3	89	70	100	100	80
	1.00%	Homework 4	60	75	80	82	80
	1.00%	Homework 5	80	60	90	85	80
	1.00%	Homework 6	70	70	90	88	85
	1.00%	Homework 7	95	98	80	85	95
	1.00%	Homework 8	95	95	90	90	100
	1.00%	Test	67	0	87	91	91
	Summary of Assignments		80	69	89	90	88
Practical design	8%		80	80	70	90	80
Experiment	20%		87	85	86	84	92
Total score of regular assessments	50%		83.85	77.34	86.37	88.2	88.72

3.3. Implementation examples and assessment target

Figure 1 gives dimensional tolerance design assessment test case in the third chapter of the course. And in-class quiz is used to consolidate the theoretical knowledge. The homework is used to let students combine the needs of actual hole shaft design to design different nominal sizes and different mating needs of hole shaft tolerances. All these assessments will further consolidate the theoretical knowledge of students. The process-oriented assessment of each chapter all follow the principle that theory is closely linked with practice, and guide students to have a deeper understanding of course contents in a progressive manner, then achieve the purpose of application what they have learned.

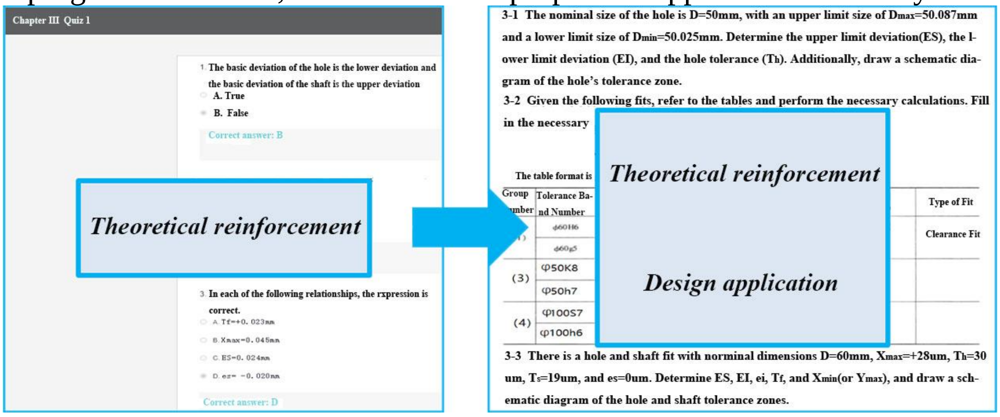

Figure 1: Testing cases of course chapter 3 with process-based assessment.

The practical design is the design of shaft. Through the study and assessment of theoretical knowledge in each chapter of the course of Tolerance Detection and Technical Measurement (including in-class tests and homework), they can design parameters such as dimensional tolerances, geometric tolerances, surface roughness, and accuracy grades based on operational conditions by previous courses study of Engineering Drawing, Principles of Mechanics, Mechanical Design, and Metalworking Practice. This lays the foundation for subsequent courses like Mechanical Manufacturing Technology and graduation projects. All process-based assessment will provide knowledge reserve for students to achieve better results in robot competition, mechanical engineering innovation competition and other competitions, consolidate professional foundation, and cultivate new engineering talents with practical engineering application ability.

Figure 2 shows the contents and roles of the experimental course. The theoretical part of the course mainly explains the mechanical product design process of precision design. The experimental part of the course consists of 8 parts, mainly involved in the measurement and inspection. And the precision designs, measurements and inspections are to ensure the quality of mechanical products which are essential requirements of technical aspects of the product. The experiments can help students to feel the actual measurement and inspection of technical requirements and then strengthen their cognition of theoretical knowledge.

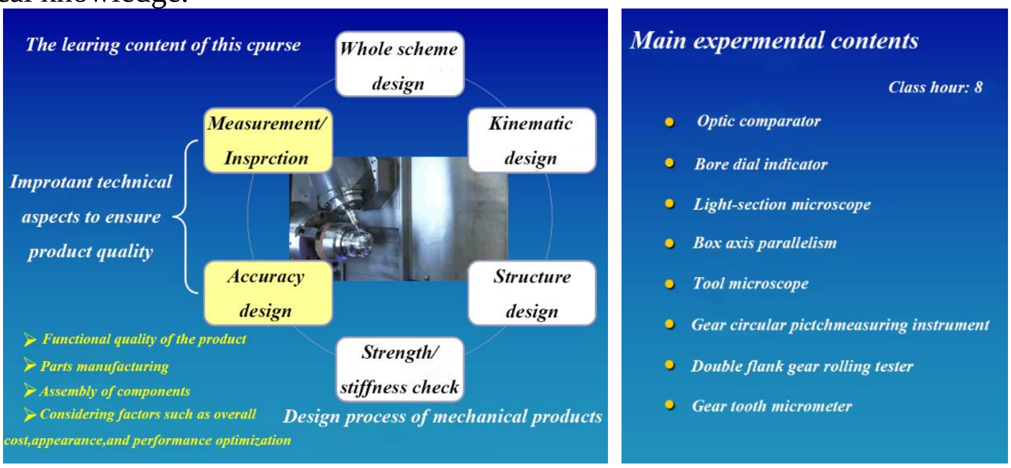

Figure 2: The content and purpose of laboratory classes in the course.

4. Effect analysis of process-oriented assessment

With process-oriented assessments, this course enables students to reasonably design and select the basic accuracy indicators of mechanical products based on its performance and requirements. It guides them to express their design concepts through correct tolerance notation, and to understand the main instruments and tools for measuring geometric parameters. Additionally, the process-oriented assessment of course aims to cultivate and establish a correct outlook on life, as well as good professional qualities and ethics. Table 4 presents the results of student evaluations of the course. Among them, 61 students were satisfied with the integration of theory and practice, and a total of 56 students expressed satisfaction with the training of students' ability to analyze and solve problems. Figure 3 shows the grade distribution of process-oriented assessment, with 2 students scoring more than 90 points in the tolerance course in the academic year of 2023-2024-1. However, there is 0 student scoring more than 90 points in the traditional assessment. Moreover, the percentage of 70-80 subsections is higher, and the percentage of subsections below 60 points is lower.

Table 4: Feedback from students.

Academic year: 2023-2024 Term: 1 Course: Tolerance detection and technical measurement Teacher's grade: 92.6692 Questionnaire numbers: 73 Effective questionnaire numbers: 65								
Number	**Standard**	**The average**	**Satisfaction**	**Proportion**	**Excellent**	**Good**	**General**	**Poor**
1	Be serious and responsible in teaching and give lessons on time.	94.54	94.538	0.1	63	2		
2	Be logical in explaining the points with clear words and accurate concept.	94.08	94.077	0.2	61	4		
3	Diversify the lessons while highlighting the main points and link the theory to the fact.	94.08	94.077	0.2	61	4		
4	Inspire and cultivate students' ability to find, analyze and solve problems.	92.92	92.923	0.2	56	9		
5	Create a great atmosphere through communicating with students and assign homework reasonably with careful correction.	92.46	92.462	0.2	54	11		
6	Effectively promote students' interest arm students with knowledge.	85.08	85.077	0.1	23	41	1	

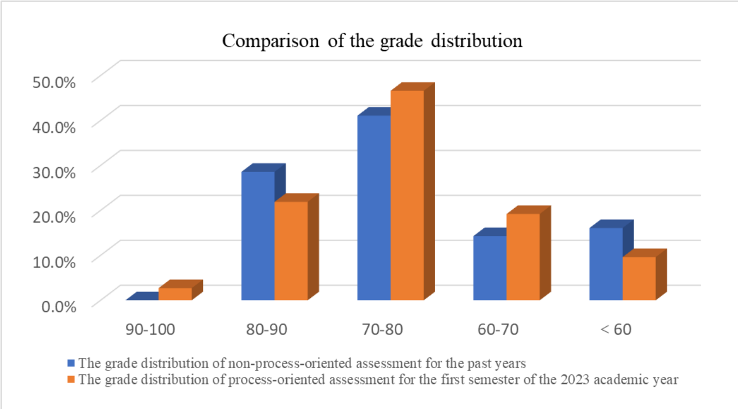

Figure 3: The comparisons of grade distribution for assessment effectiveness.

5. Difficulties and Improvement measures

5.1. Difficulties

The contents of the course involve dimensional tolerances, geometric tolerances, surface roughness, other related basic concepts and professional terms, in which the basic concepts and professional terms have high similarities and lack of interest, leading to some difficulties in students' interest in learning and knowledge mastery.

5.2. Improvement measures

a) The basic concepts and professional terms with high similarity in the course are compared and explained before and after chapters to guide learning interest.

b) Optimize in-class tests and homework questions to help students understand and break through important and difficult knowledge points.

c) Through interaction and discussion with students in class, the knowledge of the whole course is clarified and the learning initiative of students is stimulated.

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References

[1] Chen, C.Y., Chen, P.C., Chen, P.Y. (2012) Teaching quality in higher education: An introductory review on a process-oriented teaching-quality model. Total Quality Management & Business Excellence, 25(1–2), 36-56.

[2] Schreiber, N., Theyßen, H., Schecker, H. (2016) Process-oriented and product-oriented assessment of experimental skills in physics: a comparison. Insights from Research in Science Teaching and Learning, Springer, Cham. Contributions from Science Education Research, 2, 29-43.

[3] Rodrigue, J-M.G., Hunter, K.H., Scharlott, L.J., Becke, N.M. (2020) A Review of Research on Process Oriented Guided Inquiry Learning: Implications for Research and Practice. Journal of Chemical Education, 97(10)3506-3520.

[4] Pirchkhadze, M. (2023) Application of Process-oriented Methods and Approaches to Creating a Safe Environment in Higher Education Institutions. Collection of Scientific Works of Sokhumi University, 19, 2020-2021.