

Design of the Performance Evaluation Indicators for Tunnel Engineering Course

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The European Conference on Education 2023
Official Conference Proceedings

Abstract

The world is increasingly challengeable. High education would play an active role in this situation. As a traditional course needs redesigning, well-designed assessment for the course is necessary. Here is the design of the performance evaluation indicators for the Tunnel Engineering course at Chang'an University in China. Following the student-centred principle, an assessment system integrating students' learning and teacher's instruction grading is proposed to improve the course implementation. The student and teacher performance indicators focus on the students learning process and levels assessing, with the reference of the Bloom's taxonomy rubrics. 12 indexes are designed for learning performance to evaluate student's initiative, learning process and achievements, respectively. An indicator's grading is presented with the formative and summative assessments in an integrated dynamic mode. 10 indexes are applied in instruction performance grading in terms of the quality of preparation, class presentation, student's learning objective assigning, and the feedback, evaluation and instruction to student performance, respectively. The teacher's procedural performance is adjusted according to student's feedback, the effect of motivating and improving student's learning activities, while the final evaluation of a teacher's performance is checked with learning achievements on specified objectives. The quantitative or qualitative grading value for an indicator has been tuned both during instruction and at the end of a course or unit. The 12-year-practice results show that the designed evaluation indicators can provide connection between the course objectives and instruction and it is beneficial for evaluating and ultimately improving this connection to flexibly apply the evaluation indicators.

Keywords: Performance Evaluation Indicators, Student and Teacher, Design, Tunnel Engineering

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Introduction

The world is changing in various aspects. As digital issues play an increasing role in terms of personal lives and social activities, there are various newly-developed industries and numerous fields are increasingly reformed by the applications of the digital techniques. On the other hand, the world is increasingly challengeable. To adapt to the changing and challengeable world, high education would play an active role in this situation, such as through leading the reform of learning and teaching procedure in the engineering education. Since there appear new fields or industries with an increasing rate, the changing and challengeable situation in engineering education would be more urgent and significant.

Engineering education has a fundamental, global, and leading strategic position in social development (Li, 2020). Qualified and sustainable engineering education should be adapted to the requirements of contemporary and future society. The development and transformation of modern society benefits from the development and application of contemporary technology, and this trend will become increasingly significant in the future (OECD, 2015). In this process, engineering education needs to face the new requirements and challenges of the times (NASEM, 2018). In order to meet the requirements of the times, some emerging engineering education models (Graham, 2018; Stanford2025) or New Engineering Education Plan (Li, 2020) have emerged. Various innovations have been well recognized in terms of learning and teaching styles, such as Massive Open Online Course (MOOC), Small Private Online Course (SPOC), Flipped Classroom. Some innovation program in new engineering education, such as the Open-loop University in the well-known Stanford2025, the education styles at the Olin College of Engineering, have been well recognized in the world.

As there are new courses being added to meet the requirements of the new industries and some courses are even cancelled in the curriculum, a course for a specialty of relatively long history, such as Tunnel Engineering will share less time period. On the other hand, the contents of the existing course are also increasing with time. Therefore, the major curriculum needs adjusting in time, such as in terms of course and implementation plan design.

In terms of student-centered principle, the performance evaluation of both instructors and learners is vital to the success of a learning and teaching procedure. We instructors need know where we want students to be at the end of a course and how will we know if they get there or not. Assessment is vital to realize the planned target of a course. Although assessment is not new in education and a teacher is always engaged in an assessment, it is not an easy job to have a meaningful and effective assessment in practice. As assessment is to improve education or to service student learning, it should be based on the information about student learning and performance. Teachers would accordingly refine their teaching with the evaluation results of the students' performance. Here is the design of the performance evaluation indicators for the Tunnel Engineering course at Chang'an University in China.

Factors Under Consideration

The key factors under consideration for the design of the students and teachers performance evaluation indicators for the Tunnel Engineering course are presented as the followings.

1. Learning and Teaching Situations

In general, the learning and teaching situation is changing and challengeable. Education is in a constantly changing era, which is altered by the increasing information, various lifestyles. Of the engineering education situation, the key features include the followings.

(1) *Information is generally available for a learner but it is increasingly challengeable to cope effectively with the information around us.* There are various approaches of sampling information. The information available are much easy nowadays. It is vital to help the students to incorporate the sampled information into their knowledge system. For example, we are easily attracted by the information from Internet, WeChat, Tiktok, etc. It is convenient and fascinating to connectivity environment, such as enjoying the online shopping, information sampling and communication. The new information presentation and communication modes are generally beneficial to our living, studying and working. However, it is challengeable for an individual to take advantage of the information available, and the new living and working styles. It seems many aspects are changing, but some are not, such as the time itself to everyone. It is still 24 hours a day and 365 days a year. To education, the regulations of time schedule are almost unchanged, such as four years of college. In a narrow meaning, some of the new pattern information is easily abused, such as being our competition for resources, time, attention, and study enthusiasm.

(2) *Learning is a life-long issue and adaptation capability building is vital.* It is increasingly difficult to predict exactly what the new technology will be in the future, though all of us admit that there will be new breakthroughs in some fields. The capacity of adapting to the changing environment is one of the indexes of successful college student and is vital to students' profession development. Learning and work are to a large extent highly proactive and self-disciplined tasks. With self-management ability, one can take the initiative and all aspects would be smoother, such as in terms of effective work time increasing.

(3) *Techniques applied in learning and teaching are increasing.* Many information presentation styles are different from the traditional modes, which are mainly in forms of printed or handwriting. Although it is an effective way teaching with a blackboard, there are various other useful measures, such as PPT, video, flash, etc. However, it seems not an easy job to effectively use the techniques available in practice, especially at a specific learning and teaching stage or issue (Ma, 2023). Teachers should skillfully manage the techniques.

2. Course Features and Content Sampling

Tunnel Engineering is one of the sub-disciplines of Civil Engineering. To meet the requirements of development and usage of underground space in the world, tunnels increase in terms of types and the complexity of the structures. The information and knowledge system related to the subject Tunnel Engineering are increasingly accumulated with time, such as in terms of quantity, planning, design, construction, operation and management. The content related to the course Tunnel Engineering is increasing. On the other hand, as a traditional course, there is a decreasing tendency of the course hours in the curriculum.

To cope with the situation, the course design and implementation plan are accordingly adjusted with the course features under consideration. In course content preparation, the main points of the course should include planning and design, construction, operation and management in a system mode (Ma, 2022). For example, in the course information sampling,

with the consideration of tunnel performance and related factors, we focus on the required features of a planned tunnel and underground structure, construction plan and the environmental confinement of the related project, as well as their interactions in a tunneling procedure. In learning and teaching practice, the content should be specified to each step and stage in the learning and teaching procedure, respectively. For example, considering the students' knowledge building procedure and the course features in terms of the relationship between information, concept, structure and their components, activating points are designed to increase student engagement and systems thinking application (Ma, 2021, 2022). The evaluation measures and scales are accordingly designed in the course preparation.

3. Society Requirements

Education is timely tuned with requirements, in terms of personal and social issues. The social requirements are of general or macroscopic perspective and will be met through fulfilling personal needs. In terms of course design, the student's requirements are starting and procedure objectives, while the social requirements are ultimate objective. However, the both the personal and social requirements are changing. Therefore, the course design and plan implementation would be in a dynamic or iterative mode.

Student-centered course design and plan implementation will focus on student's capability development. As various factors will have influence on the results of the learning and teaching achievements, such as the current situation and characteristics of students, personal and social future perspectives, student's value shaping, college should create conditions for students and teachers should understand students' personalities and characteristics. For example, following "one person, one policy", each student has a specific training plan and responsible academic tutor. And therefore, everyone will stand out. However, we need consider not only the characteristics of personal requirements, but also the learning and teaching practical conditions. The learning and teaching performance will be with university characteristics, such as in terms of knowledge-level, personal abilities, and objectives.

4. Relationship of Learners, Instructors and Knowledge

Learning is a process of the interaction among the students, teachers and knowledge and would take place under certain context (Kozulin et al., 2003). Proper teaching practice is one of the key drivers to bear in mind for improving teaching quality and the academic achievement and motivation of students. The development of appropriate assessment instruments and intervention programs will allow instructors to service students' learning effectively. For example, a solitary achievement test is not enough. The assessment should focus on the level of student achievement indicating the learners' potential development through comprehensively considering their outcomes. A dynamic assessment is beneficial to present learner's learners' exact development, especially the potential progress in the future without assistance (Daneshfar & Moharami, 2018).

The purpose of curriculum design and classroom teaching reform is to enable students to comprehensively improve their learning level within a certain period of time. As the students' learning capability is various and changing, the syllabus of the course Tunnel Engineering is dynamically tuned, in terms of course content choosing, presentation styles, interaction between students and staffs, as well as effect evaluation. In simplicity, learning objectives, instructional strategies and assessments should be well aligned in the course design and plan implementation procedure. For example, the key factors to the learning and teaching results

of a course include: the content to be taught; the intentions and performances of both the students and staffs involved; as well as the course execution plan and evaluation measures. With the key focus of students' knowledge and capability building, the course assessments should reveal how well students have learned and what we want them to learn while instruction ensures that they learn it. Therefore, assessments, learning objectives, and instructional strategies should be closely aligned so that they reinforce one another.

5. Course Design and Implementation in a Dynamic Mode

In brief, course preparation should include content choosing, and also implementation and delivery plan in details, such as the roles of environmental/technical planning and instructional design. There also need student-staff partnership and interaction to filter and tune the course content and presentation styles, for the sake of being favorable to the student's capacity development. The actionable implementation plan, with specific content and presentation styles, are therefore prepared for learning and teaching practice (Ma, 2023). On the other hand, the outcomes should be timely assessed with the assumed criteria. Based on the feedback and evaluation results, the course design and implementation plan will be tuned in a dynamic way (Ma, 2023). As the course plan is executed in a dynamic mode, with special reference to the students' intentions and performance (Ma, 2022, 2023). In general, the results should be positively evaluated in time, such as to meet the student's various intentions of capacity development. The applied approach should be supported by the viability of the specified goals, the enthusiasm of the participants, the applicability and timeliness of the course information and resources.

As students' performance are evaluated, the staffs' intentions and performances are therefore checked in time, such as through discussion with students in a partnership way, quiz, test and assignment on the related learning contents. The experience shows that it is favorable to the student's capacity development that the students' performances are evaluated in an excitation mechanism (Ma, 2022).

Design of the Performance Evaluation Indicators

As the above-mentioned, both the students' and teachers' performance evaluations are included in the course design and implementation plan execution assessment. To design the both teachers and students performance evaluation indicators, the roles played by the learners and instructors should be under consideration. For example, in the full-life learning and teaching procedure, the quality of the student's learning outcomes are of the ultimate objective. Besides the parameters of design, assessment and evaluation, and facilitation under consideration, effective interaction is vital to create an effective learning community. In course procedure, the students will play an indispensable role (Ma, 2022, 2023). As the above considerations show that the design of the performance evaluation indicators will be learner-centered and outcome-based activities, the main focus is students' knowledge and capability building, which is evaluated with the Bloom's taxonomy (2001) in thinking skills or in terms of cognitive domains (Anderson & Krathwohl, 2001), as shown in Figure 1.

1. Instructors Roles and Performance Indicators

In the learning and teaching procedure, the instructor's roles include (Ma, 2023): (a) Subject matter expert; (b) Facilitator; (c) Manager; and (d) Assessor of student work. The performance evaluation will focus on the quality and results of the course preparation and

plan execution. In general, the intended outcomes could not be practical facts without effective activities, which would have been assessed in the related procedure, and experience is accumulated accordingly.

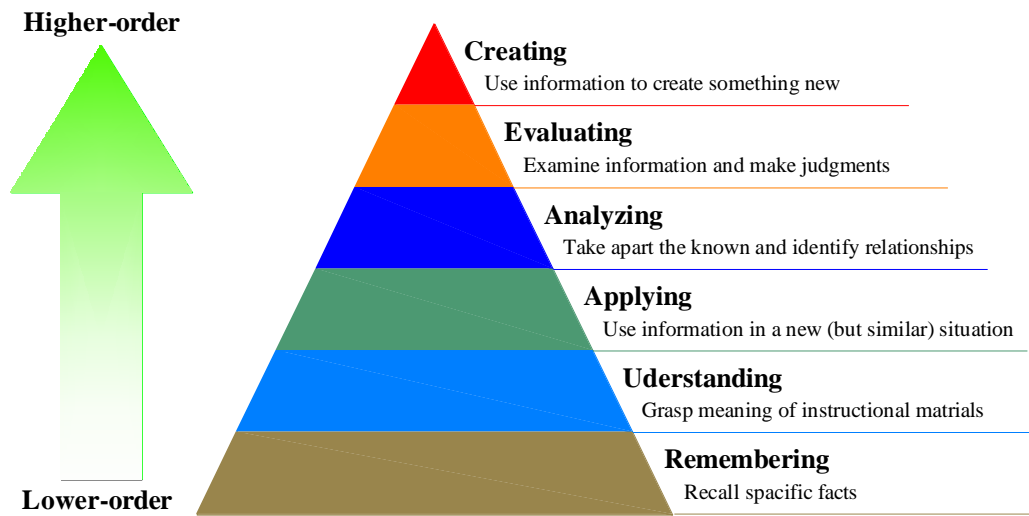


Figure 1: Sketch showing Bloom’s taxonomy (2001) in thinking skills and cognitive domains

In general, teachers’ performance indicators include: (1) Personal competence for an instructor, e.g., in terms of adaptability, education background, professional experiences; (2) Specific capability for a course teacher, as indicated with (a) Knowledge in the specified field, as an expert in course design or preparation; (b) Ability of course management or the performance in the learning and teaching procedure, as presented with six related items in Table 1; (c) Grade of the goal achievement and post evaluation. In terms of the course procedure, these indexes are presented as the performance in course preparation, learning and teaching process, and post evaluation.

Items No.	Indicators		Evaluation system			
			Indexes	Scale	Raters	Weight
1	Personal competence		Adaptability to the situation	1 - 5	Supervisors/Peers	0.7
					Students	0.3
2	Preparation	Course design	Content sampling and alignments	1 - 10	Supervisors/Peers	0.7
3					Implementation plan	1 - 10
4	Performance in the learning and teaching procedure	Performance in classroom	Lecturing	1 - 20		
5			Interaction, guiding, flexibility		1 - 10	Students
6				Performance outside classroom		Guiding and communication
7		Assignments and evaluation	1 - 10		Students	0.7
8					Step and stage evaluation	1 - 5
9		Tuning the design	Timely and effective evaluation	1 - 10	Students	
10					Post evaluation	Goal achievement and reflection
		Students	0.5			

Table 1: Teachers’ performance indicators and evaluation indexes

The Teachers' performance indicators and related evaluation indexes are tabulated with 10 indexes, which are designed with specific scale. The value of the scale is related to the contribution or importance of index in the students' knowledge and capability building. The maximum total value of the 10 indexes is 100 points. In practice, the score of each index is assessed by student-self and supervisors' or peers' evaluation, with value range of 0.2 to 0.8, respectively. The total value of the teachers' performance will be in the range of 10 to 100, as calculated with the left-side equation.

The evaluation of the indexes include index scale and weight presenting. The modes or approaches include: (1) Formative assessments, through (a) Questionnaire investigation, (b) Random Q & A, (c) Assignments and assessing results, (d) Ordinary performance recordings (esp. students); (2) Summative assessments; (3) Interaction and communication among these involved; (4) Achievement assessing and reflection. Based on the evaluated points by the raters with the scale system, the total value of the teacher's performance (T_{ip}) is calculated as: $T_{ip} = \sum_{i=1}^{10} S_i(W_{si} + W_{pi})$, where, S_i is the scale of the index i , with value range of 1 to 5 points, 1 to 10 points, or 1 to 20 points, respectively; W_{si} and W_{pi} are the weight of students' and supervisors' or peers' evaluation, with value range of 0.2 (20%) to 0.8 (80%), respectively.

1.1 Personal Competence

Teachers' competence could be generally presented with the adaptability to practical situation and is mainly related to their education background, professional and teaching experience, as well as their health condition. Since the competence is generally the basic requirement for a teacher, its evaluation scale is designed 1 to 5 points, which is assessed by supervisors/peers and students, with weight 0.7 (70%) and 0.3 (30%), respectively. The raters' weight is based on the significance to the evaluation results.

1.2 Performance in the Learning and Teaching Procedure

1.2.1 Course Preparation

Course design is the main point of course preparation, including content sampling and alignments, and implementation plan, with evaluation scale 1 to 10 points, and weight 0.7 and 0.3, respectively. Supervisors' and peers' rating is more significant than that of students.

1.2.2 Learning and Teaching Process

Teacher's performances in the learning and teaching procedure are presented with the performance in classroom, outside classroom, step and stage evaluation, and tuning the design. The performances both in and outside classroom are of importance and highly scaled, and indicated with two indexes respectively. The maximum of the total value would be 50 points, provided that they are 100% approved by the raters, as shown in Table 1. Considering the dominate position in teaching, lecturing is scaled 1 to 20 points. The interaction and guiding skills, as well as their flexibility in the procedure are scaled 1 to 10 points. Similarly, performances outside classroom, as indicated with guiding and communication with students, and assignments to students and effect evaluation, are scaled 1 to 10 points, respectively. As learning and teaching is a dynamic procedure and students' capability building would be in a spiral way, effective reflection to the goal achievement, especially for the step and stage

performance, is vital to improve in the future. As shown in Table 1, the weight of the rater's evaluation is valued as 0.2 to 0.8, respectively.

1.2.3 Post Evaluation

The post evaluation is performed at the end of a semester, especially for the assessment for the course goal achievement following a summative test. Effective reflection to the goal achievement is helpful to the next learning and teaching procedure, especially for the improvement of the course design and implementation plan. The post evaluation is scaled 1 to 10 points and the weight of the students and teachers evaluation is same as 50%.

2. Learners Roles and Performance Indicators

Of the learner's role & performance, we focus on the students' learning and cognition developing, in terms of pre-course and during the course, respectively. Considering the interaction among the students, teachers and knowledge under a specific context, students' attitude (e.g., active or not), the quality of playing the roles, such as learner, team-work, contributor to the course, are of key factors under considerations.

The students' performance indicators include: (1) Personal competence; (2) Preparation; (3) Performance in learning and teaching procedure, as indicated with Attitude, Beforehand working, Performance in class, Performance outside class, Knowledge and capability building, Self-tuning, Contribution to the course, respectively; and (4) Grade of the goal achievement and post evaluation.

As shown Table 2, the students' performance indicators and related evaluation indexes are presented with 12 indexes, with specific scale for each. Similar to evaluation of the Teachers' performance indicators, the maximum total value of the 12 indexes is 100 points, and the score of each index is assessed by student-self and teachers' evaluation, respectively. The total value of the students' performance will be in the range of 12 to 100, as calculated with the left-side equation. The total value of the student's performance (T_{sp}) is calculated as: $T_{sp} = \sum_{i=1}^{12} S_i(W_{si} + W_{ti})$, where, S_i is the scale of the index i , with value range of 1 to 5 points, 1 to 10 points, or 1 to 15 points, respectively; W_{si} and W_{ti} are the weight of student-self and teachers' evaluation, with value range of 0.2 to 0.8, respectively.

2.1 Personal Competence and Preparation for the Course

In terms of course goal achievement, students' personal competence focuses mainly on the adaptability to the course learning and is of the characteristics of knowledge preparation for the course. The indicators of the personal competence and preparation for the course are generally of basic conditions and the related evaluation scale is designed 1 to 5 points. For the personal competence, the weight of student-self is 0.7 (70%) with the students' self-evaluation before the course time under consideration.

2.2 Performance in the Learning and Teaching Procedure

The students' performance is evaluated with the indicators of attitude, beforehand working, performance in and outside class, knowledge and capability building, self-tuning and contribution to the course, with single or double indexes, respectively, as shown in Table 2.

The maximum total scales of the indicators for the performance both in and outside class and students' personal knowledge and capability building are 55 points, provided that the related assessing results by the raters are all of the highest scores. The learning attitude and self-tuning are scaled 1 to 10 points and the other two indicators, beforehand working and contribution to the course, are scaled 1 to 5 points, respectively.

Items No.	Indicators		Evaluation system			
			Indexes	Scale	Raters	Weight
1	Personal competence		Adaptability to the course learning	1 - 5	Oneself	0.7
					Teachers	0.3
2	Preparation		Background knowledge	1 - 5	Oneself	0.5
					Teachers	0.5
3	Performance in the learning and teaching procedure	Attitude	Initiative and persistence	1 - 10	Oneself	0.6
					Teachers	0.4
4		Beforehand working	Pre-class task completion	1 - 5	Oneself	0.6
					Teachers	0.4
4		Performance in class	Attending and finishing	1 - 15	Oneself	0.5
						Teachers
5			Interaction, group work, communication	1 - 5	Oneself	0.3
					Teachers	0.7
6		Performance outside class	Assignment completion	1 - 10	Oneself	0.3
						Teachers
7			Reflection and self-evaluation	1 - 10	Oneself	0.8
					Teachers	0.2
8	Knowledge and capability building	Formative assessments	1 - 10	Oneself	0.2	
					Teachers	0.8
9		Summative assessments	1 - 5	Oneself	0.2	
				Teachers	0.8	
10	Self-tuning	Tuning timely and effectively	1 - 10	Oneself	0.8	
				Teachers	0.2	
11	Contribution to the course	Feedback, criticizing and suggestion	1 - 5	Oneself	0.2	
				Teachers	0.8	
12	Post evaluation		Goal achievement and reflection	1 - 5	Teachers	0.3
					Students	0.7

Table 2: Students' performance indicators and evaluation indexes

2.3 Post Evaluation

The indicator post evaluation is designed to present the learning goal achievement and self-reflection from the course learning at the end of a semester. Effective reflection is helpful to the future learning. The post evaluation is scaled 1 to 5 points and the weight of the students' evaluation is 70%.

Discussion

The proposed performance indicators is based on the 12-year Tunnel Engineering course teaching experience at Chang'an University, in China. It is an iterative process, including the indexes choosing and raters defining, scale and the weight value evaluation, to design the indexes and their evaluating scales, raters and their assessing weights for an index. Of the total values of the performance, (1) the students' range in average is 65 to 85 points, with the maximum value 95 points; (2) the teachers' range in average is 65 to 84 points, with the maximum value 90 points. Being actively involved in the application of the performance indicators system is beneficial to the students' knowledge and professional thinking skill

development. The practice shows that the following points are vital to the effective application of the proposed performance evaluation indicators.

The Objectives of the Performance Indicators

Education is a social activity, in which learners are both participants and service recipients. A course is designed not only to transfer related knowledge to students, but also to improve their thinking capability. It is increasingly easier to know something, but it seems more challengeable to effectively incorporate the information available into one's own knowledge system. For a course with focus on professional knowledge, students' knowledge building and professional thinking skill development are the key goal achievement. Therefore, the indicators for the performance of both learners and instructors would service for this learning and teaching objective. The design of the performance indexes and related evaluation scales and weights would be favorable to realize the course goal achievement.

As the course procedure focuses on the student's knowledge and capability building, all of the indicators are designed to present their contributions to the related learning and teaching procedure. Considering effective learning is a self-discipline procedure and needs self-reflection, the indicators of the student's attitude, preparation ahead of the course, beforehand working, self-tuning and contribution to the course, are closely related to the students' performance. The results of the learning and teaching procedure are indicated with the learning goal achievement, such as in terms of knowledge and capability building. The indicators for the teacher's performance evaluation would be timely checked with the level of the student's goal achievement.

Relationship of the Involved

In a traditional learning and teaching procedure, teachers provide knowledge to students. As information and knowledge are easily available to students, it is necessary to modify our learning and teaching content and style to stimulate students' enthusiasm for personal knowledge system building and professional thinking capability development, such as in terms of acquiring and connecting knowledge, solving or defining problems, rather than just focusing on instilling knowledge. Therefore, students would play leading role in course learning and teaching procedure; teachers would be supporting role, such as course provider, director, guider, context and facility staff, etc. For example, there are numerous information available as we are increasingly immersed in a digital society. The importance of information sampling is accordingly increasing. The capacity of coping with the obtained information is more vital to both instructors and learners. The situation implies changing in course preparation and execution styles to adapt the requirement of the society.

As learning and teaching is procedure of the interaction between learners, teachers and knowledge in a specific context, which is usually presented with environment, facilities, culture and social values and expectations. In practice, teachers would design context for the specific issue and manage to prepare available facilities. However, good context is greatly depended on the relationship between learners and teachers, especially their positive and effective interaction. The evaluation scales and weights of the related performance indicators would effectively assess the performance of participant roles.

Dynamic Features

Course design and implementation plan execution are in a dynamic procedure, where there are interactions among students, teachers, environments and facilities etc. In general, there need pre-requirements for the application of the performance indicators, such as: (a) Course being well-designed; (b) Implementation plan being well-known, especially making it known to students before course time. The students' performances are more decisive to the level of the total values of both learners and teachers in a semester, esp. in the first few weeks.

The course knowledge is of system features, but student's learning is in steps. Effective learning is based on students' abilities, efforts, and active participation. Each learning and teaching step or issue must have a specific topic, which is previewed by students following carefully setting tasks and questions. And then students would actively engage in learning and teaching procedure. It is vital to activate students' subjective initiative, such as through process based assessment, students' participation in design, and joint construction between teachers and students. There need more opportunities for students' daily communication through various online and offline platforms to promote teacher-student communication. The commonly used approaches include instant feedback system, virtual teaching and research room, and process based assessment.

There are always adaptation and adjusting in the learning and teaching procedure, with the following features: (a) It is difficult and vital at beginning; (b) Assigning targets being in specific modes; (c) Applying both formative and summative assessments effectively; (d) Tuning the course design and implementation plan timely, with the learners' situation under consideration. The performance indicators and their evaluation would be favorable to this spiral progressive procedure, with student's initiative and persistence underlined.

Importance of Communication

As the performance indicators (Tables 1 and 2) show that communication between learners, supervisors and teachers is vital to the total course procedure, such as in content preparation, activities in and outside class, and post evaluation. There need responses from both learners, peers and supervisors to have effective course process. The results of the learning and teaching procedure would be assessed with evaluation indexes, which are performed by interaction and communication between the involved. For example, where interaction and communication are well, students will actively participate in the course process and will be favorable to activate students' subjective initiative. Received attention and respect from teachers, and students naturally responded positively. The daily communication could be online and offline platforms, such as instant feedback system, virtual teaching and research room, and process based assessment. Timely and effective communication would play a vital role to check and improve the course procedure and goal achievement.

Conclusion

Conclusions drawn from this study are: (1) Both students and teachers performance evaluation indicators are proposed for the Tunnel Engineering learning and teaching to improve student's learning achievement. (2) To be effective in the application of the performance indicators, the students' performances are more decisive in practice. (3) The application of the proposed performance indicators system would inspire the students being

actively involved and be beneficial to their knowledge and professional thinking skill development.

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