

# A Multi-agent Model to Mitigate Knowledge Loss in in Continuous Academic Quality Improvement Effort

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**Abstract**— In academic management, it is a lecturer’s task to ensure that the delivery of a subject complies with the syllabus and curriculum design. In most cases, lecturers have their own way of managing their classes, aided by a personally prepared lesson plan. Usually, the contents of the lesson plans change from one semester to another, either due to a change of the lecturer in charge or improvement in delivery and assessment. However, these changes are not comprehensively tracked and documented to show improvements made on the subject, which is beneficial for curriculum design review. Consequently, subsequent curriculum review fails to consider the necessary changes for improvement in the curriculum. To mitigate the effect of this knowledge loss in tracking these changes, we propose a multi-agent knowledge management approach to conceptualise a framework in tracking and capturing lecturers’ initiatives for improving the course delivery, and this can be further integrated as the change process in CQI for curriculum design review. Quantitative and qualitative analysis approaches are deployed to identify the change and update processes that lecturers adopt in updating their course delivery. This is followed by a study in multi-agent system to be applied in animating the processes. A knowledge management framework is then synthesised by considering the dynamics of the change processes to manifest the tracking and capturing of new knowledge in course delivery. The outcome of this research is a model of knowledge management process that captures the knowledge of course delivery changes made by lectures. The outcome is significance in contributing to the CQI in curriculum design review.

**Keywords**— multi-agent system; personal knowledge management; continuous quality improvement; GUSC Model, academic management

## I. INTRODUCTION

Due to hectic schedule and high demand of attention on the teaching tasks, lecturers often do a quick review on the syllabus and prepare lesson plan as the academic weeks proceed. At times, lecturers are not given the same subjects every semester, due to resource management. Discontinuity of updates by lecturers in a subject would occur if the lecturers are no longer teaching the same subject. In some universities, the lesson plans are required in subject teaching folio or file, and this file may be recreated every semester, as part of the quality management procedure. Since the contents of the teaching folio may differ from one lecturer to another, even though the subject is the same, there is a need to keep track of the contents, especially when the contents are changed drastically to reflect changes in the subject’s knowledge contents. However, there is no methodology or system by which these changes are tracked and documented, which results in consequential loss of knowledge in the course delivery. Such deficiency impedes the CQI in curriculum design review process. Hence this research attempts to mitigate the situation by proposing a multi-agent knowledge management approach to the problem.

Hence this research attempts to mitigate the situation by proposing a multi-agent knowledge management approach to the problem, with the following hypotheses:

Hypothesis 1: Tracking and documenting updates made by lecturers in course delivery may help to improve the current CQI process of curriculum design review.

Hypothesis 2: A knowledge management approach could be conceptualised to track and document the changes made by lecturers in course delivery.

Upon proving the hypotheses, the research questions are as follows:

1. What are the possible ways of tracking and updating changes made by lecturers in course delivery?
2. How could a knowledge management approach can be applied to track and updates those changes?

In order to achieve the purpose and in proving the above mentioned hypotheses, the following objectives would be the target for this research: to conceptualise a multi-agent knowledge management framework for monitoring and capturing lecturers’ initiatives in improving the quality of curriculum design.

## II. RELATED WORKS

This review covers both aspects of the study: the concept of continual quality improvement (CQI) in education; and the technical side of agent-mediated knowledge management. In applying the two domains to the current case, there is a need to include the bottom-up approach to organisational knowledge management (OKM).

### A. CQI in Institutes of Higher Learning

We differentiate the meaning of the word ‘continual’ and ‘continuous’ as follows: “Continuous improvement is gradual never-ending change, whereas continual improvement is

incremental change” [1]. We refer to the ‘continual’ improvement process in this proposal, since the curriculum design review is expected to be reported and assessed on semester basis, or in incremental mode. However, the phrases ‘continual’ and ‘continuous’ are interchangeable depending on the context and situation.

According to the Malaysian Qualification Agency (MQA) [2], continual (or continuous) quality improvement (CQI) is a cyclical and continual process to bring about the enhancement of quality. Programme or curriculum monitoring and review is part of CQI, the key elements of quality assurance in institutes of higher learning in Malaysia. In the context of such a dynamic environment, institutes of higher learning must continually review the achievement and suitability of their strategic directions, including the programmes in relation to the strategic directions, changing conditions and educational best practice [2].

From international resource unlimited to education alone, continual or continuous quality improvement (CQI) is “a process to ensure programmes are systematically and intentionally improving services and increasing positive outcomes” [3] for the customers (in this case, students) we serve. Based on an evaluation and assessment research on course assessment for curricular quality improvement [4], “while the majority of faculty members recognised the benefits of the plan, a few were sceptical; their main concerns being loss of autonomy, fear of centralised control, and erosion of academic freedom”. Since CQI is a cyclical, data-driven process, and it should be a proactive (not reactive) process [3], a technology-enabled CQI process can help in reducing and avoiding the faculty members’ worry.

Academic programme review, which includes curriculum design review, is “a comprehensive process designed to ensure that a programme adheres to university values of quality, integrity, and student-centeredness and is accountable to academic and professional constituencies” [5]. Depending on the university, a programme review committee is formed and made up of academic administrators, faculty members, and operational partners, who “completes a comprehensive self-study on the programme’s organisation, mission, curricula, faculty, students, and support services” [5].

Numerous research and development on continual quality improvement (CQI) have been made on the educational scene in the United Kingdom. The research on CQI in education is often documented on medical, clinical, pharmaceutical, nursing and related fields. This is due to the critical needs to improve the way curriculum is designed and taught in these fields, since it involves thorough grasp of concept by the students when dealing with people’s life and health. A research on development and implementation of an online curriculum framework for the medical course is conducted between 2013 and 2014 at the Flinders University, Australia, to support the storing, sharing, management, and review of learning and teaching content and resources [6]. This framework is found related to the work focused in this paper.

Efforts in CQI are not without problems. Numerous works have investigated the issues and challenges of such efforts worldwide. In a recent work, Mokhtar et al. [7] study the issues, challenges and best practices in CQI that are implemented in Malaysian universities. They discovered issues that include commitment in creating quality culture, organising a quality circle, and developing instruments and communication channels. Their findings highlight a gap in knowledge and understanding of academic quality assurance between academic and non-academic staff, lack of staff who are willing to be responsible in CQI, and a need for staff to have clearer shared understanding in higher education institutions. They also highlight best practices employed by universities for their CQI programmes.

In Malaysia, recent research on CQI in education covers the curriculum design for engineering and biomedical engineering fields. This is aligned with the need to produce graduates who will meet the job market demands as projected by the industry players. Nevertheless, it does not mean that the curriculum design for other fields, such as computer science, childhood education and aviation management, do not need continuous quality improvement. In fact, there is always the need to continuously improve the curriculum design to make it current and ensuring that future graduates are employable.

As implemented in medical and engineering fields, there is a need to engage stakeholders in curriculum design because “curriculum design and approval is one of the few institutional processes in which almost all faculty level processes and central services have a stake,” as stated in the Principles in Patterns (PiP) project by the University of Strathclyde [8]. In ensuring participation by stakeholders, the JiSC [8] came out with 8-steps process framework to produce ‘trusted, timely course information’, which is surrounded by the environment involving all stakeholders that feed (data, information and knowledge) to the development and implementation of the curriculum design cycle.

Within the institute of higher learning, there is also a need to capture and share the curriculum design process among the stakeholders (i.e. lecturers, programme coordinators, academic managers), because “anything that can tighten up thinking about why we are producing is a good thing, and it is financially a good thing because it can speed up some of the other decisions”, as quoted in the Open University Learning Design Initiative-Jisc (OULDI-Jisc) project by The Open University [8]. Supporting this, the Course Tools project by the University of Cambridge highlighted that “engaging stakeholders with ideas is very difficult as long as they remain just ideas, but demonstrators and

prototypes which allow a hands-on experience can be much more effective” [8]. This creates the need to design a system that supports continual curriculum enhancement in an “iterative cycle of feedback and review” [8]. This iterative cycle consists of a periodic review process that should be developmental and not just an audit, as stated by the City University London. The potential gain of technology-enabled systems is not only on increasing efficiency, but also improving the approval and review processes [8].

The advantages of using technology as part of continuous enhancement in curriculum design process are highlighted as follows [8]:

- it helps in developing new solutions to address organisational, technical and educational issues;
- it helps in communicating new ways with stakeholders to facilitate discussion and collaboration;
- ability to access, record and capture information about the curriculum design (to stakeholders);
- improve access to guidance for those designing and describing curricula;
- improve communication flows both internally and externally;
- provide ‘single-truth’ sources of information that are accurate and can be queried and analysed to suit multiple purposes;
- increase consistency both in terms of the learner experience and quality assurance; and
- develop more efficient administrative processes.

#### B. GUSC Model in Agent-mediated Personal Knowledge Management (PKM)

In recent years, knowledge management research has highlighted the significance of personal level knowledge management in contributing to the achievement of collective organisational goals. The bottom-up approach towards organisational knowledge management (OKM) results in the development of the GUSC Model, which postulates the four processes of personal knowledge management (PKM): get/retrieve knowledge (G), understand/ analyse knowledge (U), share knowledge (S), and connect to knowledge sources (C) [9].

The main aim of the GUSC Model is to provide a general guideline for designing a multi-agent PKM system, with intelligent software agents assigned to the G-U-S-C (i.e. get, understand, share and connect) roles, conferring the abilities to the agents to mediate the tasks of their human counterparts [9]. With such guide, a number of applications has been developed using the GUSC Model, mainly within the domain of education, such as agent-mediated classroom management system [10], social network analysis on final year project students’ interaction [11], and agent-of-things in social intelligence [12].

The main result from these applications proves that intelligent agents can be programmed to perform tasks on behalf of their human counterparts, for which the cycle of G-U-S-C processes are translated into interactions between humans and agents [10, 11, 12]. These interactions are proven to be possible between human-agent and agent-agent, easing the real human-human interactions [9].

Nevertheless, the G-U-S-C processes are not necessarily implemented in that rigid order or sequence. Since the GUSC Model is developed as a guideline, it can be applied based on the needs and situations, depending on the case. The variation in the sequence is normal because of the “different environments in which knowledge is being translated between tacit and explicit

The GUSC Model also provides the guideline by complementing the capabilities of intelligent software agents that PKM processes entail. As an example, software agents should be able to “engage in dialogues and negotiate with other agents and coordinate the transfer of information” [14], which beckon the need of get, share and connect processes. On another note, software agents need to ‘understand’ and thus have the ability to “carry out some set of operations on behalf of a user or another agent or program with some degree of independence or autonomy, and in so doing, employ some knowledge or representation of the user’s goals or desires” [15].

A software agent is commonly defined as “an encapsulated computer system that is situated in some environment and that is capable of flexible action in that environment in order to meet its design objectives” [16]. In relating to this proposal, the roles of the software agents are deployed within the institutional environment, to mediate the tasks of the human counterparts, who possess personal knowledge and perform certain tasks that are needed to fully contribute to the collective organisational goal.

### III. METHODOLOGY

This research will perform the following steps of methodology, in the duration of two years:

(a) Identify and Select Case Organization: An organization will be selected to study the issues in course delivery within the organization.

(b) Quantitative and Qualitative Designs: Due to the nature of the study, the methodology used for data collection is two-fold: quantitative and qualitative. Such methodology consists of a detailed description of: research design, population and sampling, pilot study, reliability and validity, data collection and analysis as well as a description of the interviews and other techniques for the qualitative analysis. The qualitative method is intended to ensure objectivity, generalizability and reliability.

(c) Pilot Study: The purpose of pilot study is to test and improve the validity and reliability of the research instruments. Therefore, the instrument will be pilot-tested before administering it to the selected sample.

(d) Data Collection: In this phase, data collection is carried out and a knowledge management approach is identified.

(e) Theoretical Analysis of Survey and Interview Data: In this phase, data collected from the questionnaires and interviews are analysed. The analysis should reveal the information which is required for the conception of a framework to track and capture knowledge in course delivery. Statistical techniques will be applied to obtain correlations between data items and their significance to the study.

(f) Analysis on Framework for integration with Multi-agent System: We shall study the framework for integration with the multi-agent system to animate the process dynamics. In this phase, the framework is validated. It represents proactive and strong procedures that need to be implemented in manifesting CQI in curriculum design review. forms” [13].

### IV. PRELIMINARY FINDINGS

The recent exploratory study presented a preliminary system design based on TROPOS methodology [17]. It explores the system by analysing on the soft goals and hard goals of the current CQI concept in academic programme review. The result of the preliminary model of the system design is as shown in Figure 1.

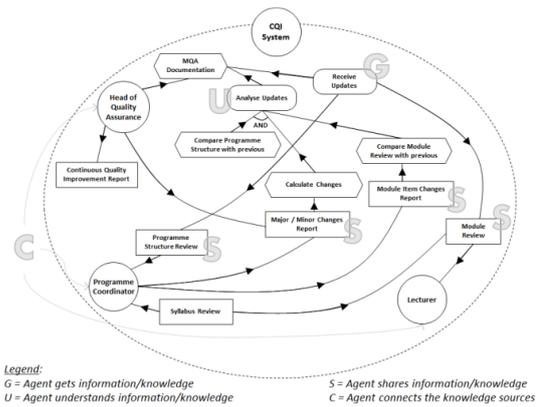


Fig. 1. TROPOS-based agent-mediated CQI system design.

The preliminary system design (Figure 1) can be translated into a nodal approach to visualise the connection and communication between the agents in the CQI system. This is further illustrated in Figure 2, in which the tasks of the actors (i.e. Lecturer, Programme Coordinator, and Head of Quality Assurance) are mediated by the agents, on top of having the role agents (i.e. Get, Understand, Share) to automise system tasks.

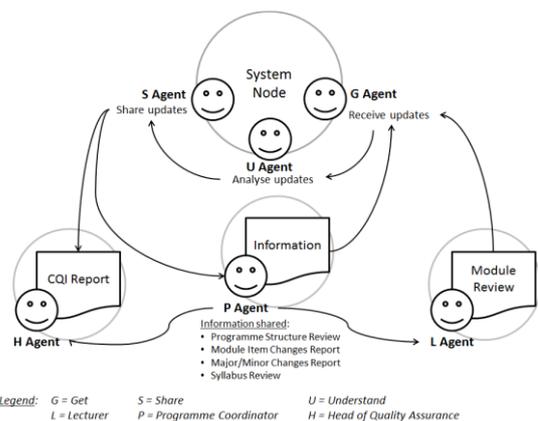


Fig. 2. Nodal Approach on Agent-mediated CQI System.

### V. DISCUSSION AND CONCLUSION

The intention for this study is to produce new findings that could be contributed to the body of knowledge of both knowledge management and multi-agent system. The significance would be on: multi-agent knowledge management framework for tracking and updating new knowledge in course delivery; and a process of deploying the changes in course delivery for CQI in curriculum design review.

Potential applications of this research outcome would be on specific KM tools that could be further developed to fulfil specific needs of KM using software agents based on the framework areas of CQI in academic management, such as total program review. Other than that, the results of the study could be assessed further for potential deployment in other areas quality management.

In terms of impact on society, the academic community would surely benefit from this work. Firstly, knowledge gained in providing better course delivery spawn other ideas based on the knowledge gained and shared. Ultimately, better delivery of courses reflected by superior knowledge is manifested which would have a ripple effect of the nation and economy in terms of reputation (as an educational hub for the region).

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