

## New Methodology for Developing Digital Curricula

Nahla El Zant El Kadhi  
Management Information System Department  
Ahlia University  
Manama, Kingdom of Bahrain  
[nahla@ahliauniversity.edu.bh](mailto:nahla@ahliauniversity.edu.bh)

Hanaa Al-Sharrah  
Information Technology Department  
Ahlia University  
Manama, Kingdom of Bahrain  
[hanaa17@hotmail.com](mailto:hanaa17@hotmail.com)

**Abstract--** The vast and rapid development in the computer, communication and Internet technologies has significantly affected contemporary educational systems. This paper describes an approach for the deployment of an e-learning infrastructure/environment in addition to a new methodology of digital curricula development for an efficient E-learning implementation and adoption. Hence, the purpose of this research is to study and analyze the role of implementing the E-learning framework and online digital curricula in K12 schools. Success factors of implementing the E-learning framework and project management perspectives of online digital curricula development are also presented and discussed.

**Keywords-***E-learning; e-content; learning design; blended learning; e-learning model; web-based educational system.*

### I. INTRODUCTION

Recent years have witnessed an enormous growth in multimedia applications and telecommunication technology like audio/video conferencing, and live video streaming, to name a few. Education technologies have been developed in the recent years where new technology-based learning methods and channels have been emerged. This paper reports the main components of a successful E-learning and introduces a new framework and model to implement E-learning in K12 schools. It becomes widely known that the national initiatives in the region to implement different kinds of E-learning technologies in the public schools struggle in most the cases. This is due to the fact that such initiatives usually did not look at the “big picture” of E-learning projects and did not implement an integrated framework. Hence, the new framework is proposed to ensure the integration of all the components and success factors of an efficient E-learning system. This paper introduces an enhanced methodology of developing the online digital curricula (e-content). This process mainly handles the digitizing of the conventional curricula into an interactive digital one. Creating an online content is a challenge that faces E-learning adopters. One of the most important elements in creating online content is the level of interactivity with the user to keep him attentive all the time. This paper introduces an instructional design model based on Bloom’s levels and the first principal. The evaluation process is based on Kirkpatrick’s model.

### II. LEARNING MODEL

This section presents the learning model that represents the foundation to understand the proposed framework and blended learning for K12 schools. The model is based on the interaction between the instructors, the learners and the content. According to Spiro [6], cognitive flexibility is the

“ability to spontaneously restructure one’s knowledge in many ways”. The proposed framework aims at enhancing the learning process by providing a better learning environment that “blends” the educational technology with the conventional face-to-face environment. The interaction between the three main components in the presented learning model is enhanced by using the technology. Hence, this model is based on the blended learning type. This “Blended learning programs may include several forms of learning tools, such as real-time virtual/ collaboration software, self-paced Web-based courses, Electronic Performance Support Systems (EPSS) embedded within the job-task environment and knowledge management systems” [4].

### III. DELIVERY ENVIRONMENT

Al-Sharhan introduced a delivery model for the new E-learning environment as explained in [7]. The elements of the environment are the learning management system, multimedia equipped classrooms (smart classrooms), and network or the Internet. The instructor guides the learning process by utilizing the online content where students access the content via the Internet. The LMS tracks the learning activities and provides the instructor with report about the learning process. Fig 1 depicts this model which was mainly introduced by Al-Sharhan in [7] and we have added to it the external environment.

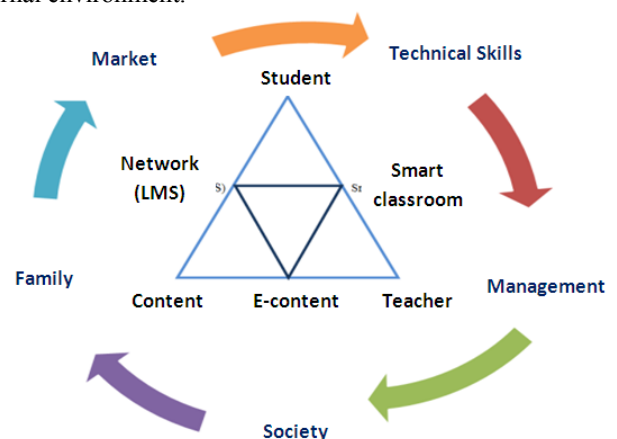


Figure 1. A new E-learning Model.

Fig 2 depicts the E-learning projects incorporated in full-fledge E-learning implementation in K12. All these projects are highly interconnected where the failure in one chain may cause serious problems in the whole implementation.

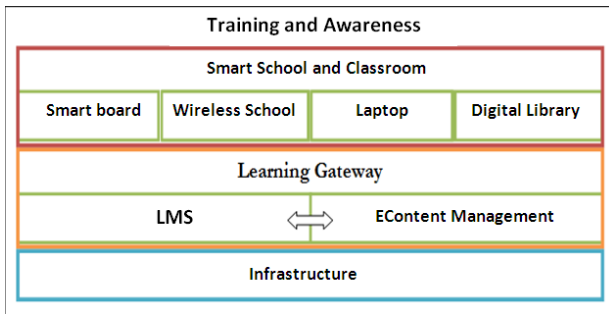


Figure 2. E-learning project.

#### IV. E-LEARNING INFRASTRUCTURE

The Infrastructure projects aims to provide a high-performance data center in the head office and the required computing devices in the schools. It also provides all the network facilities in the schools and Head office to work in both centralized and decentralized manners. The data center should provide a collection of virtual and physical devices to support the higher layer of applications such as the learning gateway and portal, Learning Management system, collaboration tools, disaster recovery, security and other applications. The design of the data center should be scalable since the E-learning projects usually implemented in phases. With the time, complex and high cost devices are added to incorporate more users and applications. A successful and scalable design of data center network must have, at minimum, Scalability, Simplification, Sharing, and Security.

#### V. DATA CENTER DESIGN

Today's data centers may contain hundreds of computers with significant aggregate bandwidth requirements. The network architecture typically consists of a tree of routing and switching elements with more specialized and expensive equipment moving up the network hierarchy. During the design of the data center, the designers should pay attention to the increasingly growing applications that possesses special requirements. In today's data center design, the typical architectures consist of either two- or three-tiers networking routing. A three-tiered design usually has a core tier in the root of the tree, an aggregation tier in the middle and an edge tier at the leaves of the tree. A two-tiered design has only the core and the edge tiers. However, in modern design for new applications N-tier design should be considered to support the applications with multi-tier. While the N-tier logic development is suitable for large, medium, and small-scale applications, and Web applications, it can also enhance system application security, performance and scalability for future expansion. The Advantages of utilizing N-Tier architecture can be summarized as follows:

- Security of data and application can be easily maintained.
- Business rules will be separated into a component that is easy to maintain, use, and reuse.
- The architecture supports high scalability and expansion where every tier is independently maintained and expanded without affected the components of other layers and tiers.

- Data storage is centralized into an independent layer for more efficiency coding and implementation.
- The architecture provides flexibility where components can be distributed to different physical machines at any time.

#### VI. SMART CLASSROOM

The Smart Classroom project aims at applying smart technologies in a physical and conventional classroom. The project bridges the gap between modern technology-based and traditional classroom activities in terms of the teacher's and student's experiences. More specifically, the components of the smart classroom enable the teacher to utilize modern technology to enhance the teaching experience. All the teaching activities can be recorded and hosted on the learning gateway for future consideration. In addition, the smart classrooms components will provide the teacher with efficient tool to manage the class and provide the students with an exceptional teaching and learning experience.

**Smart Classroom Components:** The Smart Classroom system contains several component technologies that make the interaction between the teacher and students efficient and transfers the role of the teacher to be a facilitator of the learning process. In the proposed E-learning framework the main components are, smart wireless interactive board and data projector, teacher station, laptop for each student, class management system, and wireless network to connect the laptops to the learning gateway. Teachers in the Smart Classroom can utilize different smart components inside the class or freely using conventional teaching methods to instruct students in a blended methodology.

#### VII. WHAT IS E-CONTENT

E-content can be defined as the process of digitizing the conventional learning subjects and transferring them into interactive multimedia based subjects. Creating an online content is one of the serious challenges that face E-learning adopters. the most important elements in creating online content is the level of interactivity with the user to keep him attentive at all times. When building and developing the e-content one should keep eyes on four important issues; namely:

- The Instructional Design process.
- The standards of building the e-content.
- The sharable Learning objects repository.
- The technology used in the development.

The e-Content is designed using sequencing of learning objects (LOs) or Sharable Content Object (SCO). SCOs are small chunks of information, indexed Meta-Data, self-contained and explanatory, reusable, have aggregation capability, and communication capability with LMS. In this paper, we define the SCO to have the following parts: the Learning Objective, concept explanation, exercises, and evaluation. SCOs are transferred into a digital format according to specific standards. SCOs will be stored in shared Learning Object Repositories (LOR). The course will be added to the Learning Management Systems (LMS). This concept is explained in Fig 3, while Fig 4 explains the relation between the SCOs and the online course.

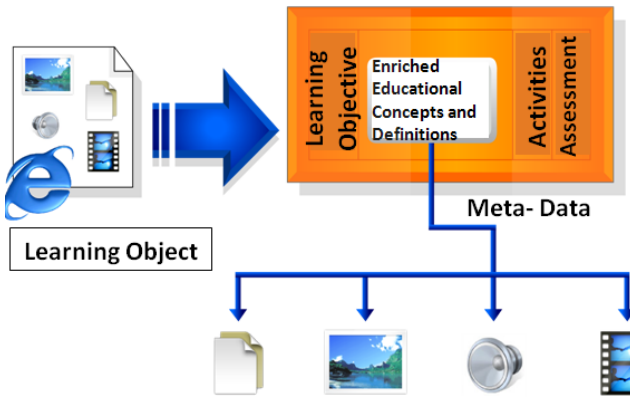


Figure 3. Learning Object Concept.

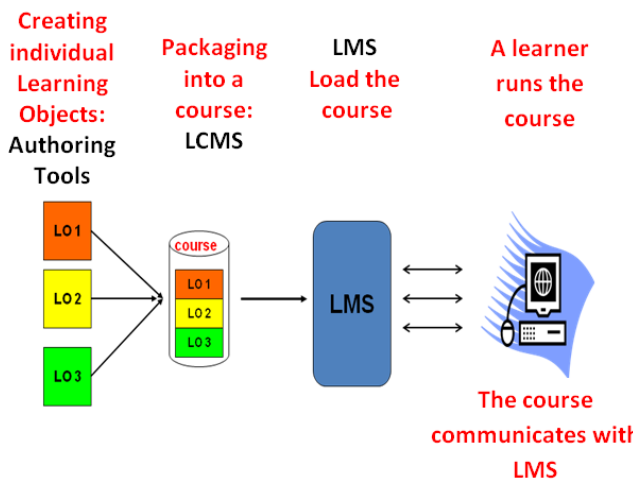


Figure 4. SCOs and e-content.

VIII. CULTURAL LEARNING OBJECT

Cultural factors are very important for a successful E-learning implementation. Culture, however, is a broad and concept with no unified definition. Fernandes believes that cultural issues and considerations are something in which people take pride, and that it must be considered and respected in the user interface [3]. Such considerations are importance because cultural design will touch several areas of a users’ culture consciously and unconsciously. Hence, cultural considerations increase the complexity of designing learning objects and e-content interfaces because more variables are added. Several cultural factors must be considered during designing and developing the learning objects and the e-content [1].

IX. ONLINE COURSE DEVELOPMENT

The phases of building online courses are as following:

- The content is divided into small chunks as raw LOs it should be before; this is performed by SME (Subject Matter Experts) in collaboration with ID (Instructional Designer) according to an agreed scheme of course structure.
- The LO Storyboarding takes place by the instructional designer.
- The storyboard is sent to the production unit –multiple production lines exist.
- LO is developed according to the storyboard which was authored by ID and under supervision of SME.

- LO is produced according to E-learning standard (IEEE-LOM) in the form of a SCO (Sharable Content Object)
- LO is stored on a learning object repository (LOR).
- LOs are packaged according to an agreed scheme of course structure which forms the standard SCORM 2004 courseware. Courseware is uploaded and stored on Learning Management System (LMS)

Fig 5 describes the life cycle of online courses development.

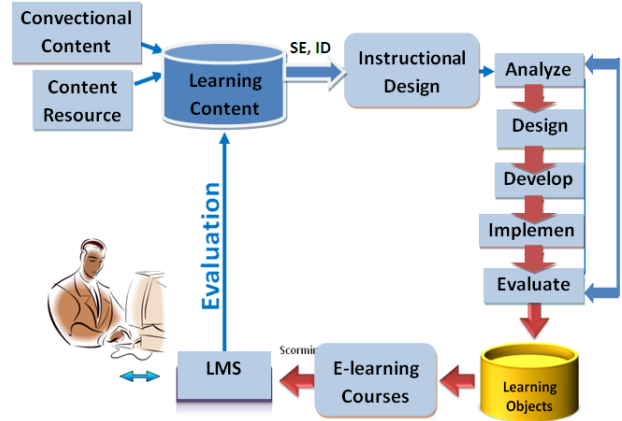


Figure 5. The life cycle of course development.

Courseware Development Methodology through Learning Objects approach goes through two major stages, an initial stage followed by execution stage, each has its own phases.

The initial stage is considered a preliminary stage required for courseware development. A large scale analysis takes place to identify: course materials, learning goals and objectives. Audience analysis is carried out to identify their learning styles and capabilities. The instructional design strategy is determined according to the results of analysis, and then the course outline (structure) is introduced. Educational material is divided into small chunks of information and data “raw learning objects”. Then the interface and templates design and development for its functional requirements is carried out. Eventually, a complete production and development for a prototype of an entire learning object is implemented. Such prototype is introduced to the concerned stakeholders for review and approval, and upon all that the execution phase is to be launched. The initial stage comprises of the following subsequent sequential phases: the analysis phase, design phase and the prototype development phase as shown in Fig 6.

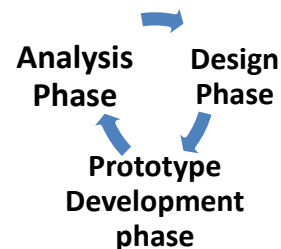


Figure 6. Initial Design.

The execution stage is considered the real start of a large scale production of learning objects. It starts right after MOE stockholders approves the prototype that gives a general and future vision of what to be expected from the execution stage.

The prototype leads to minimization of risks to their lowest rates. The execution stage composes of subsequent sequential phases; those are storyboarding phase, development phase and packaging phase shown in Fig 7.

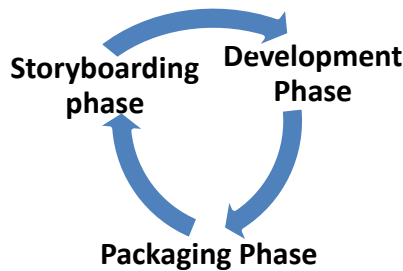


Figure 7. Execution phase.

#### X. EXISTING METHODOLOGY TO BUILD WEB-BASED EDUCATIONAL SYSTEM

Success factors in an E-learning system are related to students including the disable, instructors, the developed course content and the delivery medium and environment. A new framework for the developing and delivery of the online content or courses is presented and mapped to the activity theory. This mapping explains and organizes the interactivity relations between instructors, students and online learning objects as they are bounded by the technology, Learning management system (LMS) and educational and external environments. ADDIE Model is one of the methodologies used to build educational web that includes 5 phases [10]:

- Analyze - analyze learner characteristics.
- Design - develop learning objectives, choose an instructional approach.
- Develop - create instructional or training materials.
- Implement - deliver or distribute the instructional materials.
- Evaluate - make sure the materials achieved the desired goals.

#### XI. E-LEARNING EVALUATION

Learning and online learning evaluation mainly deals with the education quality and its management. This process is part of a broader education evaluation process because of its practical issues and aspects in addition to its complicated theoretical approach. The evaluation content includes evaluation of learning environment, evaluation of learning style, evaluation of comprehensive ability and so on. However, the evaluation of the learning objects and learning process in general is not an easy process due to the pedagogical factors involved in it. In addition to the lengthy process, learning evaluation is inherently complex. This is due to the fact the several complexity factors are associated with the sustainable and dynamic interactivity of the various dimensions of the learning process such as learning goals, instructors, learners, and instructional technologies. Hence, a flexible framework of evaluation is required in order to realistically evaluate the E-learning outcomes. The evaluation model or framework must incorporate all the issues related to the learning process. The performance

evaluation of E-learning is generally divided into the formative evaluation and the summative evaluation. Formative evaluation is performed by experts during each phase of the implementation progress of E-learning. Based on the evaluation result, an immediate action is taken to improve the current and future implementation, to improve the final results. Summative evaluation, is the evaluation performing after that all the E-learning deployment is completed, to understand the final implementation results and compare the difference of learning effectiveness of students and subjects before and after the implementation. From a pedagogical point of view, E-learning performance evaluation is considered to be purely formative evaluation. This means that the focus of evaluation shifts from the learning results to the learners' learning process. This basic idea of E-learning performance evaluation has been widely accepted by the education community [2]. It is very important that the pedagogical approaches are evaluated while creating E-learning content. Simple pedagogical approach will lack flexibility and approach. On the other hand, a complex approach will take time to develop and consume setup costs. Therefore, a perfect pedagogy should adopt the middle path by creating effective educational material while running parallel to engaging learning experience. In this work, the evaluation of the E-learning objects or the E-learning process is based on the Kirkpatrick's model. It consists of four levels, namely the reaction evaluation, learning evaluation, behavior evaluation and results evaluation. In Kirkpatrick's model, the evaluation process of learning or training program should always begin with first level, and then, should move sequentially through levels two, three, and four. The information from each level serves as the input or the base for the next level evolutionary.

The first level which is the reaction evaluation measures how students in classroom react to the learning object and the online lessons and the perception of the students. The evolution of this level depends on answering questions regarding online lesson and learning objects acceptance. Example of these questions may include: Did they like a specific learning object? This type of evaluation can be conducted using an online survey, which is part of the LMS and learning gateway. In addition, the participants' reactions have important consequences for learning. The second level named learning evaluation aims at assessing the learning capabilities beyond learner satisfaction and targets assessing students' developments in terms of skills, knowledge, or attitude. Naturally, the measurement outcome at this level is more difficult than the first level. Hence, methods of the evaluation differs from the first level and range from testing techniques to group assessment and self-assessment. A useful technique here is to have a pre-test and post-test in order to determine the amount of learning that has accumulated. The third level is the behavior evaluation that measures the impact of the learning occurred by the online lesson on learners' behavior. It measure the amount of change or the transfer of the learners behavior due to the learning material and the knowledge accumulated in the online lesson or in a certain group of learning objects. For many educators the third Kirkpatrick's level evaluation represents the truest assessment of learning effectiveness. However, measuring at



this level is not an easy task due to the fact that is almost impossible to predict when the change in behavior will happen. Hence, this level of evaluation requires important decisions in terms of when to evaluate, how often to evaluate, and how to evaluate. The fourth level of Kirkpatrick’s model measures the success of the learning process in terms of improving the performance of the educational management.

**XII. E-CONTENT DEVELOPMENT: E-CONTENT PROJECT MANAGEMENT**

The E-learning project starts with an *initiation* phase and then *planning* for the project activities and tasks. Once the planning phase is completed the *execution* phase starts along with *monitoring and control* process to ensure aligning the execution with the plans. The project is finished with a *closure* phase. The project life cycle is depicted in Fig 8.



Figure 8. Project Life Cycle.

**Defining / Initiation phase** - The first phase in the e-content development is the initiation or the defining phase, this phase includes several activities and processes such as defining the scope of the project, scope planning and defining the work breakdown structure (WBS) (see Fig 9).

**Defining the scope of the e-content project** - The scope of the e-content project mainly concentrates on digitizing the curricula of the subject of year 10-12 in the ministry of education in Kuwait .The objective is to design the “online” course according to the best practices and international standards, namely, SCORM standard . Since this project is just member of a portfolio, the target is to host all the “online” courses on a “content” server and create online sessions based on clustering methodology that will distribute the different sessions on different cluster for good load balance. In order to get of the best of the E-learning the teacher should be able to track and follow his student’s activities. Hence, the entire subject must be managed by a Learning Management System (LMS) that will create all the learning sessions.

**Defining the Work Breakdown Structure** - The Work Break Down Structure (WBS) is defined as a tool used to state and group a project's discrete work elements in a way that helps organize and define the total work scope of the project [9]. The main structure of our WBS for the e-content project specify that each learning object must reflect an integrated object that reflects a scientific concept. It should incorporate, Learning Objectives, Concept Explanation, Training exercises, and Evaluations. The Learning object also should be linked to more knowledge areas and external resources such as websites, external files and other teaching material to enrich the learning experience.

**Planning Phase** - the second phase in the project life cycle involves a set of processes and plans to help guide the project

team through the execution, monitoring and closure phases of the project. The plans created during this phase help manage time, cost, quality, communication, risk and HR management. It also helps the project team to monitor, control, and manage the changes during the execution phase. Fig 10 illustrates the planning process.

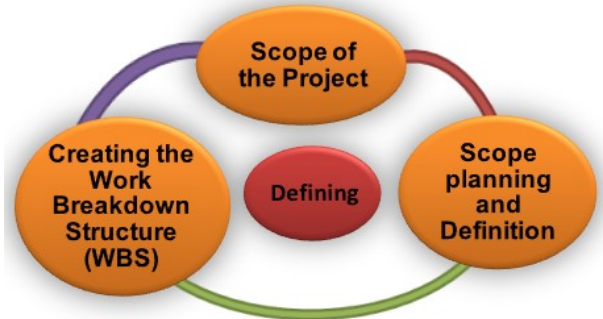


Figure 9. Initiation/Defining Phase.

**HR Management** - HR management process includes a variety of activities like internal search for employees who are willing to join the E-learning, or recruit experienced personnel, from outside. Selecting the internal staff requires evaluation of their knowledge, experience and performance levels. Training is to be involved if it will help the employee to handle situations. The required manpower for the content development are, Project Manager, Subject Experts, Instructional Designers, Graphic designers, Animators, Quality assurance engineers, Multimedia Developers, and Audio/Video specialists.

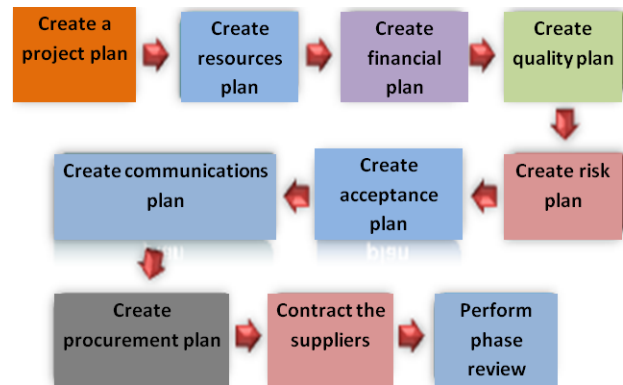


Figure 10. E-content Project Planning.

**Risk planning** - The e-content development project has several risks factors that need to be considered during the execution phase. The risk factors can be classified according to the following:

- Human related factors - availability of subject experts, the availability of the Instructional designers, and Developers.
- Technology based factors - tools to be used, Technological risks, and Incompatibility.
- Stakeholder Lengthy process - The approval process.
- Intellectual rights.

**Quality planning** - It is necessary to analyze various factors in order to deliver efficient teaching methodologies such as:

- Ease of use to implement the course and host it on the Learning Management system in order to be tracked and the tracking points must be clear for the teacher to understand the performance reports.
- Navigation: Students must not suffer of any difficulty to navigate in though the online course
- The amount of text in each electronic page.
- The amount of animation in each electronic page.
- Consistency, accessibility, interactivity & instructional issues, and content accuracy.

Managing the project - Change management process is a crucial one in each project since it ensures that the changes to the project scope, deliverables, timescales or resources are formally declared and handled prior even to the development. Applying and implementing change management is a difficult task; especially in large projects. To ensure that changes are monitored through to completion, a change management record and tracking procedure is maintained. This allows the project manager to identify any outstanding changes and to measure the actual impact of each change once implemented. The change record provides the project managers and teams with information about the changes conducted in the project at different levels. It can provides record changes within the project, monitor the change status and its project impact, record the status of all change approvals, identify and report on any change management issues, and control the amount of change required to meet your objectives.

Execution Phase - In this stage all courseware will be developed according to courseware development life cycle. Different processes are incorporated in Fig 11.

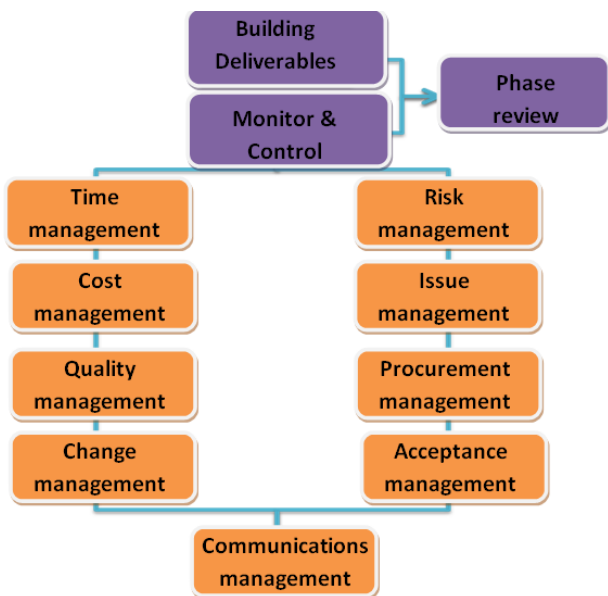


Figure 11. E-content execution phase.

Closure phase - Closing the project means delivering all the required deliverable according the agreed specifications. The project manager needs to make sure that the project closure criteria have been fully satisfied and that there are no outstanding items remaining. Also, he/she should identify a release plan for the project deliverables, documentation, supplier contracts and resources. Finally, the project manager

must initiate a communication plan to inform all project stakeholders that the project has now been closed.

### XIII. CONCLUSION

This paper presents a new implementation framework of the blended learning in K12 schools and a methodology for developing digital curricula or online courses. The proposed E-learning framework incorporates several components that are highly dependent in order to ensure an efficient implementation of the E-learning project. The evaluation and performance measure is important to guide the E-learning adopters on their directions and future impacts. The model incorporates four levels of evaluation, i.e., reaction evaluation, learning evaluation, behavior evaluation and results evaluation. However, each of the four levels presented by the model requires an empirical study to measure and evaluate the E-learning system. Another direction here is to work on an enhanced Kirkpatrick model based on fuzzy logic concepts. The main driver behind this direction is the fact that it is widely known that the first level of Kirkpatrick's model is most important level since it controls whether or not proceeding to the upper levels in the model. However one needs to design and conduct several evaluation forms, distribute them to the learners and do the analysis. This process is a lengthy one and time consuming. An enhancement is to build a fuzzy engine for the first level to be used by the teacher to evaluate the students' performance. Also the interaction between the teachers, students, smart class room technology is a very important area to be analyzed and thoroughly studied. Another area is the study of the motivations to efficiently utilize smart classroom and how to create a rich teaching environment in it.

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