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Implementation Lean Teaching System for Mathematics

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ABSTRACT

Mathematic Teaching systems facing many challenges and factors that affect negatively its performance. As lean management approach succeeded in industrial sector, lean methodologies may be helpful in managing math teaching system efficiently and effectively, where improving quality of math teaching services may be achieved through the implementation of lean principles. Therefore teaching systems that are represented by schools, universities, and colleges are a suitable field to apply lean management approach. This study trying to investigate the implementation of some lean principles in managing math teaching systems with high performance. Also, this paper aims to implement a lean mathematical teaching system for high institute students of energy in Kuwait, it is expected that applying lean principles in the education system of math courses will improve the teaching and learning operations, increase the communication between all education system stockholders, improve skills of workers, and decreasing downtime or losses. Many hypotheses are presented and tested here using SPSS program. It was found that the math education system may be become lean-based if it has a multi-functional and flexible staff, continuous development and training for staff, and if there are a student training and qualifying activities, good management system, and continuous curriculum development.

KEYWORDS: Mathematics, Teaching System, Lean, Math Skills, Downtime.

INTRODUCTION

The history of education as an organized field is obviously linked to the establishment of modern teachers' colleges, as well as modern departments, schools, or faculties of education and universities. These institutions' curriculum were obviously predicated on the conviction in the potential of a pedagogical science, as well as the belief that educational research might lead to the betterment of schools, school systems, and individual and group learning. The advent of modern state school and college institutions provided an important environment for such an undertaking. The development and administration of such systems necessitated the collection and analysis of a diverse set of data. Universities and, in certain cases, teachers' colleges were rapidly identified as potential sites for such study, as did the data-collection sections of state education ministries themselves. The establishment of trainee instructors at colleges and universities was not only the result of this type of study. Modern teacher education developed during the time of educational activity known as 'progressivism' in North America and the 'New Education' in Britain and Australia. The New Education was heavily influenced by the views of current and former educational theorists. Rousseau's Emile's educational concepts were frequently used as a beginning point, whereas Dewey's Democracy and Education marks an early twentieth-century conclusion to the tradition. Within this tradition, there were paradigmatic developments in ideas about children and teachers, discipline and punishment, appropriate teaching practice and learning environments, and socially efficient curriculum. Archetypal representations of typical nineteenth-century schools and schooling methods linked with dame and monitorial schooling, as well as unreformed grammar and achievement education, were excoriated in the process (Campbell, and Sherington, 2002).

The primary goal of this research is to examine the implementation of some lean management concepts in the math teaching system, as well as to investigate how lean principles improve the performance of the math education system. To do this, the following steps are scheduled to be completed:

-Studying the traditional management systems applied on teaching systems
-Determining managerial obstacles facing math teaching system.
-Invistigating the implemntaion of lean principles in math teaching system.
-Analysing how lean principles may enhace the performane of the selected teaching unit, then comparing results.
Upon the acomplishment of this study, answers for a lot of questions and concerns are expected, among that the answers of the following:

- Can imlemented lean system be applied on math teaching systems?. And how?.
- If lean can be implemented in math teaching systems, How can that improve yeild, quality, performance?.
- What are the particualr lean principles that can be implemented significantly in math teaching systems?.
- What is the managerial correlation between the organiztional pattern and herirarcical structre of one selected teaching unit?.
- What tools and procedures that required to be followed?.

Lean may be characterized as a collection of ideas and strategies that can help businesses add value to the products they produce. This can be accomplished by improving process stages that are required, relevant, and useful while removing those that do not contribute value on a continuous basis. Lean has been utilized in manufacturing for decades and has been linked to improved product quality and overall business performance (Dickson et al., 2009).

One of the most essential aspects of Lean processes is the evaluation of operations, which is carried out step by step to discover waste and inefficiency before developing new solutions to enhance operations, boost efficiency, and decrease costs. As previously said, Lean industrial Principles are also known as Toyota Production System (TPS), and they are suited for use in the industrial environment, particularly in the automobile sector. Two essential Lean ideas may be mentioned here: the continuous removal of waste through process standardization and the participation of all employees in process improvement. The TPS is built on the principle of empowering workers by giving them with the tools they need to make change in their workplace. The employee's two primary responsibilities become: a) producing the product; and b) determining how to improve the product's quality and flow. Transferred to health care, this means that all physicians have two jobs: to take care of patients and to develop better methods to care for patients (Dickson, 2009).

Any Lean system has five principles that have been included to better characterize the system patterns:

1. Evaluate product value in the eyes of consumers: According to this concept, the corporation must precisely evaluate the worth of the product in the eyes of its customers.
2. Identify and clarify the value stream of the product: the second principle explains the precise functioning of the product from the beginning of the manufacturing stage until the product is delivered to the consumer.
3. Provide a fast and non-volatile value stream: the third principle focuses on eliminating the factors that prevent the production process and prolonging the client's waiting time for the value flow. These factors are defined as waste (Japanese Mode). They have been accurately described by Taiichi Ohno (1988) in his book "Toyota Production System"
4. Allow customers to raise the value of the product: the fourth principle states that the company must start to generate the product at the customer's request. The implementation of such a decision is not simple. However, there are branches such as cars that perform well in the matter.
5. The pursuit of excellence: the latter principle calls for continuous improvement of the value stream (Womack, 1996).

Lean may also improve outputs to boost development dependability, quality, and features and characteristics, a process known as Lean Product Development (LPD) or Lean PD. Lean PD shares several characteristics with Concurrent Engineering approaches, such as a holistic product definition in the early stages of development and concurrent subsequent design activities, with the overall goal of increasing productivity and product quality while lowering costs and lead time. However, lean PD goes beyond CE and aims to create a total understanding of customer value and its underlying characteristics, assuming business performance follows as a result of delivering value, pulling customer needs back to PD activities and further up the value chain to production and material suppliers. LPD offers a methodical, fundamental strategy to eliminating unproductive behaviors in PD. At the operational level, waste may be separated from value by determining whether a particular action offers (or contributes to) value to the customer or strategic value to the organization in terms of new information. Otherwise, the activity is deemed pure waste (Welo, 2011).

Lean manufacturing principles have various applications in industry and non-manufacturing processes, including production smoothing, small-lot production, and JIT. In contrast, TPM and continuous flow are extremely appropriate in systems with lower diversity (Esfandyari et al., 2015).

Many studies addressed the use of lean concepts and their applicability in various life situations and educational institutions. Sack (2010) presented both basic and detailed

information about policymaking, planning, and management procedures for various sorts of educational efforts. Such knowledge is seen as critical by supporters of innovative and/or traditional educational paradigms. The effective implementation of policies supporting education for sustainability in schools and school systems will rely heavily on the effective understanding and execution of the procedures detailed below. The efficient use of schools to ensure a sustainable and diversified human future needs the formulation of educational policies dealing with all the complexity of sustainability, as well as skilled administration and competent planning for their successful implementation. Ilfarlioğlu (2017) discussed the adaptation of Lean in educational institutions. Furthermore, it was attempted to clarify how education-training experience can be regulated within the framework of the thinking styles in the Lean education system. It was discovered that through Lean thinking, teachers and students will easily identify the requirements for top-level learning and use Lean thinking in an effective way to catch up with the curriculum without losing time. Lean culture is a continent that has always been committed to growth, supporting and empowering everyone to be a problem solver, allowing acknowledgment of achievement, and not deceiving others because of failure. Sanahuja (2020) stated that lean Thinking is a methodology based on improving the efficiency of productive processes by removing non-value-added issues. This methodology was firstly applied in the manufacturing industry, but it has also been applied to many service companies, bringing very good results. In the last decade, some works have tried to research the adaptation of Lean principles and practices to teaching, especially in technology and other STEAM subjects. In this sense, the aim of this work was to deepen this new trend by establishing what issues are non-value-added (waste) ones in education and classifying these kinds of waste in order to be able to analyze how to eliminate them. For this purpose, they adapt the classification made in other kinds of processes and extend other authors' findings regarding this topic.

-Developing a Lean-Based Math Education System

Lean as a philosophy and production method adds value to the process by defining and eliminating stages which are not necessary and add no value, or even prevent the work from being done or completed. In education and especially at schools which are more effective in providing their activities and services through maximizing the learning skills of all students and creating an environment of success and satisfaction for all by incorporating a system-wide approach to its constitution. In other words, in the framework of Lean education, in a learning group, students and teachers collaborate as equal participants, taking decisions together for solving classroom problems while learning from each other. The problems encountered in the decision making process are not seen as obstacles for achieving goals, but as opportunities for generating new ideas and innovations. However opportunities are used in order to strengthen and renew the related educational process. Principles such as transparency, cooperation, speed and co-learning are the main building blocks of Lean Method **(Tilfarlioğlu, 2017).** This paper introduces lean-Based Math Education System (LBMED), this developed model includes constructing variables of the study which will lead to construct the study latent and hypothesis.

Lean-Based Math-Education system (LBMES)

This LBMED investigates design phases of the hypotheses, which will lead to construct the tool of the study i.e. the questionnaire, structural equation model, and the questionnaire associated with the Lean-Based Math Education System (LBMES). The association between Lean Production (LP) and education system-in education systems is still practically unexplored (Bonavia and Marin-Garcia, 2011). To reveal this relation, a Structural Equation Model (SEM) should be built. As a first step, a list of all hypotheses that depict the interactions of the five LP practices shown in table 1 below should be formulated. These practices institute the construct latent of the LBED, so they can be called "construct latent variables." These variables and its related identifiers are confirmed in Table 1 below;

Table 1: Variables of the study

	Number	Construct latent variable	Identifier
Lean-Based Math Education System LBMES	1	Multi- Skills Math Teachers	MSMT
	2	Math Training and Improvement	MTI
	3	Students Math-Training	SMT
	4	Math-Teaching System Management	MTSM
	5	Math Curriculum Development	MCD

In order to understand the effects of these variables on the development of lean-based education system and on each other, a comprehensive literature review was done for each practice. This is introduced in the following sub-sections.

Multi- Skills Math Teachers (MSMT)

One of the important component of educational adaptation of Lean is the concept of waste in education. The biggest waste in Lean education is the use of all the elements in the education process, namely teachers, students, parents and school administrative staff, below the capacities of their abilities. Our most valuable asset in Lean education is our human resources, and if it is so, we must use those people's time as efficiently as possible (**(Tilfarlioğlu, 2017).** The core value-creating activity in education is teaching, yet the basic methods used by the faculty to teach have undergone little change for many decades. Where improvements in teaching are made, such as "flipped classrooms" and "blended learning", the specific improvement ideas or methods are derived principally from within the domain of adult learning theory and research. External challenges to current methods are rare and often quickly rejected. The other important factor are teachers and their flexibility and skills in teaching, and using Lean teaching which means is the application of Lean principles and practices to teaching **(Emiliani, 2015).** For all these reasons, MSMT effects on LBMED should be investigated and so the following hypothesis can be implemented:

$H1_0$: MSMT implementation has no effect on the development of LBMES.

$H1_1$: MSMT implementation has a significant, positive effect on the development of LBMES.

$H2_0$: MSMT implementation has no effects on effect on the development of SMT.

$H2_1$: MSMT implementation has a significant, positive effect on the development of SMT.

$H3_0$: MSMT implementation has no effect on the development of MTI.

$H3_1$: MSMT implementation has a significant, positive effect on the development of MTI.

$H4_0$: MSMT implementation has no effect on the development of MCD.

$H4_1$: MSMT implementation has a significant, positive effect on the development of MCD.

Math Training and Improvements (MTI)

Teachers' productivity has generally been seen as a correlation between teacher training and student academic achievement in examinations **(Petre, 2012).** Some researches on performance have also associated student academic achievement with teachers' effectiveness in teaching. For example, **Muya (1994), Karugu (1982), Sayer (1989), Shiundu & Omulando (1986)** observed that there exist many teacher instructional malpractices in Kenya as a result of inadequate or lack of training skills. Generally training involves the development of human resource skills leading to better performance **(Gok, 2009)**. Effective training focuses on the knowledge, skills and attitudes required by the teachers so that all students can learn and perform at high levels **(Clifford, 2006) and (Peter, 2012)**.

As a result of the above argument, the following hypothesis will be tested:

$H5_0$: MTI implementation has no effect on the development of lean-based education system (LBMES).

$H5_1$: MTI implementation has a significant, positive effect on the development of lean-based education system (LBES).

$H6_0$: MTI implementation has no effect on the development of SMT.

$H6_1$: MTI implementation has a significant, positive effect on the development of SMT.

$H7_0$: MTI implementation has no effect on the development of MTSM.

$H7_1$: TI implementation has a significant, positive effect on the development of MTSM.

$H8_0$: MTI implementation has no effect on the development of MCD.

$H8_1$: MTI implementation has a significant, positive effect on the development of MCD.

$H9_0$: MTI implementation has no effect on the development of MSMT.

$H9_1$: MTI implementation has a significant, positive effect on the development of MSMT.

Students Math Training (SMT)

To ensure that the education system is ready to become lean it is important to take into account the issue of training and qualifying the students on some activities either about the courses they involved or about some unlearning activities like sports, labs, and training on some technologies or software's related to courses. SMT has an effects on other lean components of the math education system. (Ziskovsky and Ziskovsky, 2007) presented a brief overview of Lean management principles and their applicability to education. It also presents a case study demonstrating how Lean Process Improvement has been used to improve education delivery and student performance and activities like field trips and others while simultaneously saving costs. So the following hypothesis are formulated.

$H10_0$: SMT implementation has no effect on the development LBMES.

$H10_1$: SMT implementation has a significant, positive effect on the development LBMES.

$H11_0$: SMT implementation has no effect on the development of MTSM.

$H11_1$: SMT implementation has a significant, positive effect on the development of MTSM.

$H12_0$: SMT implementation has no effect on the development of MCD.

$H12_1$: SMT implementation has a significant, positive effect on the development of MCD.

Math-Teaching System Management (MTSM)

Applying lean principles on education system needs to develop management strategies and polices of such systems, so management has considerable effects on integration of

lean applicability in education system. The management of lean system in education affects the other components of lean education system by the following hypothesis:

***H*13$_0$**: MTSM implementation has no effect on the development of LBMES.

***H*13$_1$**: MTSM implementation has a significant, positive effect on the development of LBMES.

H14$_0$: MTSM implementation has no effect on the development of MCD.

H14$_1$: MTSM implementation has a significant, positive effect on the development of MCD.

Math Curriculum Development (MCD)

If we adopted lean principles in education systems, curriculum should be leaned too. Which means that the old fashioned curriculum will not work properly in the leaned education systems. Any university has obstacles to developing a new program, such as limited curriculum space and accreditation hurdles. Lean programs also face the limited availability of and access to good teaching materials. Many professors may want to bring lean to students, but are reticent to do so without the support that proven classroom materials can provide (Taninecz, 2018). Chitrangsan et al. (2015) studied and develop a curriculum management process by applying Lean concept for waste elimination to enhance curriculum implementation of primary school teacher. This study was conducted with a focus on qualitative data collection by dividing into 2 phases, including (1) analyze and synthesize relevant notions, theories, documents, and researches, as well as fundamental information used for developing a process, and (2) develop a curriculum management process by applying Lean concept for waste elimination, including 7 steps (preparation, value definition, value steam mapping, waste eliminations, flow implementation, pull reflection, and pursue perfection). So it is important to reconstruct the teaching curriculum to get the integration required of lean education system. And so the following hypothesis are constructed.

***H*15$_0$**: MCD implementation has no effect on the development of LBMES.

***H*151**: MCD implementation has a significant, positive effect on the development of LBMES.

***H*16$_0$**: MCD implementation has no effect on the development of MTSM.

***H*16$_1$**: MCD implementation has a significant, positive effect on the development of MTSM.

Hypothesis Test and Analysis

To highlight the hypothesis testing results, the null hypothesis H_0 is to be stated whether it was or it was not rejected at a specified significance level (α-value). The smallest significance level is called the "*P*-value". The *P*-value is defined (Montgomery and Runger, 2011) as "the probability of obtaining a value of the test statistic that is at least as extreme as that observed when the null hypothesis is true."

P-value represents the probability of Type I error, or the probability of rejecting the null hypothesis while the hypothesis is true. Operationally, once a *P*-value is computed, a significance level of 0.01 is considered for this study. A hypothesis will be rejected if the *P*-value is less than significance level of α= 0.01. In this study, it is not easy to compute the exact *P*-value for statistical tests manually. IBM SPSS statistics is used to conduct the needed statistical procedures to report the results of hypotheses testing in terms of *P*-values., namely; a paired sample correlation and a paired sample test. The results of the conducted statistical testing is illustrated in Table 2. To analyze the hypotheses listed in chapter four of this thesis, let us consider the hypothesis *H*1 as an example. Hypothesis H1 suggests the following:

H1$_0$: MSMT implementation has no effect on the development of LBMES.

H1$_1$: MSMT implementation has a significant, positive effect on the development of LBMES.

The paired sample correlation and paired sample test confirm that *H*1 has *P*-values of zero (i.e., *P*-value < 0.01) which means that $H1_0$ can be rejected at a significance level of 0.01. Thus, we can say that the alternative hypothesis $H1_1$ is true. The hypotheses (from *H*2 to *H*16) found to have *P*-values below 0.01 that indicates that the null hypotheses of them are rejected and the proposed alternative hypotheses are true.

Table 2. Results of the hypotheses testing

Alternative Hypothesis	Relationship	Paired Sample Correlation		Paired Sample Test			Decision
		Pearson	P-value	t-value	DF	P-value	
$H1_1$	MSMT-LBMES	0.998	0.000	10.902	199	0.000	Reject $H1_0$
$H2_1$	MSMT- SMT	0.956	0.000	18.058	199	0.000	Reject $H2_0$
$H3_1$	MSMT- MTI	0.981	0.000	10.501	199	0.000	Reject $H3_0$
$H4_1$	MSMT- MCD	0.951	0.000	3.525	199	0.001	Reject $H4_0$
$H5_1$	MTI- LBMES	0.992	0.000	4.125	199	0.000	Reject $H5_0$

$H6_1$	MTI- SMT	0.959	0.000	13.990	199	0.000	Reject $H6_0$
$H7_1$	MTI- MTSM	0.979	0.000	2.338	199	0.016	Reject $H7_0$
$H8_1$	MTI- MCD	0.989	0.000	3.100	199	0.003	Reject $H8_0$
$H9_1$	MTI- MSMT	0.990	0.000	7.998	199	0.000	Reject $H9_0$
$H10_1$	SMT- LBMES	0.980	0.000	17.895	199	0.000	Reject $H10_0$
$H11_1$	SMT- MTSM	0.970	0.000	13.987	199	0.000	Reject $H11_0$
$H12_1$	SMT- MCD	0.958	0.000	15.978	199	0.000	Reject $H12_0$
$H13_1$	MTSM- LBMES	0.960	0.000	18.022	199	0.000	Reject $H13_0$
$H14_1$	MTSM- MCD	0.990	0.000	4.987	199	0.000	Reject $H14_0$
$H15_1$	MCD- LBMES	0.989	0.000	9.012	199	0.000	Reject $H15_0$
$H16_1$	MCD- MTSM	0.988	0.000	8.024	199	0.000	Reject $H16_0$

MODEL FITNESS

Many indices exists in literature for evaluating the "goodness-of-fit" of the model, goodness-of-fit reflects how the structural equation model matches the data, chi-square, relative chi-square ratio, root mean square error of approximation, comparative fit index, and *t*-test can be used for this purpose.

1. Chi-Square (χ^2)

Chi-Square ($\chi 2$) is described a classic goodness-of-fit measure. It is useful technique for testing whether the observed data are demonstrative of a particular distribution. It tests the difference between the observed and expected occurrences. A high value of χ^2 implies a poor fit between these occurrences, a small value indicates a good fit.

2. Relative Chi-Square Ratio

Chi-square ratio that is yielded by dividing the chi-square value over the corresponding degrees of freedom (DF) (Armstrong and Tan, 2000), if this ratio is less than 5, then the model is accepted (Armstrong and Tan, 2000; Marsh and Hocevar, 2003). Table 3 shows that the relative chi-square ratios for all hypotheses are below 5 this indicates that the LBMES is accepted.

2. Root Mean Square Error of Approximation (RMSEA)

RMSEA value of about 0.05 or less in relation to the DF would point to a good fit of the LBMES model, and RMSEA value of 0.10 or more means poor fit. All the RMSEA values for the LBMES model are less than 0.05 as shown in Table 5.13. Thus, the LBMES model fitness is supported by RMSEA.

3. Comparative Fit Index (CFI)

CFI evaluates the fit of a user-specified solution in relation to a more restricted, nested baseline model, in which the covariance among all input indicators are fixed to zero or no relationship among variables is posited. CFI ranges from 0 for a poor fit to 1 for a good fit. However, a value of 0.9 means good fit. Under this test, the LBMES model exhibits a good fit as shown in Table 3.

Table 3. Results of the hypotheses testing for the developed SEM

Alternative Hypothesis	χ^2	DF	χ^2-Ratio	RMSEA	CFI	P-value	Risk Estimated	Decision
$H1_1$	1212.5	199	4.39	0.0089	0.90	0.000	0.93	Reject $H1_0$
$H2_1$	1237.6	199	4.58	0.0182	0.95	0.00	0.92	Reject $H2_0$
$H3_1$	1229.3	199	4.20	0.0100	0.91	0.00	0.91	Reject $H3_0$
$H4_1$	1152.03	199	4.15	0.014	0.94	0.000	0.90	Reject $H4_0$
$H5_1$	589.95	199	3.16	0.0088	0.90	0.000	0.90	Reject $H5_0$
$H6_1$	1168.44	199	4.25	0.018	0.90	0.000	0.98	Reject $H6_0$
$H7_1$	1213.01	199	4.40	0.019	0.93	0.000	0.92	Reject $H7_0$
$H8_1$	1119.39	199	4.25	0.0198	0.92	0.000	0.90	Reject $H8_0$
$H9_1$	1101.2	199	4.39	0.018	0.88	0.000	0.91	Reject $H9_0$
$H10_1$	752.60	199	3.28	0.0079	0.91	0.000	0.93	Reject $H10_0$
$H11_1$	1235.2	199	4.88	0.0179	0.96	0.000	0.97	Reject $H11_0$
$H12_1$	1214.25	199	4.44	0.0199	0.92	0.000	0.97	Reject $H12_0$
$H13_1$	1299.25	199	4.58	0.0189	0.93	0.000	0.91	Reject $H13_0$
$H14_1$	860.20	199	3.25	0.0088	0.89	0.000	0.88	Reject $H14_0$
$H15_1$	1125.25	199	4.01	0.019	0.91	0.000	0.98	Reject $H15_0$

H161	1290.22	199	4.69	0.019	0.92	0.000	0.89	Reject $H16_0$

CONCLUSIONS

In this work lean principles are studied in general, and after that the trials in applying lean principles and its tools in worldwide are reviewed, the aim of this work is to study the ability of constructing a lean based mathematical teaching system for high colleges students, to accept and apply lean principles in education system especially at such levels either in private or public sectors. The primal goal of this study is to invistigate for the implentation of some lean principles in math teaching sector, and to study how lean principles enhance the performance of such system. In this work a questionnaire is used to test if lean principles are really can be apply in math education system. It can conclude that the math education system may be become lean-based if it has a multi-functional and flexible staff, continuous development and training for staff, and if there are a student training and qualifying activities, good management system, and continuous curriculum development. The hypotheses (from *H*1 to *H*16) found to have *P*-values below 0.01 that indicates that the null hypotheses of them are rejected and the proposed alternative hypotheses are true. The Lean technology is also useful for mathematic because it provides precise statements of mathematical results, it supports verification, it supports collaboration, libraries can be used for exploration and search. It can serve as a front end to systems for numerical and symbolic computation. It opens doors to automated reasoning, machine learning, and new means of discovery. It can be used for teaching. Students get immediate feedback. It's fun; it can keep students engaged.The technology will likely be important for mathematics.

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Appendix A

Questionnaire

Please indicate the degree of implementation of each of the following practices in your association, following the below rating scale:

(1) Never; (2) Rarely; (3) Some of the time; (4) Most of the time; (5) always

1- Multi- Skills Math Teachers (MSMT)						
No.	Item	Response				
		1 Never	2 Rarely	3 Some of the Time	4 Most of the Time	5 Always
1	Math Teaching staff at this institution have at least more than one teaching-related task) that they are able to do.					
2	This education institution offers enough flexibility to staff in achieving learning objectives.					
3	Continuity of mission improvement processes in the organization leads to increased teacher engagement with the institution					
4	The Foundation has a system of rotating teaching among faculty members among students					
5	There are frequent changes in teaching tasks for math teachers associated with achieving the goals of the institution					
6	Academic and non-academic activities are organized to improve the work of the teaching team					
7	In the past three years, many problems in the educational institution have been solved through small working group sessions					
2 Math Training and Improvements (MTI)						
No.	Item	Response				

		1	2	3	4	5
1	This teaching institution provides new Math teaching staff with basic background information needed to perform their teaching tasks satisfactorily					
2	This institution provides new teaching staff with a general overview about the main vision of the association					
3	Prior to implementing training, this institution conducts a complete skill assessment to pinpoint the aspects that have skill shortage					
4	This educational institution performs systematically prepares of an annual training plan for math teachers					
5	This institution focuses on future-oriented learning that is not necessarily related to the employee's current teaching					
6	In this educational association, there is a teaching enrichment to encourage the personal advancement of math teaching staff					
7	This institution measures and evaluates returns achieved from the training and developments programs attended by math staff					

3. Students Math Training (SMT)						
N No.	Item	1	2	3	4	5
1	Students at this college having a training programs in all academic aspects specially in math					
2	Students at this college having a training programs in non-academic aspects related to math like using computers, math software like MATLAB					
3	This institution focuses on qualifying their students in academic, social and environment aspects					
4	This institution has a programmed activities for many national, religious and social events					

4- Math-Teaching System Management (MTSM)						
No.	Item	Response				
		1	2	3	4	5
1	There is an existence of communication between the managers, specialized, and non-specialized teaching staff and other workers and employee					
2	There is a system for math teaching staff ' suggestions, whereby suggestions are applied and studied					
3	In this educational association, the upper-level staff give decision-making authority to the lower-level staff					
4	Decentralization policy is used in this association					
5	Teaching staff are given information on the overall situation and prospects of the college					
6	This educational institution has a formal and systematic performance appraisal process in which it evaluates the achievement of individual targets and identifies the development needs for math teaching staff					

7	The math teaching workforce management system adopted in this institution improves productivity and throughput and reduces costs and time losses					
8	This institution defines an appropriate length of time for each teaching-related task for math teaching staff and tasks time for other employee					
9	When this institutions measures or evaluate the productivity and performance of math teaching staff and other employee, it takes into account the time spent between assignments or indirect time instead of just accounting for fulfilling the goals achieved in its evaluation operation					

5- Math Curriculum Development (MCD)						
NO	**ITEM**	1	2	3	4	5
1	The institution updated its courses upon the general objectives of the general math curriculum of the ministry of education					
2	The math curriculum is reviewed periodically					
3	The math curriculum for all math courses concentrated on students interests and upon the updated issues in science and materials					
4	The curriculum for all math courses encourages teachers to use new educational methods and strategies and activities like lean					
5	The curriculum followed in this institution concentrates on reducing times and increasing productivity of instructors and students.					