Modeling Total Quality Management in Higher Education with Case-Based Reasoning

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Abstract

Total quality management (TQM) is a philosophy and a system for continuously improving the services and products offered to customers through ongoing refinements in response to continuous feedback. With regards to higher education, quality education needs to be emphasized in ensuring progressive intellectual capacity building. Both quality assurance and management are critical in ensuring that higher learning institutions provide better services to their primary customers. The continuous improvement and growth focus of TQM would offer more excitement and challenges to students and lecturers as compared to a "good enough" traditional learning environment. In this paper, elements of an education system that focus on total quality assurance and management are discussed. This paper emphasizes on the mastery learning approach, which is in line with TQM. The learning process contains the following steps: Plan, teach (Do), Check (formative evaluation), revised teaching (Act), and Test (summative evaluation). The two main objectives of using TQM in education, which are to improve learning and to improve cost effectiveness, are emphasized. The paper concludes with a TQM system model that applies genetic algorithm (GA) in case-based reasoning (CBR) that can be used as guidelines to total quality assurance and management in higher education. The combination of CBR and GA will produce a better TQM system model as compared to the one introduced earlier in a previous paper. It is believed that this newly proposed system model is useful in building intellectual capacity in higher education.

Keywords: *Case-Based Reasoning (CBR), Genetic Algorithm (GA), Higher Education, Intellectual Capacity Building, Total Quality Management (TQM)*

1. Introduction

Malaysia, one of the most progressive developing countries in the world, is currently facing a lot of challenges in ensuring that the quality of its tertiary education is at par with the world's standards. Quite recently, most universities in Malaysia (private and public) are in the process of making sure that their education systems are given accreditations by various quality control and standards organizations such as ISO. In fact, quite a few already got accreditations from MQA (Malaysian Qualifications Agency; formerly known as National Accreditation Agency). In order to get full accreditations, a university's course program structure must follow all the requirements and standards set by MQA. ISO (International Organization for Standardization) on the other hand has more requirements that must be complied by organizations getting ISO certification.

Institutions of higher learning throughout the world must admit the fact that changes must take place in our education system in order to absorb the impact of globalization. It is now widely acceptable that traditional way of imparting knowledge is no longer relevant and considered outdated, since nowadays information can travel from any location in this world within seconds. New approaches and techniques must be adopted by our education system so that the products of our higher learning institutions are able to cope with the ever changing technologies and working environment.

In order to ensure progressive intellectual capacity building, we need to ensure that our education system meets certain standards, and this has got something to do with quality education. Total quality assurance and total quality management (TQM) must be imposed on our education, and to be more specific it must be imposed at the higher education level. The continuous improvement and growth focus of TQM would offer more excitement and challenges to students and lecturers as compared to a "good enough" traditional learning environment.

2. Motivation

Based on current scenario worldwide with regards to the need of having very competitive graduates as the products of all institutions of higher learning, it is believed that there is a need to ensure that intellectual capacity building becomes the main agenda of every institution of higher learning. The motivation of writing this paper is based on the following set of objectives:

- To emphasize on quality education at higher education with the implementation of total quality assurance and management within the education system.
- To promote a progressive learning environment within the system using the mastery learning approach; enhance intellectual capacity building.
- To come up with a new TQM system model using CBR that can be used as guidelines to total quality assurance and management in higher education.

3. Literature Review

In a previous paper [1], a TQM system model that could be used as guidelines was proposed. It incorporated the necessary components that are needed in ensuring total quality assurance and management in higher education are in place. To improve the quality of the earlier framework or model, several new approaches and techniques are studied and applied to this research paper.

Tie Li and Qihong Ren [2] presented a model, which is based on the "2-tuple ordered weighted geometric (TOWG) and 2-tuple weighted geometric (TWG) operators" that evaluates the quality of public physical education class in higher education.

In another paper, Hwa-Young Jeong and Hae-Gill Choi [3] proposed a design model of a "personalized u-learning system" with the intention of improving the "learner's learning effect" by offering different learning materials and set of questions to learners while attending lectures.

Several other related works on the use of soft computing components or artificial intelligent techniques were also being considered in coming up with the newly proposed system model for the Total Quality Management System (TQMS).

In [4] the CBR technique was used in analyzing the quality of software requirements specifications (SRS) for a given project. Within the CBR, fuzzy logic (one of the various soft computing components) was used in measuring the similarity level of the new project or case to be evaluated.

In another work [5], GA (Genetic Algorithm) and pattern recognition were used within the CBR in coming up with an effective framework documentation approach for object-oriented application framework.

Based on all of the above research works, the Total Quality Management System (TQMS) model is proposed.

4. Total quality assurance (TQA)

The Quality assurance is defined as a planned and systematic process of checking to see whether a product or service being developed is meeting specified requirements. The main objective of having a quality assurance system is to increase customer confidence and also to increase a company's credibility and image. Other reasons include to improve work processes and efficiency, and to enable a company to have competitive edge over its rivals. It is hoped that the quality system is able to detect defects before they get to the final product.

There are many ways of measuring quality, but different people have different standards. A good quality product or service might satisfy some people, but not the majority of people. In order to make sure that all organizations who claim that they have good quality products that meet certain standards, certain quality measurements were introduced. ISO (International Organization for Standardization) introduced a family of standards for quality management systems called the ISO 9000 family. The set of standards applicable to institutions of higher learning is the ISO 9001:2008 series. In general, ISO standards will ensure that products are trustworthy and of good quality, and will reduce costs by minimizing and reducing errors [6]. Consequently, productivity is also increased and many global challenges can be overcome effectively.

5. Total quality management (TQM)

"Total Quality Management (TQM) is a comprehensive and structured approach to organizational management that seeks to improve the quality of products and services through ongoing refinements in response to continuous feedback [7]."

Basically, TQM is composed of three paradigms as given below:

- *Total*: Involving the entire organization, supply chain, and/or product cycle; comprehensive coverage of quality management.
- *Quality*: Meeting specified standards.
- *Management*: The system of managing with steps like Plan, Control, Lead, Staff, provisioning, and organizing.

Meanwhile, Quality Management System (QMS) is "a set of coordinated activities to direct and control an organization in order to continually improve the effectiveness and efficiency of its performance [8]."

TQM can also be viewed as philosophy and a system for continuously improving the services and products offered to customers by implementing a comprehensive quality management to the entire system within the respective organization.

ISO 9001:2008 Quality Management System's specifies requirements for a quality management system in which an organization must have the following characteristics [9]:

- The need to demonstrate its ability to "consistently provide products that meet customers and applicable statutory and regulatory and regulatory requirements ", and
- Be able to enhance "customer satisfaction through the effective application of the system, including processes for continual improvement of the system and the assurance of conformity to customers and applicable statutory and regulatory requirements."

The above requirements are generally applicable to all organizations, irrespective of type, size, and provided product.

The following eight quality management principles [9] on which the quality management system standards of the ISO 9001:2008 series are based upon can be used by senior and top management as a framework to guide their organizations in improving their performance.

- Customer focus
- Leadership
- Involvement of people
- Process approach
- System approach to management
- Continual improvement
- Factual approach to decision making
- Mutually beneficial supplier relationships

5.1. Total quality assurance and management in higher education

Quite a number of universities throughout the world have quality management systems in place. Quality management systems can be applied at the higher institutions learning level or to be more effective these quality systems can be applied within the Ministry of Education of a country. By having the strategies and policies being standardized throughout the country's educational system, quality awareness can be integrated into the mind of the people at early age. This will definitely benefit the entire nation because by the time the young students reach tertiary education level, they already have proper foundation and knowledge about quality.

The Ministry of Education (MOE) of Jordan [10] is ISO 9001 certified and it has a website that provides quite detailed explanation about its quality management system. The main objective of this system is to develop institutional capacity in managing qualitative development of educational services, and to introduce developed administrative systems in the Ministry of Education (Jordan).

The Capacity Building Project in Management of Qualitative Development of Educational Services system of Jordan's MOE has the following objectives on quality assurance and management [10]:

- Adopting the philosophy of total quality management

- Documenting work policies and strategies
- Designing total quality management programs in line with the nature and characteristics of the educational system, with a basic aim of obtaining the ISO (9001) certification

5.2. Intellectual capacity building

In a paper entitled "Developing Countries and the Global Knowledge Economy: New Challenges for Tertiary Education", Jamil Salmi [11] discussed in very detail the role of tertiary education in building up the capacity of developing countries to participate in the global knowledge economy client countries. Here he focused on the importance of tertiary education in the construction of knowledge economies and democratic societies. He also stressed that tertiary education is central to the creation of the intellectual capacity on which knowledge production and utilization depend and also to the promotion of lifelong learning practices. In addition, new information and communication technologies must be applied in order to gain competitive advantage over other higher learning institutions. Dissemination of knowledge is now accelerated with new information and communication technology (ICT). As a result, the life span of technologies and products gets progressively shorter and they become obsolete so quickly and this will directly affect the quality of graduates. Those students that are equipped with the right set of tools and knowledge will continue to be relevant to current work force requirements.

The following is an excerpt from the UN Science, Technology and Innovation MDG Task Force Interim Report, December 2003 [12] as cited in [11]:

"Science, technology and innovation underpin every [Millennium Development] goal. It is impossible to think of making gains in concerns to health and environment without a focused Science, Technology and Innovation (STI) policy, yet it is equally true that a well-articulated STI policy can make huge gains in education, gender equality or upgrading of living conditions [12]."

New methods in imparting knowledge are required and trainings must be provided to equip students, fresh graduates and also workers to meet current working requirements. Focus must be given to producing graduates with the ability to think critically and able to analyze and solve problems and give concrete reasoning for solutions given. All of these give more reasons why total quality assurance and management in education has to be implemented.

6. Elements of education to support TQM

There are several elements that are necessary in supporting any effort of implementing TQM in education. This paper discusses several of the more important elements.

6.1 Peoples' Awareness and Commitment

Each member within the education system must know his/her main responsibilities and is constantly working towards working on improving services to customers. In addition, each individual must be given a clear understanding regarding total quality management system. Quality awareness programs and workshops must be conducted so that everyone has proper knowledge on TQM.

6.2 Clear Vision and Mission

A clear vision and mission must be in place. Each institution of higher learning must have a general mission and mission. For example, the vision of Universiti Tenaga Nasional (UNITEN) is to become "*A leading global energy university that shapes a sustainable future*", while its mission is "*We strive to advance knowledge and learning experience through research and innovation that will best serve human society*". All efforts must be geared towards achieving the institution of higher learning's vision and mission.

In addition, each faculty or college within an institution of higher learning must also have its own vision and mission. This will make sure that each faculty has more specific objectives that need to be achieved. Smaller units within each faculty or college may also have their own visions and missions. The visions and missions are important in setting the right directions for each unit.

6.3 A System's Planning Approach

A proper overall system planning must be prepared and it has to be adopted and practiced at all levels within the education system so that each individual has the same understanding of how the system should work. Ron Fitzgerald [13] in his paper entitled "Total Quality Management in Education" used a simple Ishikawa diagram as depicted in Fig. 1 to represent a plan for the entire education system. It is believed that lack of system planning is a serious obstruction to achieving high quality in teaching and learning.

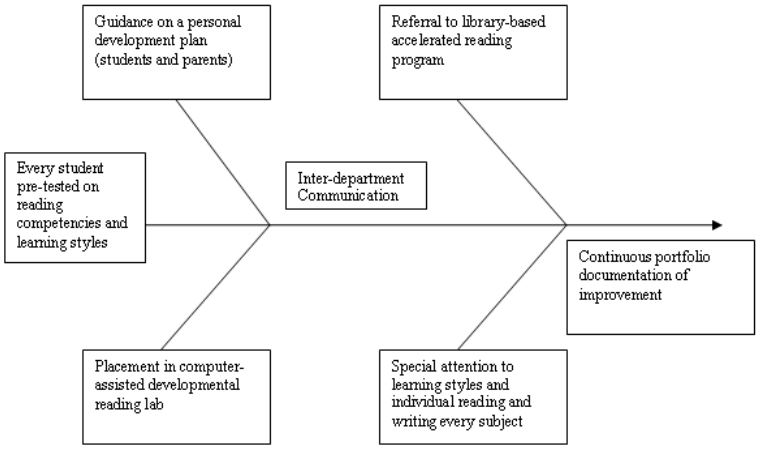

Figure 1. Ishikawa diagram representing a system's planning for an education system [13]

6.4 Progressive and Dynamic Learning – Mastery Learning Approach

In order to cope with the ever changing demands of the world labor market, some changes must take place in our education learning and training approach. Individuals who are seeking for jobs must be trained to be flexible and be able to adapt to any working environment's demands. The traditional approach to learning by studying for a period of time to acquire a degree or to complete post-graduate education before moving to professional life is being progressively replaced by practices of lifelong education.

Mastery learning was introduced into the American education more than 70 years ago [14]. The application of mastery learning is based on Benjamin Bloom's Learning for Mastery model, with some additional refinements made by Block [15] as cited in [14]. Mastery learning proposes that each and everyone of us can learn when provided with the appropriate learning conditions in classroom [16]. In other words, everyone can learn given the right circumstances. It is an alternative method of teaching and learning that involves the student reaching a level of predetermined mastery on units of instruction before being allowed to proceed to the next unit within the course structure. It is believed that towards the end, the majority of students can achieve the same level of content understanding or mastery but at different time intervals.

The mastery learning approach divides a subject matter or a course into units that have predetermined objectives. Each student or groups of students work(s) through each unit in an organized fashion, and after completing each unit the students must demonstrate mastery on unit exams, normally 80%, before proceeding to new material [14]. In other words, a student is assumed to have mastered a unit (achieve mastery) if he/she has mastered at least 80% of the material. Those who fail to achieve mastery receive remediation through tutoring, peer monitoring, small group discussions, or additional homework and more learning time is subscribed to them. The cycle of learning and testing continues until mastery is met [14]. The bottom line is that no one is allowed to proceed to new material until basic prerequisite material is mastered.

Generally, the following procedures must be followed in order to implement mastery learning:

- Define major objectives representing the purposes of the course or define standards of mastery of the subject matter.
- The substance is divided into relatively small learning units, each with its own objectives and assessment.
- Learning materials and instructional strategies are identified; teaching, modeling, practice, formative evaluation, re-teaching, reinforcement, and etc.; summative evaluation is also included.
- Each unit is preceded by brief diagnostic tests, which give some idea what to achieve.
- The results of diagnostic tests are used to provide supplementary instruction to help student(s) overcome their specific problems. Students are provided with specific feedback about their learning progress at regular intervals throughout the instructional period.

Back in 1968, theoretically Bloom, as cited in [14] made several predictions about the gains from the above mastery learning procedures. One of them is that in classes taught for mastery, 95% of the students will achieve at the level previously reached by the top 5%. Bloom also claimed that students do not have to put in much more time on school tasks to reach this level of proficiency. Furthermore he argued that, even though students taught for mastery need more time to reach proficiency in the initial stage of a course, they normally need less time to master more advanced materials because of the firm understanding of fundamentals that they should gain from their earlier efforts. Bloom also believed that mastery learning increases the attitude and interest of students [17].

In general, mastery learning approach increases student achievement, student attitudes, parent attitudes and student attendance. All these will contribute to better learning outcomes in subjects or courses that implement the mastery learning approach.

6.5 PDCA (Plan-Do-Check-Act) System's Approach

PDCA is an iterative four-step problem-solving process that is typically used in quality control. The following gives brief descriptions of the steps:

- *Plan*: Establish the objectives and processes necessary to deliver results based on some predetermined specifications.
- *Do*: Implement or carry out the processes.
- *Check*: Monitor and evaluate the processes and results, and compare them against the plan.
- *Act*: Apply necessary actions to the outcome for improvement. This implies reviewing all steps (PDCA) and modifying the process to improve it before its next implementation.

Improvements to the education and the teaching and learning systems will be more effective if everyone within the system follows the PDCA (Plan-Do-Check-Act) cycle. Analyses on data and information related to academic and non-academic matters must be performed regularly. Once the analyses have been carried out, improvements initiatives can be recommended and to make sure that all these initiatives are carried out accordingly, the management must make it a point to follow up on action items. The PDCA cycle is very useful in maintaining and ensuring that a particular education system achieves its quality objectives. Each individual (staff or student) within the system must abide to the PDCA approach in handling any process.

Within the teaching and learning system, the PDCA cycle can be described as follows: Plan, Teach (Do), Check (formative evaluation), Revised Teaching (Act) and Test (summative evaluation). It has an extra step at the end, which is Test. This step is important in making sure that the students undergoing the Mastery Learning Approach have achieved the minimum 80% of mastery with regards to the unit concerned before proceeding to the next advanced unit.

6.6 Management by Data/Measurement

Data must be collected and gathered at all time in order to assist in the analysis and measurement process of the quality of services and products. Performances must be benchmarked against certain well-known standards. Analyses and measurements are used in knowing whether or not there are some improvements in the services based on the feedbacks and complaints from the customers. Charts must be employed in detecting and discovering trends in keeping track of the performances of staffs and students within the education system. The results of the analyses are critical in determining future

course of actions. Continual improvement must be adopted and corrective actions must be implemented as appropriate.

Analysis of data must provide information relating to the following items (based on ISO):

- *Customer satisfaction*
- *Conformity to product requirements*
- *Characteristics and trends of processes and products including opportunities for preventive actions*
- *Suppliers*

Higher learning institutions must take note of the two basic purpose of TQM in education, which are as follows [13]:

- *Improved learning*
- *Improved cost effectiveness*

Both objectives can be achieved if all elements of education are present and the system planning is followed strictly by all parties within the education system. To ensure data and information integrity, some level of data security, validation and verification must also be maintained. All these are also part of quality assurance and control measures. There are a few other elements that we need to have to ensure acceptable level of support for implementing TQM in education. It is very important to note that a proper transformation plan must be ready before any of the above elements can be implemented. A proper TQM steering committee or a quality assurance center must first be set up and advices from those with experience are also needed.

7. Case-based reasoning (CBR)

CBR is an artificial intelligence technique that reasons by remembering previously experienced cases, and this technique will speed up whatever processing that needs to be done. Previous experiences or cases that are similar to the current case at hand are stored in a knowledge base, which is normally referred to as a case base. The main steps within a CBR cycle are *Retrieve*, *Reuse*, *Revise*, and *Retain*.

Each time a new case or problem is encountered, the case base is consulted and the most similar case or set of cases will be retrieved (*Retrieve* step). If there is a *perfect match*, then the related solution to the existing case or problem is used directly (*Reuse* step). Otherwise, the most similar case or set of cases will be used and revised/adapted so that the solution can be derived (*Revise* step) more efficiently and retained (*Retain* step) for future use if the same case reoccurs.

The descriptions of the steps within the CBR cycle are as follows [18][19]:

- Step 1 - *Retrieve*: Retrieve the most similar case or set of cases.
- Step 2 - *Reuse*: Reuse the information, knowledge, and solution in that case to solve the problem at hand (in this paper a case is any TQM problem) if there is a perfect match.
- Step 3 - *Revise*: Revise and adapt the most similar case or group of cases as appropriate if a perfect match is not found.
- Step 4 - *Retain*: Retain or save the new experience or case for future retrievals and problem solving, and the case base is updated by saving the newly learned case.

In this paper, Genetic Algorithm (GA), which is a component of soft computing, is used within the CBR cycle in retrieving (*Retrieve* step) the most similar case or set of cases within the case base. Here, a case is any past experiences or examples related to any of the TQM processes or activities (within the TQM system). In general, genetic algorithms (GAs) are adaptive heuristic search algorithms premised on the evolutionary ideas of natural selection and genetics [20]. GA optimizes the search process during the retrieval of the most similar case or set of cases. Usually, the simplest form of GA involves only *selection*, *crossover* (single point crossover), and *mutation* [21].

Figure 2 presents the details of the CBR component that is added to the conventional TQM system (TQMS) model, which was introduced in [1]. The addition of the CBR component will improve the entire TQM system's performance since it has the ability to recall previously experienced cases that can simplify the decision-making process.

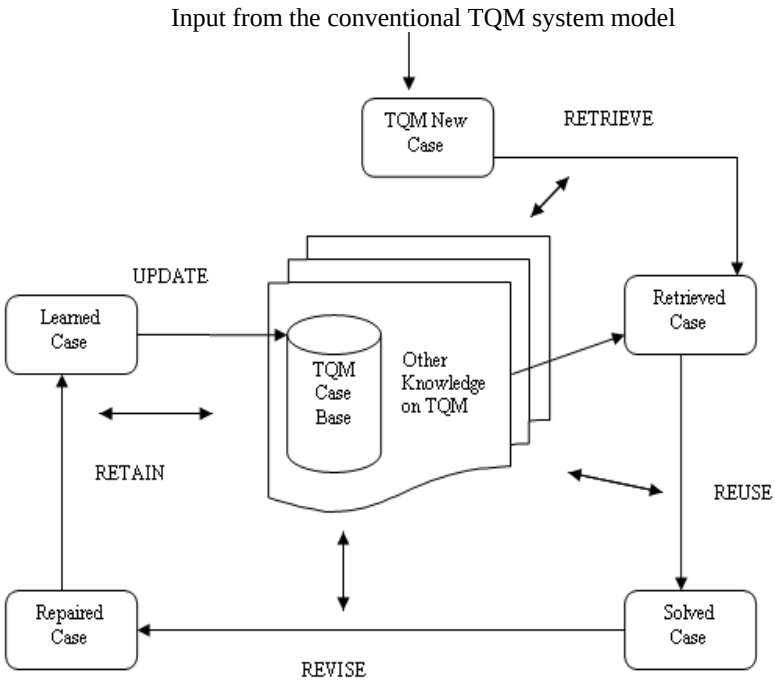

Figure 2. The TQMS-CBR component/cycle

8. The proposed TQMS model using CBR

Basically, the education system total quality management system shall follow the ISO 9001 series that emphasize more on the ISO process-based quality management system. The ISO promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system, to enhance customer satisfaction by meeting customer requirements.

The organization that is interested to implement this process-based approach must first identify and manage numerous linked activities. Process approach can be defined as the application of a system of processes within an organization, together with the identification and interaction of these processes, and their management.

The PDCA (Plan-Do-Check-Act) approach mentioned above is applied to all processes to ensure quality process and consequently quality products and services. It is well known that in order to get good quality products and services, we must first have good quality processes. The proposed TQMS (Total Quality Management System) model is based on the process-based quality management system that is used by ISO in ensuring quality. Several modifications and enhancements are applied to the original model in [1] to reflect an improved model for higher education total quality management system using CBR.

The newly proposed TQMS model is shown in Figure 3. The model simply illustrates the general architecture of the TQMS model.

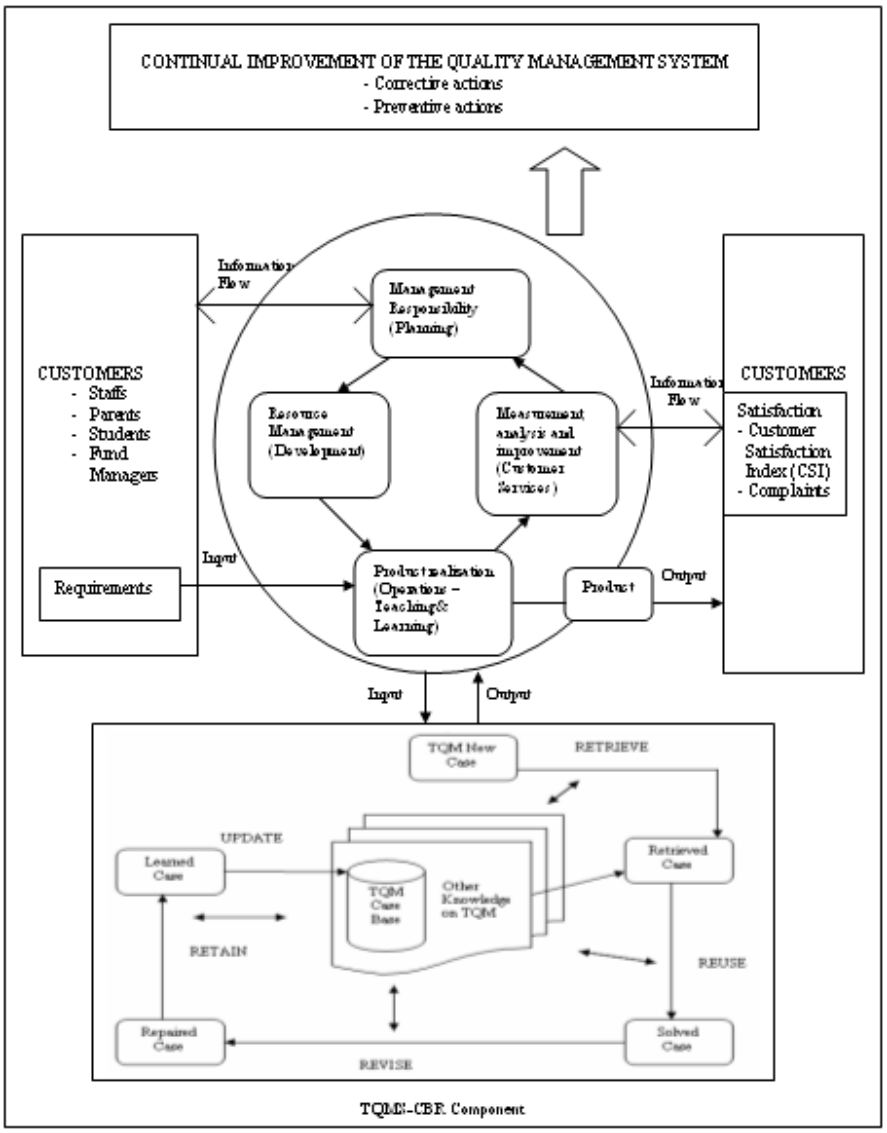

Figure 3. The proposed TQMS (Total Quality Management System) model in higher education

As shown in Figure 3, the TQMS-CBR component (refer to Figure 2 for the details) accepts inputs from the TQMS conventional process model and the output that results from the CBR process will be used in improving the TQM system's performance by reusing solutions to past experiences that are stored in the case base.

9. Conclusion

Based on the above study, it is reasonable to conclude that both quality assurance and management are critical in ensuring that higher learning institutions provide better services to their primary customers. The direct results of imposing total quality assurance (TQA) and total quality management (TQM) to our higher education system are high quality services and products.

The products of institutions of higher learning are of course graduates in many different disciplines, and it is hoped that those graduates are of high quality graduates, who are fully equipped and have the required skills in facing all challenges of the rapidly changing global world. In addition to producing quality graduates, nowadays, many universities that are categorized as research universities are also

required to be innovative and creative in producing new inventions through research collaborations with relevant industries and research institutes. Consequently, new inventions contribute directly to intellectual capacity building in higher education that will result in better quality tertiary education. The introduction of the new TQM system model would be able to contribute significantly in achieving the quality objectives set by each institution of higher learning.

10. Acknowledgment

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11. References

[1] Hajar Mat Jani, “Intellectual Capacity Building in Higher Education: Quality Assurance and Management”, In Proceeding(s) of the 5th International Conference on New Trends in Information Science and Service Science (NISS2011), IEEE/AICIT, Macao, China, pp. 361-366, 2011.
[2] Tie Li, Qihong Ren, "Model for Evaluating the Quality of Public Physical Education Class in Universal Institutions of Higher Learning with 2-tuple Linguistic Information", JDCTA: International Journal of Digital Content Technology and its Applications, Vol. 5, No. 12, pp. 491 ~ 497, 2011.
[3] Hwa-Young Jeong, Hae-Gill Choi, "A Design of Personalized U-Learning System using IRT", JCIT: Journal of Convergence Information Technology, Vol. 7, No. 6, pp. 268 ~ 275, 2012.
[4] Hajar Mat Jani, and Salama A. Mostafa, “Implementing Case-Based Reasoning Technique to Software Requirements Specifications Quality Analysis”, International Journal of Advancements in Computing Technology (IJACT), Vol. 3, No. 1, pp. 23-31, 2011.
[5] Hajar Mat Jani, and Lee Sai Peck, “Using GA and KMP Algorithm to Implement an Approach to Learning through Intelligent Framework Documentation”, In Lecture Notes for Business Information Processing (*Springer*) & Proc. of 8th International Conference on Information Systems Technology and its Applications (ISTA 2009), Campbelltown, Australia, pp. 202-213, 2009.
[6] ISO-International Organization for Standardization , Retrieved 1 May, 2012, from http://www.iso.org/iso/home.html.
[7] “Total Quality Management”, Retrieved 1 May, 2012, from http://searchcio.techtarget.com/definition/Total-Quality-Management.
[8] “Quality Management Systems”, Retrieved 2 May, 2012, from http://www.businessballs.com/dtiresources/quality_management_systems_QMS.pdf.
[9] ISO, “Quality Management Principles”, Retrieved 5 May, 2012, from http://www.iso.org/iso/iso_9000.
[10] MOE (Ministry of Education) Jordan, “Capacity Building Project in Management of Qualitative Development of Educational Services”, Retrieved 30 June, 2008, from http://www.moe.gov.jo, 2002.
[11] Jamil Salmi, “Developing Countries and the Global Knowledge Economy: New Challenges for Tertiary Education”, In Proceeding(s) of the International Workshop, 2005.
[12] UN STI, STI (Science, Technology and Innovation) MDG Task Force Interim Report, Cited in Salmi, 2003.
[13] Ron Fitzgerald, “Total Quality Management in Education”, Retrieved 30 June, 2008, from http://www.minuteman.org/topics/tqm.html, 2004.
[14] Denese Davis and Jackie Sorrell, “Mastery Learning in Public Schools”, Retrieved 5 May, 2012, from http://chiron.valdosta.edu/whuitt/files/mastlear.html, 1995.
[15] J. Block, “Mastery Learning: Theory and Practice”, New York: Holt. Rinehart, & Winston, Cited in Davis and Sorrell, 1971.
[16] Funderstanding.com, “Mastery Learning”, Retrieved 29 June, 2011, from http://www.funderstanding.com/mastery_learning.cfm.
[17] J. Fehlen, “Mastery Learning Techniques In The Traditional Classroom Setting”, School Science and Mathematics, 68, 241-245, Cited in Davis and Sorrell, 1976.

[18] Agnar Aamodt and Enric Plaza, “Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches”, AI Communications, IOS Press, Vol. 7, No. 1, pp. 39-59, 1994.
[19] Hajar Mat Jani, “Applying Case-Based Reasoning to Software Requirements Specifications Quality Analysis System”, In Proceeding(s) of the 2nd International Conference on Software Engineering and Data Mining (SEDM 2010), IEEE/AICIT, China, pp. 140-144. 2010.
[20] Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, Second Edition, Addison Wesley, 2005.
[21] Melanie Mitchell, An Introduction to Genetic Algorithms, Massachusetts: The MIT Press, 1998.