An efficient constructive e-alignment for onsite-online learning

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Abstract: This paper aims at proposing an efficient constructive electronic-based alignment (CeA) to promote self-learning amongst the students via e-learning environment where e-lectures/e-tutorials are developed followed by e-assessments. The CeA is developed based on behaviourism, cognitivism, humanism and constructivism to ensure the students' learning does take place in the e-learning environment. Considering engineering related courses at higher education, it has been shown that the decline in mathematical background of the students causes difficulties in accomplishing the quantitative curricula. A well-designed constructive alignment is thus necessary to support active learning of the students having different background. Onsite tutorials and seminars may be helpful; however, they may not be very effective, especially in a large-sized and/or high-diversity class. Therefore, in this paper, the proposed CeA not only helps the onsite students strengthen their knowledge but also provides the offsite students with various kinds of learning supplement. Particularly, a case study is presented to show the potential impact of the CeA on both onsite and online learning of mathematics for postgraduate students in both telecommunications engineering and computer networks.

Keywords: constructive alignment; online learning; onsite learning; engineering subjects.

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1 Introduction

As the population increases along with the rapidly enhanced technologies, higher education (HE) has been transformed and diversified to support people of various background and requirements (Fry et al., 2009). Specifically, the HE has provided education to students wishing to have A-level qualifications, the people preferring to study part-time due to either work or family commitments and more importantly the people having disabilities that restrict them to attend the classes frequently. Although there are many opportunities open for learning, the learners are required to have basic background knowledge to be able to follow the selected Programs. For example, in engineering-related programs, most of the modules require the students' background in mathematics. However, some of them do not have enough background but have capacity to learn.

In this paper, the modules under investigation are those that we are currently responsible as the module leader, including a module of level 7 for MSc in Computer Networks and a module of level 4 for BSc in Telecommunications Engineering. Related modules that we are teaching are also discussed as a motivation for developing a generalised framework for all engineering-related modules. Generally, most of students do not have enough background in mathematics to be able to follow the engineering course. Also, the students are of different levels and thus they have different starting points. To cope with this, we were asked to arrange some workshops on mathematics running in parallel with the main course. These workshops were specifically designed for the BSc students in Telecommunications Engineering. As we taught different modules, we realised that such workshop would be also very helpful for other students following other modules, such as the MSc students in Computer Networks. Therefore, this paper can be regarded as an exploratory initiative which if successful could be rolled out more widely in the future.

Through the distance learning of Postgraduate Certificate in Higher Education (PGCertHE) that we have been experiencing, we found that e-learning would be promisingto be the optimal solution for the above issue. With the development of technologies, e-learning not only facilitates mass education but also provides flexibility to students' learning (Mason and Rennie, 2006; Bates, 2005; Moeng; 2004). The e-learning can be referred to as the employment of information and communication technologies (ICT) in learning models to either fully or partly support individuals, groups and organisations to access knowledge, acquire new skills and solutions for enhancing learning.

In this paper, we aim at integrating the e-learning into constructive alignment (CA) for the workshop on mathematics. As one of the powerful teaching and learning tools, CA has been introduced for assessment tasks in HE. This approach has indeed influenced the design of the mathematics workshops, which will be shown in the following sections. As defined by Biggs (1996), the CA is seen as a marriage between a constructivist understanding of the nature of learning and an aligned design for teaching. With the CA approach, the tutors need to answer the following questions:

[Q1] What do I intend my students would be able to do after my lecture/seminar/lab session? And at what level?

[Q2] How do I provide learning activities that would assist them to achieve the above-targeted outcomes?

[Q3] How do I assess the level they have achieved? And how well?

Instead of focusing separately on the content, teaching methods and assessment process, the tutors can now align the assessment, teaching strategies and intended learning outcomes and thus the coherence of the curriculum can be maintained.

Regarding engineering-related courses at HE, it has been shown that there is a decline in mathematical skills of the students in these days (Warwick, 2008). For example, most of our Postgraduate students do not know how to calculate differentiation/integration; even they have met many obstacles in solving basic equations and system of equations. In order to understand and solve engineering problems, a high mathematical skill is a definite requirement. Also, the students usually have different starting points of different levels and background. This accordingly motivates us to develop a more-efficient CA for active learning. It is undoubted that supplemental lectures, tutorials, seminars could be provided to support the students and they are certainly very helpful for onsite students. However, taking into account a large-sized class where students' learning experiences are unpredictable, some students may feel bored and distract others, some cannot concentrate in a large class, some are nervous of asking tutor for unclear problems, etc. Furthermore, this problem would be more complicated for offsite students or even onsite students who could not participate in these supplemental classes.

To cope with the above limitations, in this paper, we propose an efficient constructive e-alignment (CeA) to promote self-learning amongst the students via e-learning environment. The proposed CeA is based on the core concepts of blended learning theory where the traditional classroom-based method is combined with online digital-based approach (Dębska et al., 2016; Jia, 2017; Wang, 2017). Particularly, as the main components of the CeA, e-lecture, e-laboratory and e-tutorial/e-seminar are developed followed by e-assessment and e-feedback. In order to show the impacts of the CeA on both onsite and online learning experiences, a case study is presented where postgraduate students in both Telecommunications Engineering and Computer Networks are suggested to take supplementary classes in mathematics. Note that although online learners considered in this work are postgraduate students using online materials as a supplement to the university courses, the proposed approach can be adapted for other online learner types, such as self-education and distance education. All students are encouraged to access online materials via e-learning, and thus can also be regarded as blended learning

(Bates, 2005; Dębska et al., 2016; Jia, 2017; Wang, 2017). The CeA is expected to not only help the onsite students strengthen their background knowledge but also provides the offsite students with various kinds of learning supplement in mathematics. The novelty of the proposed approach lies in the fact that the CeA can be employed for teaching students at different levels in different modules where mathematics is the required background. The proposed CeA is shown to be able to answer the questions raised above as follows:

- [Q1] The students are expected to have a deep understanding and can solve the problems not only in our modules but also in other engineering related modules which require a good background in mathematics.
- [Q2] Components of CeA, i.e., e-lectures, e-seminars and e-laboratories, will be provided to achieve the outcome of the modules.
- [Q3] For assessment, e-assessment together with e-feedback will be employed during the course.

In the rest of this paper, we firstly identify the main issues of the modules that motivate us to propose CeA as a potential solution. We will then discuss the design requirements of the proposed CeA for different modules. Given these requirements, we will investigate the development and deployment of the CeA for modules of different levels to show the advantages of the e-learning environment in encouraging and supporting the students' learning as well as outlining the challenges in the design of a perfect CeA. We will also present the modifications that could be done to all the modules via the proposed CeA to help the students become independent workers in future career. Finally, we will provide evidences to show how the proposed CeA meets the UK professional standard framework.

2 Modules' overview and rationale of CeA

We have been module leaders for various modules including a level-7 MSc module in computer networks program and a level-4BSc module in telecommunications program. All the above modules run over 24 weeks including one-hour lecture and two-hour seminar/laboratory sessions per week. The leadership and teaching of different modules at different academic levels allow us to critically evaluate and have an in-depth view of the strong and weak aspects that these modules have in common, which can be summarised as follows:

1. Strong aspects:
   - The modules are the core modules covering the fundamental concepts required for the program. The background knowledge of the students could be therefore verified through these modules.
   - The modules run throughout two semesters in 24 weeks so there are many topics that could be discussed, including not only those in the core materials but also up-to-date relevant works for further study (e.g., topics on 5G technologies in Tran et al. (2018) and Bhuvanasundaram et al. (2017).

- The lectures cover the basic theoretical aspects encouraging students to investigate further at home. The most related work is also included along the main material to help the students have an overview of the outside world.
- The seminars provide some practical problems for discussion. Only selective problems are solved during the limited time while the other similar problems are suggested to solve at home and the challenging problems are given with hints. This approach helps encourage students' self-study.
- The laboratories exploit the most relevant equipment/toolkit for experiment as well as the well-known software for simulation.
- The class size of the modules is generally rather small with less than 20 students allowing more interaction and discussion.

2 Weak aspects

- The students do not have enough background knowledge to follow the course. Most of them are very weak in mathematics, which is very important for solving engineering-related problems.
- The students are of different levels in learning styles. So, it causes misalignment in learning.
- The time for seminar session is limited with only two hours to solve the problems.
- There is no time for teaching mathematics, as this is not a mathematics course.
- There is no assessment for the mathematics skills throughout the course.

Given the above weaknesses raised in the board of studies, the program leader decided to temporarily organise some workshop as all students following these modules expected to have extra sessions to consolidate their mathematics knowledge. After some workshop sessions, we realised that these workshop materials are also very helpful for the other modules that our colleagues are teaching as mathematics is crucial to follow any engineering-related courses at any levels. However, due to the diversity of students of different levels and different modules' requirement as well as timetable clashes, it is quite hard to arrange a class to support all modules at the same time. Therefore, this motivates us to think of how to develop a supplementary learning environment in parallel with in-class sessions, where all lecture notes, slides, audio and/or video captures for the workshop could be freely and selectively accessed by the students learning other modules of different levels.

Recently, telecommunications has emerged as one of the fastest growing industry with various innovative technologies, and thus proposing a need of increasing the number of researchers and trained engineers (Deloitte, 2013). Many companies are now eager to sponsor their staffs to take on part-time postgraduate level (i.e., MSc, MEng) as a means of personal development. However, due to the time constraints, they may miss some classes. Therefore, it is necessary to provide supplementary sessions in the form of e-learning along with the main sessions in class. As stated in Bates (2005), there are several other key points that cause the need of e-learning, such as cost-effectiveness, commercialisation, geographical location, social equity and access, etc.

In this paper, we propose a CeA for students wishing to review the learning sessions, especially for those who could not catch up the onsite sessions or miss the sessions.

Based on existing learning theory models, we will outline the differences between the classroom-based learning and online learning approaches.

3 Design requirements of CeA for mathematics course

In this section, we first introduce the design of supplementary course on mathematics in the form of workshop and its relation to other modules. Then, we will discuss the requirements for the design of an e-learning environment for mathematics course.

3.1 Design of workshop on mathematics

Besides the weekly lectures, seminars and labs, the course on digital transmission systems for postgraduate students has two-hour workshop on mathematics. The main aim of this workshop is to consolidate the students' background in mathematics to be able to follow the main course. The workshop can be organised as either a lecture, a seminar or a practical laboratory session.

- *Lecture-formed workshop (LW)*: in the LW, we prepared lecture notes summarising basic concepts in mathematics, where we may act as a facilitator with student-centred learning. In order to explain how to derive some complex expressions or proofs of theorems/lemmas, we exploited available facilities in the classroom, e.g., smart board, whiteboard markers and flipcharts.
- *Seminar-based workshop (SW)*: in the SWs, we selected some problems and asked the students to solve them based on what they learnt in the LWs. we first engaged the students into discussions on possible approaches to the simple problems and then asked the students to solve the similar problems on their own. By using this way, it helps enhance the students' engagement in learning and solving various kinds of problems in a step-by-step fashion. In fact, as statistically shown in Hardjito (2010) and Anghileri (2006), the scaffolding approach enhances students' engagement in solving complex problems, while the help required by students decreases over time. For problem solving, we used either whiteboard markers or flipcharts.
- *Practical workshop (PW)*: in the PWs, we asked the students to evaluate and verify the numerical results of the expressions learnt in the LWs and derived in the SWs using MATLAB, which is licensed simulation software available on all PCs in the university laboratory. Thus, in the initial weeks of the main course, an in-depth training session on how to use and program with MATLAB was designed for all the students following this course.

From our own teaching experiences of other engineering-related modules, we observed that the students were also willing to have similar workshop to help gain a required level of mathematics. This accordingly raises a question of how to provide supports to all students, especially when they are of different levels with different requirements. To deal with this issue, in this paper, we propose a CeA that can be adaptively changed based on the students' learning experiences.

3.2 Design requirements of CeA

The proposed CeA is employed via online platforms (e.g., 'my learning'), and thus it is critical to ensure that the learning takes place through online resources. In Koohang et al. (2009), e-learning is regarded as an instructional design concept where behaviourism, cognitivism, humanism and constructivism are all taken into account. As shown in Brown and Voltzi (2005), the heart of the e-learning is formed by six key elements consisting of activity, scenario, feedback, delivery, context and impact. Following the same approach in Beetham and Sharpe (2007), we construct design requirements of the CeA for LW, SW and PW on mathematics as follows:

- comprehensive e-lecture, e-seminar and e-laboratory materials (e.g., slides, notes, hand-outs and relevant references/textbooks) are always available for online access
- multimedia support is integrated within the materials to enable the offsite students from anywhere to easily understand the materials and also to support the onsite students to review the materials after the session
- e-learning environment should be pleasantly designed, which is professional but simple to use
- formative and summative e-assessments need to match the onsite assessment criteria in classroom
- tutor's engagement with the students has to be maintained throughout the course.

Over all the above, the key design requirement of the CeA is the engagement of the tutor and students. To cope with this, we propose the use of desktop video (DV), which can:

- Maximise students' engagement and learning experiences by appropriately designing interactive e-lectures that enable not only stimulating contexts but also reflection and feedback.
- Illustrate the thinking process to solve the problems in e-seminars, and thus the problems would be easier for understanding and memorising.
- Facilitate the training of how to use the simulation software (e.g., MATLAB) in e-laboratories. Also, tasks/exercises are designed with instructions/hints for further practice.

While teaching the workshop, we noticed that different modules also required the students having different levels in mathematics. Therefore, we aim at developing an efficient CeA that can be adaptively applied to the other related modules with the following additional design requirements:

- e-lectures, e-seminars and e-laboratories need to be organised for easy access from the students of different modules
- introduction on how to choose the right materials should be provided
- e-learning environment should be open access with encouragement to gain more knowledge of mathematics.

4 Design and implementation of CeA components

In e-learning environment, a virtual but 'real' learning can take place by using constructivism-learning theory (Atherton, 2013). Knowledge is constructed based on learners' previous experiences, i.e., learning among learners. Therefore, an e-learning constructivism model should be built based on the design of learning activities, learning assessment strategies and instructor's role in managing them.

The basic components of a CeA consist of e-lecture, e-laboratory, e-tutorial/e-seminar, e-assessment and e-feedback. All the CeA components are hosted on either the university website or free web pages (e.g., Google pages). The website would have separate sections for e-lectures, e-seminars and e-laboratories. E-assessment and e-feedback are integrated in e-seminars and e-laboratories. Further Subsections would be designed for each of the above sections to highlight the general content required in all modules as well as specific content in different modules. In order to record and store e-materials, the legal issues need to be considered (JISC, 2010). An excellent relation between the lecture recordings and seven principles of good practice (Chickering and Gamson, 1987) is summarised in Martyn (2009).

Basically, to imitate an onsite classroom environment, e-lectures, e-laboratories and e-tutorials/e-seminars can be generated by capturing audio and/or video of the lectures, laboratories and tutorials along with copies of relevant onsite materials. They are then uploaded to a school learning website or blog, and thus they are available anywhere and anytime given an Internet connection with a web browser. They are also compatible with different platform (PC, MAC, smartphone) and operating systems. They are quite easy to use with some basic instructions, adapt well with different students' schedules and allow repetition where the students are able to run as many times as they like.

However, for some challenging problems, we realised that it was quite hard to understand them even we already delivered the solutions for them. Thus, we propose to build steps for solving these problems and embed animation for clarifying these steps either with or without voice recording.

In this section, we will present five components of the proposed CeA which are developed to ensure learning performances. Also, this section will outline how to integrate them into the modules that we are teaching. Specifically, the first three components, i.e., e-lectures, e-seminars and e-laboratories, are based on behaviourism and cognitivism, while the last two components, i.e., e-assessment and e-feedback, are constructed on the basis of humanism and constructivism aiming to provide an effective learning environment.

4.1 E-lectures for LW

In the onsite classroom, AV equipment is normally used to enhance further the content and quality of the lecture slides. However, considering the video capturing for e-lectures, this may cause a problem as it is difficult to emphasise the information delivered on the slides.

Desktop video capturing (DVC) is shown to be an appropriate solution by which the tutor is able to narrate the explanation on the slides along with taking notes during the lecture. By using the DVC, one-hour lecture can be easily divided into Subsections based on the slide structure with slide numbers, and thus students' learning can be improved. Furthermore, this allows the students to ask more specific questions with section number, Subsection number and DVC recording time in the discussion board via e-feedback that will be described in Subsection 4.5. In fact, as stated in Bligh (2000), the students as well as the tutor's engagement and performance decrease over time. Therefore, the DVC with short Subsections would be suitable for e-lectures.

Considering the modules that we are teaching, the students usually show less interest since these modules require a good mathematics background. Therefore, to capture the LW on mathematics, we propose the use of DVC technique with software available at our university including Camtasia Studio (TechSmith, 2012a), Snagit (TechSmith, 2012b) and Autodesk (2012).

4.2 E-seminars for SW

For the SW in mathematics course, we propose the development of e-seminars as supplementary for the onsite SW. We will include a variety of problems of different levels for the students to work on. These problems should match the corresponding LWs and cover from basic to challenging problems where we will provide hints depending on the students' level.

Furthermore, we will upload supporting videos for some selected problems to show how to solve them in a step-by-step manner. These videos could be generated using DVC in a similar way as for the e-lectures. However, in order to encourage the students to be a self-learner, we will set these videos invisible to the students until the students give the first attempt.

Considering mathematics course, there are many possible solutions for a problem and the way the students input the answer on the spaces provided on the website is quite hard for the PCs to understand, especially with mathematical notation even with very powerful and smart PCs at the moment. Therefore, at the initial stage, we will ask the students to do the calculation with real numbers and fill in only the final result for checking. As the technologies move forward, the advanced PCs with cognition capabilities would allow us to design more complicated questions to improve the quality of the e-seminars.

4.3 E-laboratories for PW

In the PW on mathematics, we use MATLAB for simulation and numerical analysis, as MATLAB is a high-level language and interactive environment that not only facilitates the numerical computation but also provides visualisation and programming capability (MathWorks, 2014). Onsite laboratories would provide valuable learning experiences to the students. However, they are not always available to all students due to both time and space constraints. Therefore, we propose the design of virtual laboratories (or e-laboratories) as alternative/backup for the PW.

In order to access e-laboratories, the students need to log in the university network. This accordingly raises many related issues that need to be dealt with, such as network security, network availability, auto-saving work, etc. Therefore, we will design a full step-by-step online tutorial on how to set up the virtual machine and also how to use the MATLAB software from a very basic level.

Similar to e-seminars, we will exploit supporting videos with DVC technique for interpreting difficult activities and tasks in the e-laboratories. In order to assess the students' understanding, we will include questions at the end of the e-laboratories in the simple form of either multiple-choice, true/false or filling-the-blank questions.

4.4 E-assessment

An effective assessment should provide linkages between outcomes, the design of assessment tasks, criteria, marking procedures and feedback (Brown, 2004). Computer-assisted assessment or e-assessment can be simply regarded as self and/or peer online assessment. E-assessment has been shown to achieve pedagogic benefit where the students are fairly assessed with detailed and timely feedback on their work (Bull, 2000). They should include not only marks/grades but also steps to reach the solutions of mathematical problems. For the sake of illustration, screen capture, animation or diagram should be used. Therefore, the e-assessment can promote independent learning, attitudes, critical thinking and skills for solving mathematical problems.

The e-assessment could achieve the real pedagogic benefits if the assessment questions could be well designed throughout the course. However, the e-assessment has some limitations including high development costs, hardware and software dependencies, network security risks, limited question types and network availability/access issues. As stated in Gipps (2005), for certain subject disciplines, the construction of high-quality objective questions to promote deep learning is a non-trivial task and may be challenging. Institutions that plan to adopt e-assessment should make provision for appropriate training, which results in a high initial development cost with a time-consuming process.

By applying learning technologies, we will develop a system that could automatically assess and give feedback for certain types of problems/exercises. Specifically, as shown in Subsections 4.2 and 4.3, we will integrate the e-assessment at the end of each e-seminar and e-laboratory session.

At the initial stage of the development of supplementary mathematics course, there is no requirement of summative assessment at the end of the course. However, we will provide two informal e-assessments for SW and PW at the end of the course with respect to each module. We will allow the students to access a host server to undertake the test. In the test, we will first give a brief introduction on the timing as well as explaining how the e-assessment will work. Then, the host server will randomly select the questions from the question bank for each student. The students will fill in the spaces with only the final answer to assist the automatic marking of the computer.

In Morris (2010), podcasting and mobile assessment are shown to not only enhance the overall student learning experience but also promote better academic performance in either blended learning environment or full e-learning environment. Therefore, in addition to the online e-assessment, we will provide an e-coursework asking the students to record their solutions of an assigned problem in a video format for podcasting via a submission link.

4.5 E-feedback

Feedback is a crucial element to support learning for all age groups (Biggs, 2003; Gipps and Stobart, 2003). As outlined in Nicol and Macfarlane-Dick (2006), a good feedback practice could be applied to both onsite and online education.

Following the same approach for the mathematics workshop, we will develop an e-feedback over e-learning environment to provide step-by-step approaches toward the solution of a problem rather than simply giving marks or automatic feedback based only on the correctness of the answer. Therefore, we will use DVC technique to provide e-feedback in addition to the automatic feedback.

Moreover, to generate an interactive environment for discussion, we will set up an online discussion board, namely e-board, within each e-lecture, e-seminar and e-laboratory session where the students would be able to post related questions. As stated in Subsection 4.1 regarding the lecture recording, the usage of DVC enables the section division with detailed time length. Therefore, the students would easily raise more specific questions on the e-board. Then, other students and we would be able to view and answer these questions on the e-board. By using this approach, the learning engagement could be further enhanced. Additionally, this would allow us to easily monitor student performance as well as reflect for the next sessions.

5 Feedback, testing and evaluation plan

As this is the first run of the workshop on mathematics for MSc students in Telecommunications Engineering, the feedbacks of the students are very helpful for us not only to reflect on our teaching but also to design an efficient CeA for this workshop in the next term. The following is the feedback of the students in the board of study on our workshop session:

- "The workshops are really productive and the students learn a lot in every session, reasoned by they feel really grateful."
- "Student voice leader reported that majority of the students are not happy, but this is related to the frequency of the session. They want the workshops more frequency. Happy with the content and everything going according to schedule."
- "Student voice leader reported that the workshop was good, very open, can indicate weaknesses and work on it."

Based on the above feedback, the students were expecting more workshop sessions. However, we could not afford that due to our timetable and the students' timetable and also our teaching load of more than 12 hours per week. Besides the formal feedback from the students, we had a chance to discuss with the students about our plan to build the e-learning for the workshop. Below is the informal feedback from the students:

- "It would be great if there would have videos available to download on the Unihub. If I miss any classes or could not follow you, I could just watch the videos and will only come to see you if there is anything not clear."
- "I can view the videos many times"
- "It is very useful to review the lectures at home"
- "It may help improve my understanding of the complex problems"

Therefore, it is crucial to develop CeA as a virtual environment where the students can easily access the teaching materials with real video captures, assessment as well as feedback for self-study. The details of the CeA design and implementation can be seen in

Section IV where we show how to construct and apply e-lectures, e-seminars, e-laboratories, e-assessment and e-feedback in practice.

Accordingly, in the next step, we are planning to design the first four sessions for a trial run of the CeA in the first four weeks. This design will be carried out during the summer holiday and will start running for the new MSc students in both Telecommunications Engineering and Computer Networks. All the materials and media files will be uploaded to 'My Learning' of the university website for the students to easily access. The actual feedback from the students will be collected by asking the students to fill in an online tabular form and submit it before logging out the online learning. These feedbacks are very important at the initial stage, which would be able to help us improve further the CeA for the following sessionsin the term.

6 CeA meets UKPSF

The UK Professional Standards Framework (UKPSF, 2015) was developed by the HEA providing a general description of the roles of teaching and supporting learning within the HE environment. There are totally three dimensions in practice and four descriptors defined in the UKPSF. The three dimensions consist of areas of activity, core knowledge and professional values, while the four descriptors outline the key characteristics of the practitioner and cover the full range of teaching and supporting learning roles within the HE.

In this section, we will demonstrate how the proposed CeA meets the UKPSF descriptor 2 (D2) compared with the conventional CA learning approach as follows:

1 *Successful engagement across all five Areas of activity*:

   a *Area of activity A1 (design and plan learning activities and/or programs of study)*: in this paper, we have outlined a plan with detailed design of the components of the CeA (i.e., e-lectures, e-seminars, e-laboratories, e-assessment and e-feedback) for the modules with various online learning activities (c.f. Sections 4 and 5).

   b *Area of activity A2 (teach and/or support learning)*: the proposed CeA is designed to consolidate the students' background in mathematics and thus it is a promising approach to achieve the curriculum aims of the engineering-related modules.

   c *Area of activity A3 (assess and give feedback to learners)*: as shown in Subsection 4.5,we have proposed the e-feedback as a component of the CeA along with open discussion on e-board. This interactive environment can also be regarded as a feed-forward approach to improve the students' learning as well as enhancing learner autonomy.

   d *Area of activity A4 (develop effective learning environments and approaches to student support and guidance)*: the proposedCeA is realised via e-learning environment open toall students of various culture and knowledge level with no discrimination, and thus providing an effectivesupport and guidance for the students' learning.

   e *Area of activity A5 (engage in continuing professional developments in subjects/disciplines and their pedagogy, incorporating research, scholarship and the evaluation of professional practices)*: following the PGCertHE module, we have learnt various learning, teaching and assessment strategies, which are very helpful to improve our teaching and allow us to propose the changes, evaluate and reflect on our own practice. Moreover, we have frequently attended various conferences in our research area. The up-to-date technologies learnt from these conferences help us improve the curriculum of the modules that we are teaching.

2 *Appropriate knowledge and understanding across all aspects of core knowledge*:

   a *Core knowledge K1 (the subject material)*: as shown in the evidences for areas of activity, we have planned to design various e-learning activities within the CeA to support the students' learning along with the up-to-date learning materials.

   b *Core knowledge K2 (appropriate methods for teaching and learning in the subject area and at the level of the academic program)*: in Section 4, we have proposed the use of appropriate learning technologies for the CeA, e.g., video captures, online forum for discussion and feedback, etc.

   c *Core knowledge K3 (how students learn, both generally and within their subject/discipline area?)*: the CeA is designed to support the learning of both the onsite and offsite students, and thus it is expected to meet the students' requirements.

   d *Core knowledge K4 (the use and value of appropriate learning technologies)*: As shown in the evidence for K2, we have applied various online learning methods. They are web-based design and thus are appropriate for all the students following different modules of different levels with no restriction on space and time.

   e *Core knowledge K5 (methods for evaluating the effectiveness of teaching)*: in Subsection 4.5, we have designed the e-board not only for discussion but also for providing feedback, which allows us to evaluate the effectiveness of the CeA in supporting the students' learning.

   f *Core knowledge K6 (the implications of quality assurance and quality enhancement for academic and professional practice with a particular focus on teaching)*: although the comments and feedback from the students on e-board are informal, they are able to imply our teaching and the students' learning, and thus enabling reflection for enhancement of our teaching practice.

3 A commitment to all the professional values:

   a *Professional value V1 (respect individual learners and diverse learning communities)*: in this paper, we have designed the CeA aiming at all students with no discrimination in ethnicity, faith, class, age, etc. Individual students are respected in the e-learning environment where they are encouraged to give comments and feedback to improve the teaching and learning practice.

b *Professional value V2 (promote participation in HE and equality of opportunity for learners)*: In the CeA, we have proposed the use of video captures with various online activities, assessments and discussion at the end of each session that all students can freely participate and have opportunity to raise relevant questions.

c *Professional value V3 (use evidence informed approaches and the outcomes from research, scholarship and continuing professional development)*: in order to enhance practice and the student learning experience, we have additionally integrated our own research experiences in wireless communications and networking into the curriculum design.

d *Professional value V4 (acknowledges the wider context in which HE operates recognising the implications for professional practice)*: the e-learning is well known and has been effectively applied at schools and also in industry for training purposes. This accordingly acknowledges the applicability of the CeA as professional practice.

4 *Successful engagement in appropriate teaching practices related to the Areas of Activity*: by attending the PGCert module, we are able to critically evaluate and review our teaching experiences, which help us feel more confident. Specifically, we have identified the issues when teaching and thus motivated us to propose the CeA via e-learning environment to enhance student learning experiences.

5 *Successful incorporation of subject and pedagogic research and/or scholarship within the above activities, as part of an integrated approach to academic practice*: for up-to-date technologies, we have integrated our research experiences in the modules that we are teaching. And vice versa, through the feedback and questions from the students, we have the motivation to continue doing our research.

6 *Successful engagement in continuing professional development in relation to teaching, learning, assessment, and, where appropriate, related professional practices*: we have attended the PGCert in HE Teaching and Supporting Learning workshop. All of the sessions are very helpful for us and have enhanced significantly our teaching practice. Additionally, as part of the continuing professional development, we have attended various conferences and have done various voluntary work such as program committee, session chair and reviewer. These professional practices are also helpful to enhance both our teaching and research experiences.

7 Conclusions

In this paper, we have proposed an efficient CeA to promote self-learning of students on mathematics for engineering. From the modules that we are currently teaching, we have identified the common weak aspects that are related to mathematical background and time constraint. This accordingly motivates us to propose the CeA.

In order to develop an e-learning constructivism model, we have shown how to design and implement e-lectures, e-seminars, e-laboratories, e-assessment and e-feedback. They are expected to have significant impacts on both onsite and offsite students. In fact, for large-sized class, onsite students can consolidate their knowledge and skills through the repetition capability of the proposed CeA. For distance learning, offsite students now have various kinds of supplement learning materials.

Specifically, we have proposed the design of an online mathematics course in the form of lecture-formed, seminar-based and practical workshop, which could be applied to all engineering-related modules. Also, we have discussed the motivation and requirements of CeA followed by the design and deployment of the CeA components for the online mathematics course.

DVC is suggested to be a suitable solution for developing e-lectures for LW, e-seminars for SW and e-laboratories for PW. The design of a high-quality e-assessment with various kinds of assessment problems would be challenging but could be improved by applying the future's enhanced cognition technologies. For e-feedback, we will also exploit DVC technique to provide step-by-step solutions. Additionally, we have proposed the development developing an e-board where the students and tutors' engagement would be considerably enhanced along with reflection on learning practice. Moreover, we have shown the proposed CeA meets the UKPSF descriptor 2.

For practical implementation, we have outlined our plan to have the first trial run of the CeA for MSc students in both Telecommunications Engineering and Computer Networks. This design will be initially set up and start its first trial running in upcoming semester. All the materials and media files will be uploaded to 'My Learning' of the university website along with necessary guidelines. The feedback from the students will be then collected via an online tabular form for further improvement of the CeA in future development. If successful, the proposed CeA would be able to be extended for other subjects that also require the students having background in mathematics.

The design and development of an efficient e-learning environment would be time-consuming and require a high cost at the initial stage. However, taking into account the long-term and student-centred education, this would be worth of investment.

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