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The Evaluation Result of Online Master Course During Pandemic: Case of Industrial Management Course at Mongolian University of Science and Technology

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***Abstract*— This paper describes shortly about Mongolia, its higher education in current days, teaching during pandemic in Mongolia and evaluation of online master course at Mongolian University of Science and Technology (MUST). Mongolia is a developing country and the engineering education is one of the important issues of country development. There are comparatively high number of higher education institutions in country which proves need of families to support education of their children. The MUST is a public university which offers the most engineering study courses. The MUST offers bachelor, master and doctor programs in different fields. This paper covers teaching of master courses for "Industrial Management" professions at Graduate School of Business. Due to the pandemic situation the teaching format switched from traditional to fully online mode without any preparation time. Since winter semester of 2022 teaching format returned to face-to-face mode but it is still important to figure out feedback from students who attended master courses fully online during pandemic. Therefore, this paper describes evaluation model and evaluation results for the master course "Industrial Management".**

Keywords*— *teaching during pandemic, online master course, SURE, structure-oriented evaluation, Mongolia.

I. INTRODUCTION

1.1 Mongolia and its higher education

Mongolia is the second biggest landlocked country in the world after Kazakhstan [1]. The population of Mongolia is 3 296 866 and 50.8% is female and 49.2% is male. The citizens until 15 years old is 32.1%, between 15 and 69 is 65.5%, more than 70 years old is 2.4% [2].

In Mongolia children start to study from elementary school (first 5 years) and move to high school (from 6 to 12 years). After high school based on general nation exams pupils can apply for university or other educational institutions for different professions.

Engineering education is one of the key points of development in every country. Specially, for developing countries like Mongolia the engineering education is the important. The first public university, National University of Mongolia (NUM), was established in 1942 in the capital city of Ulaanbaatar [3]. Higher education plays major role in country development in many sectors: mining, construction, information and communication technologies, economy, agriculture for instance. In current days, 88 higher educational institutions are run in Mongolia [4]. 37 of them are universities, 48 are institutions and 3 are colleges. The number of public institutions is 20, private 65, middle 2 and 1 religion university in count. In total 147 293 students are studying for higher education. The Mongolian University of Science and Technology (MUST) was founded in 1959 as faculty of NUM [5]. Nowadays in MUST belongs 18 professorship, 11 departments, 37 faculties, 43 research centers and 4 research institutions.

1.2 Teaching during pandemic

The pandemic started slowly in Mongolia. Therefore, in the first months of pandemic higher education ran normally only with masks. On 11th November 2020 Mongolian government announced about strong lockdown for the whole country. Due to the lockdown all schools and universities switched their teaching format fully to online [6]. All teachers, learners and educational institutions were not fully prepared for this change. COVID-19 attacked the whole world and same challenges are faced by almost all countries in education sectors. Only Swedish government reacted in a completely different way and kept face to face teaching without masks [7]. Mongolia followed recommendations from UNESCO and

all educational processes were switched to fully online, distance model [8]. The television channels were used to deliver lessons for elementary and secondary schools to learners [9]. To support pupils' learning activities and to keep their learning motivation different projects started during pandemic, for example: E-travel; Knowledge channel [10].

Internet and different learning platforms were used to deliver university courses to students [11]. Most public universities had their own learning platforms for online teaching. For example, UNIMIS is the distance and online learning platform of the MUST and it was one of the basic learning spaces for all students and working place for professors [12]. All type of courses of all universities converted to online courses. This was an unexpected change in teaching and learning for professors and as well as for students. It happened and teaching was done. But questions are coming out about quality of online teaching and many professors started to do back thinking and self-evaluation for their online teaching [13] [14] [15].

1.3 Evaluation of online courses

The evaluation of online courses started in Mongolia quite early. Scholars applied different methods and models for evaluation of e-learning. Some authors offer to apply data mining algorithm for e-learning evaluation [16]. Lecturers of Mandakh university did self-evaluation of online course during pandemic period [17]. The Mandakh university evaluators used selective method for data collection and applied SPSS software for data processing. Many lecturers and professors did self-evaluation on their online courses: math course [18], statistic [19], electronic [20], virtual laboratory [21], teacher training courses [22], programming [23], content development [24].

The evaluation of e-learning developed early worldwide and it is continuously developing with different models and techniques. The quality of e-learning attracts attention from educational institutions and as well as professors. Some institutions tried to define evaluation criteria for e-learning [25]. The hexagonal e-learning assessment model (HELAM) applied to measure quality of learning management system (LMS) in multi-dimensional approach [26].

The UK universities applied Partial Least Squares - Structural Equation Modelling (PLS-SEM) to measure satisfaction of students [27], in China Technology acceptance model (TAM) was applied to find out effects of e-learning during pandemic [28], also the TAM model was applied to examine satisfaction of students of e-learning in Vietnamese higher education [29].

II. METHODS

To measure effectiveness of online master courses during pandemic we applied structure-oriented evaluation (SURE) model as evaluation methodology. The SURE model was created for evaluation of e-learning courses [30]. Therefore, we selected this model as main tool for our evaluation process.

2.1 Basic steps of the SURE model

The SURE model includes eight steps in evaluation process [30]:

- Key goal definition
- Sub goal definition
- Goal structure confirmation
- Evaluation criteria formulation
- Evaluation criteria confirmation
- Data collection
- Data processing
- Evaluation result report

The core of the SURE model is definition of evaluation goals. What has to be evaluated? What is essentially important for the evaluation? Which goals have to be reached successfully to measure positive achievement of evaluation objects? How can the key goals be achieved? These questions should be answered by the evaluation team before the start to design evaluation process. That means if the evaluation team applies the SURE model for an evaluation process above defined eight steps should be followed.

In first step, the evaluation team has to define essential important goals of evaluation. These goals are called in the SURE model as "key goals". The key goal structure is visualized as series of logical structures. And the final evaluation result will be positive or successful only, if all defined key goals achieve their evaluation goal successfully.

In second step, the evaluation team has to define sub goals which should work as in group for the success of the linked key goal. These kinds of goals are called in the SURE model as "sub goals". The logical structure of sub goals is parallel. And the final evaluation result of collective sub goals will be positive or successful, if any one of the sub goals reaches its goal successfully.

Third step is for confirmation of evaluation goals. Defined key and sub goals have to be checked and accepted by the evaluation team. Only confirmed evaluation structure can give access to next step.

In the fourth step, an evaluation checklist or criteria for data collection should be created. As the basis the sub goals of evaluation should be considered. The sub goals of evaluation should be re-formulated as data collection criteria.

Fifth step is acceptance step for data collection criteria or checklist. The evaluation team has to check and test all questions or criteria and based on that process the criteria for data collection should be proved. Only acceptance of criteria or checklist can give right to go to the next step.

In the sixth step, data should be collected from target groups. The target group can be students who attended the online course, or individuals who received learning courses by e-learning, or experts in e-learning who are doing accreditation evaluation of e-learning. Data should be collected online, if possible, by some open or free forms like Google form. Important is here that the data should be collected objectively not manually.

Seventh step is data processing step. In this step collected data should be calculated by the SURE formulas which are developed based on logical structures of evaluation goals.

Eighth step. Report and summary. After data processing the SURE online tool will produce results in table and include four different SURE scores. First one is general evaluation score, second is evaluation score of key goals, third is

evaluation scores of sub goals and last one is evaluation score of each response.

2.2 Evaluation process

This sub section describes evaluation process by the SURE model.

First step. Key goals of evaluation

The key goals of evaluation were defined in this step. Five key goals had to reach their goal to receive successful evaluation score after the evaluation process. There were:

- Quality of lecture (B1)
- Quality of seminar (B2)
- Quality of learning environment (B3)
- Quality of teaching (B4)
- Quality of online course in total (B5)

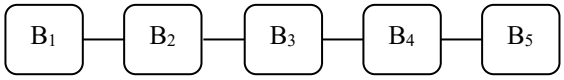

Fig. 1. Series logical structures for key goals

In Fig.1 shows related logical structures for key evaluation goals.

Second step. Sub goals of evaluation

Corresponding sub goals were defined in this step. First key goal consisted of five sub goals; second key goal consisted of three sub goals; third key goal consisted of four sub goals; fourth key goal consisted of four sub goals and fifth key goal consisted of five sub goals. There were:

Key goal B_1 - Quality of lecture

- Content of the lecture
- Schedule of lecture for online teaching
- Recorded video lecture
- Support from professor to understand lecture
- Theoretical knowledge from lecture

Key goal B_2 - Quality of seminar

- Content of seminar lesson
- Relation between theoretical knowledge from lecture to seminar lessons
- Skills improvement by seminar lessons

Key goal B_3 - Quality of learning environment

- Software which applied for online teaching
- Learning resources
- Learning environment for online learning
- Learning environment which supported by country wide

Key goal B_4 - Quality of teaching

- Preparation of professor for online teaching
- Quality of learning materials, files
- Teaching skill of professor for online teaching
- Response quality of professor to students' request

Key goal B_5 - Quality of online course in total

- Students' readiness for online learning
- Quality of e-learning environment in country
- Online learning and traditional learning
- Quality of online teaching
- Satisfaction of online learning
- Fig. 2 shows related logical structures for sub goals of evaluation.
- *Third step.* Confirmation of evaluation goal structures
- The evaluation team: Professor who teaches the course and evaluation expert both accepted the goal structures.
- *Fourth step.* Creation of checklist for data collection.

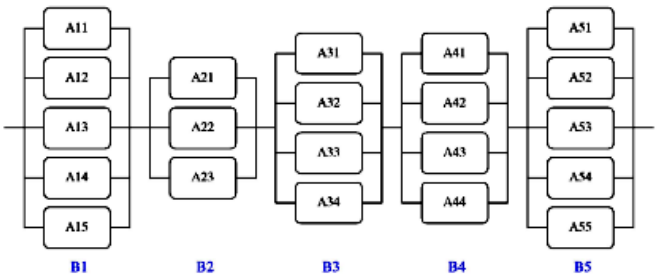

Fig. 2. Parallel logical structures for sub goals

TABLE I. Checklist

Sub goals	Criteria
A_{11}	The content of lecture was clear and understandable
A_{12}	The lecture was delivered in time online
A_{13}	The recorded lecture was easy to follow later on
A_{14}	During the lecture professor accepted questions and it was helpful to understand
A_{15}	The lecture lesson improved my theoretical knowledge
A_{21}	The content of seminar lesson was clear and understandable
A_{22}	The seminar lesson supports to own theoretical contents from lecture
A_{23}	The seminar lesson improved my skills
A_{31}	It was easy to use software which applied for online learning
A_{32}	Learning materials and books provided well
A_{33}	I can manage my learning environment during online class and it was helpful
A_{34}	The learning environment for online classes are not developed in my country
A_{41}	The lecturer preparation for lesson was excellent
A_{42}	The quality of files for learning was excellent

A_{43}	The teaching skill of lecturer was excellent
A_{44}	The lecturer was communicative and could support with useful guidance
A_{51}	I was prepared to receive online courses
A_{52}	The e-learning environment in my country is well prepared
A_{53}	I will prefer to study online than in classroom
A_{54}	The quality of online courses was in same level with traditional teaching
A_{55}	I am ready to select more online courses

The checklist for data collection is shown in Table 1.

Fifth step. Acceptance of checklist.

The evaluation team checked the questions and accepted it.

Sixth step. Data collection.

Fig. 3. Google form example for data collection

For data collection Google form (Fig. 3) was created with prepared questions. The link was sent to students who enrolled online master course. All students reacted to the request to take part in evaluation process and in total 11 responses were collected by Google form.

Seventh step. Data processing.

The collected data processed by online tool of the SURE model [31]. During pre-processing the data was downloaded from Google form in Excel sheet. Qualitative answers transformed to quantitative values. The numeric values are converted to comma separated vectors (CSV) via online tool. The CSV was entered as input to data computation into online tool. The SURE evaluation scores were returning in table form to screen.

The SURE evaluation general score calculated by:

$$Q_c^*(C) = \frac{1}{n}\sum_{k=1}^{n} Q_c^{*(k)}(C) = \frac{1}{n}\sum_{k=1}^{n} \sqrt[r]{\prod_{t=1}^{r}\left(1 - \sqrt[s_t]{\prod_{j=1}^{s_t}\left(1 - q_{tj}^{*(k)}\right)}\right)}$$

The key goal evaluation scores are calculated by:

$$Q_c^*(B_i) = \frac{1}{n}\sum_{k=1}^{n} Q_c^{*(k)}(B_i)$$

The sub goals of evaluation calculated by:

$$Q_c^*(A_{ij}) = \frac{1}{n}\sum_{k=1}^{n} Q_c^{*(k)}(A_{ij}) = \frac{1}{n}\sum_{k=1}^{n} q_{ij}^{*(k)} = Q^*(A_{ij})$$

Normalization of original data computed by:

$$Q^{*(k)}(A_{ij}) = q_{ij}^{*(k)} = \frac{x_{ij}^{(k)} - x_0}{x_1 - x_0}$$

Eight steps. Results

Four different SURE evaluation scores were computed by online tool and returned to screen as table. The SURE general evaluation score, key goals evaluation score, sub goals evaluation scores and evaluation of each response is computed.

III. Results and Discussion

3.1 Statistical results

Total number responses were 11 which confirms all master students have reacted to evaluation process and contributed their feedback. 63.6% of them were female and 36.4% were male students.

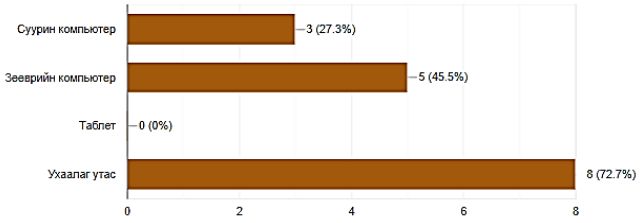

Fig. 4. Devices which were used for online courses

Fig. 4 shows various devices which were used for online course. No tablets mostly smart phones (72.7%) were used. Total number of devices are more than 11 due to the multiple use of devices by single student

Most students used fixed internet connections (45.5%) and data of smart phones (45.5%) to receive online course (Fig. 5).

	B_1					B_2			B_3				B_4				B_5					
k	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{21}	A_{22}	A_{23}	A_{31}	A_{32}	A_{33}	A_{34}	A_{41}	A_{42}	A_{43}	A_{44}	A_{51}	A_{52}	A_{53}	A_{54}	A_{55}	$Q^*_{e,k}(C)$
1	4	4	3	4	3	4	3	3	4	2	2	0	3	3	3	4	3	3	4	4	4	1
2	4	4	3	4	4	4	4	4	3	3	4	0	4	4	4	4	4	3	4	4	4	1
3	4	4	4	4	4	4	4	4	4	4	4	0	4	4	4	4	4	4	4	4	4	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1
5	4	4	4	4	4	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	0.94
6	4	4	4	4	4	4	4	4	4	3	4	1	4	4	4	4	2	3	3	4	4	1
7	4	4	4	4	4	4	4	4	4	4	4	0	4	4	4	4	4	4	4	2	4	1
8	4	4	3	3	4	3	2	3	3	2	2	3	3	2	2	3	3	2	3	2	3	0.72
9	4	4	4	4	3	4	4	4	3	4	4	3	4	4	4	4	3	1	1	1	1	0.83
10	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	3	3	2	2	2	0.91
11	2	3	4	4	3	3	3	1	1	3	4	2	4	3	3	3	2	2	2	1	1	0.77
$Q^*(A_{ij})$	0.95	0.98	0.93	0.98	0.93	0.93	0.89	0.86	0.84	0.84	0.91	0.48	0.95	0.91	0.91	0.95	0.82	0.75	0.8	0.73	0.8	$Q^*_e(C) = 0.9245$
$Q^*_e(B_i)$	1					0.92			0.97				0.97				0.83					

Fig. 6. The SURE evaluation results

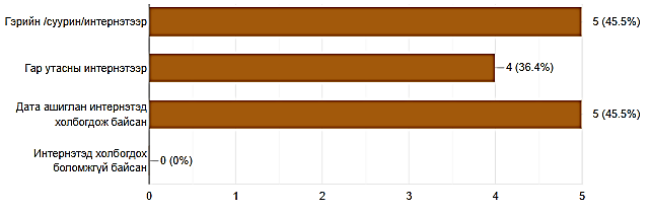

Fig. 5. Internet connections

3.2 SURE results

The SURE model computed four different evaluation scores from collected data (Fig. 6). The first and most important evaluation score is $Q_e^*(C)$. This score is a general score of evaluation process and in this case, it is $Q_e^*(C) = 0.92$. Maximum value can be 1. That means 0.92 is very high score and all students evaluated the master online course as very good.

Second SURE scores are calculated for key goals B_1-B_5.

The results show evaluation scores of key goals as: B_1=1; B_2=0.92; B_3=0.97; B_4=0.97 and B_5=0.83. This confirms all key goals have reached their target successfully.

Third SURE scores are computed for sub goals A_{11}-A_{55}. The results show evaluation scores of key goals as: A_{11}=0.95; A_{12}=0.98; A_{13}=0.93; A_{14}=0.98; A_{15}=0.93; A_{21}=0.93; A_{22}=0.89; A_{23}=0.86; A_{31}=0.84; A_{32}=0.84; A_{33}=0.91; A_{34}=0.48; A_{41}=0.95; A_{42}=0.91; A_{43}=0.91; A_{44}=0.95; A_{51}=0.82; A_{52}=0.75; A_{53}=0.8; A_{54}=0.73 and A_{55}=0.8. Sub goals evaluation scores mostly high than 0.8. Only one sub goal had low score: A_{34}=0.48.

Fourth SURE scores are evaluation of each response. In this case 11 responses are delivered. 7 of them evaluated the online master course with maximum score 1. 8th and 11th students are evaluated with 0.72 and 0.77.

3.3. Discussions

What does the SURE evaluation scores describe?

All evaluation goals are bigger than 0, that means all sub and key goals are evaluated as reached their targets. This confirms success of the online teaching by this evaluation process.

Can we accept it as final result about the quality of online teaching?

Unfortunately, no. This evaluation is result of only 11 students who enrolled were enrolled to selected course. The number of data set is really small and we cannot give guarantee that this evaluation result will be same or similar if number of students is significantly large! For short, we should look to this result with critical view.

What have we learned from this evaluation?

To evaluate own course is not easy. It is confirmed by this evaluation process. We need evaluation experts; we should apply corresponding evaluation models or methods to increase trustfulness of evaluation results. But self-evaluation process opens many important points for professors as to prepare for next round of online teaching. Therefore, this case gave positive impact to the teaching professor.

IV. Conclusion

The evaluation of master online course was very successful with evaluation score 0.92. The highest evaluation score 1.0 was received by the first key goal for quality of lecture. Only one sub goal was measured as 0.48. The comparatively low score was given to the sub goal A_{34} - The learning environment for online classes are not developed in my country. From this feedback we can conclude that the students were not satisfied with learning the environment development in Mongolia for e-learning.

By evaluation process the evaluation team could find out that the students were satisfied with the quality of lectures and seminars. But the learning environment and the general feeling about e-learning were not really high by students' feedback. Reason for this kind of reaction could be the not enough readiness of university, as well as country for full online teaching for all level of education.

Weakness of this study was the size of collected data. 11 is not a high number from quantities perspective. But these are almost all master students who were enrolled to the evaluated online course. By means of qualitative approach the evaluation result can be accepted which is a valuable information about online course feedback.

In future to improve the evaluation process different evaluation model can be applied for the next round and attempt to collect data not only from one selected course, maybe extend data collection by other online master courses. If more data from other courses can be collected, a comparison analyses on the collected data can be made. And such as study can be support to improvement and quality of online courses and could help students to be more successful by e-learning.

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