Enhanced Agility of E-Learning Adoption in High Schools

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ABSTRACT

Education is one among the many social services that enjoyed information technology as an enabler. The digital media and e-learning systems have played significant role as a learning content as well as learning platform with the aim to enhance access to education and quality of learning. In this paper, we investigate the practice of adopting digital media (combination of text, images, audio and video) into the school curricula (taking Ethiopia as a case study). We surveyed the accessibility of multimedia-rich e-learning resources; the experiences of students and teachers on using multimedia technologies; and their experiences on adopting multimedia in teaching learning process. Our findings indicated that the experiences of teachers and students on using advanced digital technologies is fair. However, there is only limited access to multimedia rich e-learning resources, and premature practice of adopting the technologies into the teaching learning. The mapping of these results to the existing models of adopting e-learning into the curricula showed that the schools' status correspond to the initial phases and further recommendations on successful e-learning adoption is provided. In addition, we proposed an agile model to continuously catch the evolving technological innovation and for large scale e-learning adoption into a curricula.

Keywords

E-learning, Multimedia, Agility, Computers in education, Adoption models, Ethiopia, High school, Curriculum, Authentic learning, Edutainment, Advanced learning technologies

Introduction

The proliferation of information technology has made significant contribution to leverage accessible and quality education. For example, computers have been in use assisting the education sector as tools for the learning process; as the entity being studied; and or as instructional content development and delivery platforms (Taylor, 1980; Grundmeyer & Peters, 2016). According to Corbett and Trask (2000), the term e-learning is often used to refer to the development of a computer program or series of programs with explicit aim of replacing the current methods of instruction, often referred to as computer-based instruction; which are traditionally categorized into tutorials, drill and practice, and simulation and games.

Today, text, audio, image, video, and their combinations are in use for the development of digital learning content and interactive learning systems; thereby assisting the conventional learning (Horton, 2011). In addition, concepts such as edutainment (Artistikarini, 2017) and authentic learning (Hill, 2016) are shaping the development of advanced e-learning technologies so as to make education enjoyable, and allows students to meaningfully construct concepts and relationships in contexts that involve real-world problems respectively.

Other digital media types (devices and content) can also be incorporated into e-learning. For example, study in (Ghinea & Ademoye, 2010; Dmitrenko & Obrist, 2016) describe additional types of media associated with the sense of smell. Ghinea, Timmerer, and Gulliver (2014) denoted the inclusion of non-conventional media types (e.g., olfaction, haptic, and gustatory) as multi sensorial media, mulsemedia for short. It is also worth mentioning the importance of the mobile technology, virtual reality and augmented reality in education (Merchant et al., 2014).

E-learning is regarded as one educational strategy that can be adopted into a particular subject (Ghinea & Chen, 2006; Panke & Seufert, 2013). Accordingly, its role must be re-evaluated with respect to the pedagogical advantages it provides in components of a course where other strategies are failing. That is, a well-designed and properly adopted e-learning presents materials in an effective way, facilitates communication between teachers and students, and between students themselves; enables collaborative learning activities, easy access to resources, encouraging self-paced learning, and providing online assessment (Anderson, 2002; Bargeron, 2010). Therefore, e-learning can play its part in enhancing the teaching-learning process and enforce a steep learning curve.

In order for e-learning to be effective, it requires planning, academic expertise, and knowledge of information technology. Asan (2003) showed that the extent of introduction of information technology innovation in schools is limited by a number of constraints. This includes, the extent of use of computers beyond the actual computer classes, literacy level of teachers and students on basic skills of using computing devices, knowledge and skill of teachers on the use of computing devices for instructional purposes, availability of expertise for the instructional use of computing devices, and availability of appropriate digital resources. In addition, Abdullah and Ward (2016) regarded that the perceived usability and usefulness of e-learning systems is significant constraints in the design of various technology adoption models.

Several countries tend to incorporate e-learning into their education system. Likewise, in Ethiopia, fragments of computerization initiatives have been carried on at schools with the goal to enhance education quality using e-learning and the awareness on the relevance of information technology in schools by the school community is rising. Thus far, schools have acquired significant number of computing devices through government financing, from donations and the private sector; primarily to supplement the subject of information technology. Mesfin (2004) showed that, although the student to computer ratio is insignificant, schools of all levels at urban areas have introduced computers for office use; a few of them established computer labs for students; and some have Internet access. That is, the computers in schools are mainly used for learning about computers, and for the preparation of teaching materials and examinations.

Significant number of computer literate teachers have also joined the Ethiopian schools through different fragments of teacher development programs (Mesfin, 2004). In addition, there are significant number of technical and vocational education training institutes, colleges and universities training professionals in the area of information technology which would contribute towards providing technology friendly teachers who can adopt e-learning into the curriculum.

Studies such as in (Patel et al., 2017; Mesfin et al., 2017a) highlighted that incorporating e-learning is needed to fill the gaps that exist in the Ethiopian education and enhance the information retention rate. However, to the best of our knowledge, there is a limitation in the existing literature to address the current dynamism in the evolution of digital technology and complement the effectiveness and efficiency of adopting e-learning into the school curricula. Thus, the primary objective of the paper is to explore the existing circumstances in schools (in the Ethiopian context) in terms of students' and teachers' access to digital technologies, usage experience and experience of adopting the technologies into the curriculum as variables as described next.

- Access signifies the extent of access to e-learning infrastructure and content both by students and teachers. The down side of this variable could be, for example, lack of access due to unavailability, incompatibility, or insufficient specification (lack of upgrading) for accessing and sharing multimedia rich learning content.
- Usage experience signifies the degree of affinity of teachers and students towards technology which is manifested by acquiring technical skills and attitudes for utilizing digital resources.
- Experience in adopting into curriculum represents the challenges of adopting e-learning technologies into the different topics of a particular course.

In addition, we conducted a review of prevailing e-learning adoption models and mapped the results of assessment of the variables described above - accessibility of e-learning infrastructure and content, the technology usage experience of teachers and students, experience and tendency to enhance the classroom practices using e-learning technologies, particularly in the context of the high schools in Ethiopia.

The findings show that teachers and students demonstrated reasonably fair experience in using digital technologies. However, there is only limited access to multimedia rich e-learning resources, and the practice of adopting them into the teaching learning is premature. The mapping of these results to the e-learning adoption models correspond to the initial phases. In addition, we proposed a phased agile model that would continuously catch the evolving innovations in advanced e-learning technologies and also for successfully applying large scale e-learning adoption. Thus, the agile adoption model benefits high schools so as to effectively integrate advanced e-learning technologies and approaches such as mulsemedia, edutainment, and authentic learning into their curricula.

The paper is organized as follows. The next section presents related work; data analysis, and discussion of results are provided in subsequent sections, respectively; and the last section provides conclusion.

Related work

E-learning technologies

E-learning involves technology, services and content which includes PC based simulation, Web-based training, media streaming, content management systems (CMS), learning management systems (LMS), and hosted digital learning composed of learning objects (Govindasamy, 2001; Henry, 2001; Han & Shin, 2016). Today, LMSs are in use together with learning objects to offer enterprise level design, hosting, and delivery of online courses. For example, Blackboard (see http://uki.blackboard.com/), and Moodle (see https://moodle.org/) are among the LMSs that allow authoring multimedia rich learning objects (Yang & Tsung, 2003). Moreover, current e-learning projects such as NEWTON (see http://newtonproject.eu/) aspire for new platforms which would incorporate learning objects which are based on technologies like fabricated labs, gamification, multisensory media, and augmented/virtual reality.

Learning objects are designed for use in multiple training contexts to increase the flexibility of training, and ease of update as described in the SCORM (see http://scorm.com/scorm-explained/) specification (Chiu & Churchill, 2016); content authors store, retrieve and assemble the learning objects into courses (Yang & Tsung, 2003); while the LMSs enable to integrate fragmented courses, learner profiling, adhere to standards, testing, and scoring (Yang & Tsung, 2003). In addition, the LMS provides streaming media, access control, calendar, and communication. Such e-learning technologies enable implementation of learner-centered principles in the classroom (McCombs, 2000). Today, concepts such as edutainment (Artistikarini, 2017) and authentic learning (Hill, 2016) are shaping the development of advanced e-learning technologies so as to make education enjoyable, and allows students to meaningfully construct concepts and relationships in contexts that involve real-world problems, respectively.

E-learning in Ethiopian schools

The success of integrating e-learning technologies requires studies in terms of academic success, curriculum, standards, and attitudes of teachers and students (Eib & Mehlinger 1998; Levine & Donitsa-Schmidt, 1997; Mesfin et al., 2017c; Milton, 2003). It is limited by constraints - literacy level of teachers/students, extent of computer-use for instructional purpose, availability of expertise, availability of appropriate digital resources, and perceived usability and usefulness of e-learning systems (Abdullah & Ward, 2016; Asan, 2003; Mesfin et al., 2014; Mesfin et al., 2017b). In this regard, Ethiopia, like many other countries has attempted to adopt e-learning technologies aiming at enhancing education quality in which schools have acquired significant number of computers (some of them established computer networks and Internet) which are mainly used to supplement the subject of "information technology" and prepare teaching materials; and significant number of computer literate (potentially technology friendly) teachers have joined the schools through various teacher/professional development initiatives (Mesfin, 2004). According to Patel et al. (2017), there exist a need for incorporating e-learning in the Ethiopian education to fill the gap by enhancing the learners' retention rate. However, to the best of our knowledge, the existing literature lacks to address the dynamic evolution in technological innovations and complement the effectiveness of adopting e-learning into the school curricula.

Adoption models

Successful adoption of e-learning technologies in schools require combining different parts of the learning environment which includes a culture of innovation, defining educational goals, the use of technology by teachers and students as a learning tool, working in collaboration for learning; and to become more skillful in choosing own goals, strategies, assessing and monitoring own progress are some of the characteristics that demonstrate successful digital learning adoption (Milton, 2003). As there is a difference between technology acquisition and deployment for intended purpose, the focus needs to be shifted from instructional design to the design of learning environments like teacher development (Kozma, 2000); and various such models indicate that teachers' awareness of the knowledge society, proficiency in digital resources, imagination for new collaborations, and exposure to complex social dimensions and project-based learning are important for successful adoption (Laferrière, 2009).

The purpose of adopting e-learning into the curricula is to exploit the power of technology to assist learning (Anderson, 2002; Miller, 1997). Thus, the school community (including students and teachers) must accept the fact that computers are part of everyday school life and invest in the design/use of e-learning resources – supply

of resources, technical support, training and reforming the curricula through subject matter re-evaluation (Miller, 1997).

Brunner (1990) and Partee (1996) also pointed out that successful e-learning adoption takes place when technology becomes invisible or transparent and both the teacher and students can concentrate on the content of the course and therefore making it possible for students to use computers in the natural flow of classroom activities. Hence, the impact that e-learning makes in the classroom depends on its availability and upon the ways in which it is used.

The adoption of e-learning into a curriculum depends on the context of the scenario on which it is applied. For example, research in (Alkharang & Ghinea, 2013) identified the lack of management awareness and support, technological barriers, and language barriers as the hindrances of e-learning adoption in higher education.

Several e-learning adoption models have been developed with varying goals and phases. According to Abdullah and Ward (2016), self-efficacy, subjective norm, enjoyment, computer anxiety, and experience of the teacher are among the common factors for the design of technology adoption models; and the perceived ease of use is most affected by self-efficacy while enjoyment is for the perceived usefulness. In this paper, we consider the apple classroom of tomorrow (ACOT), CAMI mathematics, make it happen (MIH) and evolutionary models of e-learning adoption.

ACOT model. The ACOT model was developed aiming at documenting how learning and teaching change in a technology-rich classroom (Fisher, Dwyer & Yocam, 1996). The model identified factors which inhibit the changes and support needed to effect fundamental and sustainable change. The ACOT model has entry, adoption, adaptation, appropriation, and invention phases based on the level of introduction of computers in the learning process (Dwyer, Ringstaff, & Sandholtz, 1991).

CAMI model. The CAMI model was based on the running of a commercial computerized mathematics school and the implementation of which aim to implement software and new methodology in schools (Miller, 1997). Unlike the ACOT model, CAMI does not focus on technology but on teachers' skills, hardware, software, and examination results. In this model there is an individualized seat-based learning in the initial phase with the emphasis of improving the retention of knowledge. It has knowledge retention, processing and expansion phases.
MIH model. The MIH model is based on an explicit objective set by the school to facilitate collaborative planning and teaching to foster higher-order thinking and it sets the goals of inspiring school leaders to support e-learning adoption; motivate teachers to evaluate and tune their curriculum for inquiry-based learning; and encourage thinking capability, cooperative learning behaviour, and positive attitude towards learning (Zorfass, Remz & Persky, 1991). It has three components - the curriculum, the teacher development and the school facilitation component, which can be implemented over a two years period in three phases.

Evolutionary model. The evolutionary model, developed by Miller (1997), is a synthesis of the above mentioned models for a reason that the case study school involved had dominant features of the three models. In this model, successful adoption required teachers' ownership of necessary technology, skills and role-player capability in the design and evaluation of the curriculum; and the school should make computers part of its planning, train teachers in the method being used in the classroom, and share the goals of e-learning among all the school community. This model has five phases- introduction, entry, intermediate, penultimate, and creation, which does not have a particular time limit and individuals can be at different phase in their e-learning adoption; and transition takes time because it involves people, skills, attitudes, beliefs, organization and finance.

Ongoing challenges

Several authors have disclosed the causes for the failures of a number of e-learning initiatives (Saeedikiya, Mooghali, & Setoodeh, 2010; Ssekakubo, Suleman, & Marsden, 2011). For example, majority of e-learning initiatives in developing countries do not fulfil their potential because of low ICT literacy rates among the student community (Ssekakubo, Suleman, & Marsden, 2011); low comfort levels with technology; usability limitation of learning systems; poor marketing strategies; ineffective maintenance strategies and insufficient technical support. These challenges together with the fast change in e-learning technologies has motivated the innovation of many e-learning adoption strategies, activities, and pedagogies (Bidarra & Rusman, 2017; Macleod & Kefallonitis, 2017). However, to the best of our knowledge, the existing literature did not provide a generic e-learning adoption framework that addresses the impact of dynamic technological evolution overtime.

Similarly, Saeedikiya, Mooghali and Setoodeh (2010) mentions the challenges of failure stories of e-learning implementations in terms of high rate of dropout in online courses in universities. The authors suggested a staged approach of adoption (composed of diagnosis, decision making, design, development, delivery, and post-delivery) for implementing in three phases (preparation, operation, and post operation).

Although, nowadays irrelevant for many countries, the above mentioned challenges still persist in many developing countries including Ethiopia. For example, because only insignificant proportion of high schools students in Ethiopia have access to a range of technologies including mobile devices, ICT illiteracy remained an issue.

In general, many of the adoption models focus on mapping the current status of the schools in relation to a presumed full adoption. However, sufficient attention is not given to the fact that attaining complete adoption is an illusion (like that of any automation) and the impact of the ever changing innovation in digital technology on adopting them into the curricula is not given due consideration. Thus, this paper addresses limitations of the existing literature considering the dynamism in the evolution of digital technology and complement the effectiveness and efficiency of adopting into the curricula through a survey of students' and teachers' access to digital technologies, usage experience and experience of adopting the technologies into the curriculum.

Methodology and analysis

Methodology

Our approach for the study reported in this paper focuses on the adoption of e-learning in the high schools in Ethiopia. Ethiopia was chosen as a research object because we believe that this is the most convenient (with respect to the first author) to answer our research questions (Marshall, 1996). Thus, following our review of related work, we employed questionnaire as our data collection instrument, and the results were mapped into the requirements of the existing e-learning adoption models presented in the previous section.

The questionnaire was designed for all high school students and teachers (in urban as well as rural areas) and made available online on Google drive. Accordingly, email invitations that state the purpose and containing a link to a Web-based questionnaire were sent out in spring 2017.

It has been pilot tested using responses from ten respondents and validated using the Cronbach's Alpha (http://www.real-statistics.com/reliability/cronbachs-alpha/) test (the analysis result was 0.77 which is between 0.7 and 0.8). In order to enhance the response rate at a reduced cost and time, we purposively invited more than sixty five (65) potential respondents, who can be easily contacted to respond to the online questionnaires. Thus, we obtained a total of thirty one (31) responses.

The questionnaire is composed of questions (negative and positive phrased) concerning respondents' access to digital resources, computer skill, e-learning adoption experience, opinions towards approaches for adoption into a curriculum, and an open space for further remarks and the following scoring mechanisms were employed - strongly-disagree, disagree, neutral, agree and strongly-agree.

The demography of respondents was 55% students and 45% teachers. Out of this 32% are information technology teachers; 25% natural science teachers/students; 35% social science teachers/students and 8% teach other subjects. In addition, 22% of all the respondents are personal owners of the computers; 64% use the schools' computers; and the remaining 14% use computers from other sources.

Overall, our procedure began with review of related work, and data analysis. Next, a mapping of the current status of the schools into the e-learning adoption models was performed. Finally, we employed our study results and provided a description of an agile e-learning adoption model.

Analysis

We performed the analysis using statistical tools including the correlation function to determine the influence of variables (access to and skills on multimedia and computing infrastructure) on the adoption of e-learning. Percentage, mean, and standard deviation are also employed to explore the extent of e-learning adoption,

respondents' skills, and the dispersion from the mean value, respectively. Thus, the mean responses and standard deviations corresponding to each variable and to each question is shown in Table 1.

Table 1. Mean and standard deviation of results

Variables		Total		Teachers		Students	
	Questions#	Mean	*SD*	Mean	*SD*	Mean	*SD*
Access	1	3.839	0.820	3.534	1.235	4.082	0.616
	2	2.065	0.574	2.076	0.857	2.077	0.615
	3	4.000	0.516	3.742	1.343	4.153	0.533
	4	3.129	0.619	2.879	1.013	3.301	0.606
	5	3.032	0.948	3.142	0.930	3.306	0.991
	Mean	3.213	0.372	3.075	1.076	3.384	0.672
Use	6	4.000	0.775	3.777	1.228	4.219	0.698
	7	3.807	0.654	3.135	1.043	3.541	0.634
	8	3.484	0.724	3.370	1.180	3.684	0.607
	9	2.839	0.454	2.468	0.875	2.770	0.421
	10	2.484	0.626	2.246	0.759	2.541	0.634
	Mean	3.323	0.295	2.999	1.017	3.351	0.599
Adoption experience	11	3.000	0.516	2.727	0.792	2.852	0.533
	12	1.258	0.576	1.354	0.717	1.388	0.738
	13	3.968	0.795	3.777	1.326	4.077	0.917
	14	1.968	0.836	1.747	0.847	1.847	0.864
	15	2.387	0.882	2.271	0.982	2.393	0.836
	Mean	2.516	0.361	2.375	0.933	2.511	0.778
Views on approaches	16	4.355	1.050	4.042	1.354	4.153	1.231
	17	4.484	0.769	4.011	1.402	4.383	0.738
	18	4.355	0.709	3.925	1.449	4.541	0.746
	19	4.484	0.626	4.024	1.439	4.612	0.625
	20	4.258	0.930	3.928	1.352	4.235	1.049
	Mean	4.387	0.521	3.986	1.399	4.385	0.878

In addition, brief description of the percentages of responses on access, skill and attitude to use, existing adoption practices, and the respondents' views on the need for adoption approach is provided next.

Access to digital resources. The first five questions (in the questionnaire) were designed targeting the respondents' agreement on the level of access to digital resources. Accordingly, 79% teachers and 47% students inclined to agree that they have access to digital resources. These results substantiate the work in (Mesfin, 2004) which pointed out that the important factors for accessibility are somehow available - pupil-computer ratio, connectivity and availability of educational software. This is because high schools are used to receive computers for the information technology course and a few computers are connected as local area networks and to the Internet; and satellite based network for broadcasting digital multimedia. In most cases, the computers are used to have document editors, spreadsheets, and drawing tools; sometimes encyclopedia, tutorial, drill games, and test applications for subjects such as mathematics, physics and language specific tools can be found.

Usage experience. The usage experience factor, which focuses on the skills and attitudes of the respondents in digital technologies, was also analyzed based on the responses on a set of five questions in the questionnaire. Thus, the mean responses to the five questions 76% and 79% agreement for having perceived skills and attitudes by the students and teachers, respectively.

Adoption practices. Another five questions were also dedicated to investigate the experience of students and teachers on using digital resources for learning purposes. The mean responses of agreements for the five questions were 0% and 21% by students and teachers, respectively. These results reiterate the fact that furnishing schools with digital resources and advanced learning technologies does not necessarily imply successful adoption (Mesfin, 2004).

Views on adoption approach. Adopting computers in education has positive contribution towards student's learning outcome (Ghinea, & Chen, 2008; Hadley, & Sheingold, 1993). But, we concentrated on the challenges of dynamic technological change (e.g., advent of advanced technologies) and the holistic myth for adopting e-learning resources into the curricula; and the respondents' views on adoption approaches they foresee were

collected from the responses of other five questions in the questionnaire. Accordingly, the levels of agreements on the questions targeting these concerns were 100% and 93% by students and teachers, respectively.

Correlation. The correlation between respondents' access to digital resources and adoption experience; and computer usage experience and adoption experience into the learning was analyzed. Accordingly, the correlation coefficients of the mean responses of agreements of both respondent types for access and usage experience were -0.17 and 0.09, respectively.

Finally, the independent samples *t*-test result for the two groupings (access versus integration, and usage versus integration) is shown in Table 2. In Table 2, *p*-value of the mean differences in scores of the responses corresponding to both groupings is zero which shows that the difference in mean scores between the groups is statistically significant.

Table 2. Independent samples *t*-test result

	Levene's Test for Equality of Variances		*t*-test for Equality of Means						
	F	*Sig.*	*t*	*df*	*Sig.* (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval	
								Lower	Upper
Access vs Integration	179.515	.000	27.412	238	.000	23.061	.841	21.404	24.718
Usage vs Integration	68.150	.000	35.016	238	.000	19.371	.553	18.281	20.460

Accordingly, based on this statistical result, a mapping of the existing status of the schools in Ethiopia into the e-learning adoption models is described in the next section. In addition, an e-learning adoption model (in the context of advanced e-learning technology) is proposed, and further discussion on the overall result is provided in subsequent sections.

Mapping into adoption models

Based on the analysis result provided above, we performed a mapping of the schools' current status in the process of e-learning adoption. The mapping is achieved with reference to the adoption models described in the previous section - ACOT, CAMI mathematics, MIH, and Evolutionary. Although adoption models such as in (Abdullah & Ward, 2016) are more recent, these models are more relevant and hence selected because they attempt to address specific issues about schools.

Accordingly, we employed these models to map and reflect on the scenario of adopting digital learning technologies into the schools with respect to the responses from the online questionnaire (see Table 3). Table 3 depicts each phases of the models shaded with green, yellow and orange background representing the extent of the mapping-fitness of the schools status as fit, moderate, and unfit, respectively.

The goal of the ACOT model is to provide understanding on how technology would affect teaching and learning; hence requires technology rich environment (Fisher, Dwyer & Yocam, 1996). It assumes that teachers will be more likely taking the next step in integrating digital learning technologies into their teaching when their comfort with technology increases (Ertmer & Ottenbreit-Leftwich, 2010). Arguably, the schools in Ethiopia in general are not well equipped with digital learning technologies. However, the high schools have acquired relatively enough as discussed above which substantiate to correspond more to the entry phase (and somehow to the adoption phase) on the ACOT model. In addition, the outlier responses (standard deviation) could perhaps be because teachers use computers to prepare their lecture notes; but it is not sufficient condition to fit in the adaptation phase.

The transition between phases in the CAMI model is assumed to be triggered by the change in the skills of teachers and availability of technology (Miller, 1997). As the knowledge retention phase does not require sophisticated technology, supplementing lectures using simple drill software is a satisfactory condition to fit in. However, such drill software (in addition to document edition) is only intermittently employed which makes it somewhat fit into the retention phase.

In the MIH model, the need for deliberate integration of digital learning requires reorganization of the school to support integration, a team of organized teachers study, experiment and tune the curriculum (Zorfass, Remz &

Persky, 1991). The deliberate integration of technology into the school environment might correspond to the SchoolNet initiative in Ethiopia. However, the lack of curricular re-evaluation as to how certain learning objectives can exclusively be supported by the technology, makes it unfit even to phase one of the model.

Table 3. A mapping of Ethiopian high schools into adoption models

Phase	ACOT	Evolutionary	CAMI	MIH
1	**Entry** - Technology is installed; Staff is unfamiliar; Use traditional methods	**Introduction** – Computers and connectivity introduced; teachers understand technology; training begins; some teachers attempt to use in teaching	**Knowledge retention** – limited skill; drills used to retain recently taught subjects; small networked system	**Phase one** – Curriculum evaluated; topics selected for integration; vision shared; inquiry-based learning software; innovative teachers select for piloting
2	**Adoption** - High computer access; drill supplements lecture; traditional methods	**Entry** - Drill software supports teaching; teachers drop fear of technology; small change in class layout	**Knowledge processing** - Sufficient software for data processing; skillful teachers; teachers can plan and prepare	**Phase two** - The same team (phase 1) continues implementing in the first year
3	**Adaptation** - Integrated into classroom; new cognitive outcome; Traditional lecture	**Intermediate** - experiment and use for learning; teachers investigate teaching strategy; look for new systems and class rearrangement	**Knowledge expansion** - sufficient hardware and software; better skills; organizational planning skills of teachers	**Phase three** - The old team continues to plan, design and evaluate the curriculum; adds more teams; mentors the new teams
4	**Appropriation** - Teachers mastery of computers; collaboration and interaction; self-paced; multi-modal; change of timetable for team work	**Penultimate** - Team teaching develops; school timetable changes; better computer skills; teacher's role changes to facilitator and looks for better technology		
5	**Invention** - Intensive access to computers; high interaction; learning by doing	**Creation** – Teachers gain the capacity to decide which technology fits their practices		

Note. Green, yellow and red representing the extent of fitness of the schools status as fit, somehow fit, and unfit, respectively.

The evolutionary model, on the other hand, requires teachers to have high access to computers and the schools' plans for gradual integration digital learning into the curricula. In this regard, the statistical results described above show that the curricula lack prescriptive guidelines for adopting digital learning which makes the schools status to somehow fit on the introduction and entry phases.

Overall, the existing models only map the e-learning technologies available during the mapping for the high school context in Ethiopia and no advanced learning technologies which may be introduced in the future are considered. Thus, we propose new e-learning adoption model as described next.

Agile adoption approach

In our analysis, respondents have opted for an adoption approach that embraces the dynamically changing technological innovations and also recognized the need for gradual progression (as opposed to big bang) in the process of adoption. Thus, we propose an agile adoption model that insists prescriptive guidelines through explicit curricular re-evaluation; which takes the access to relevant e-learning resources and usage opportunities for certain experience of state-of-the-art technologies that teachers and students have as a driver.

Agile e-learning is not a new concept. For example, Tesar and Sieber (2010) suggested an e-learning development approach that focuses on personalized learning, usability of learning utilities, learner centered design, and flexible course concepts based on the manifesto of the agile software development. However, to the

best of our knowledge, there is no e-learning adoption model that considers the need for dynamically responding to the ever changing technological innovations. Accordingly, we coined the continuous technology adoption approach depicted in Figure 1. In addition, we adopted agile principles for integrating the dynamically changing e-learning technologies into the curricula (see Table 4).

The approach in Figure 1 takes into account the fact that the digital technology continues to evolve throughout the lifetime of the curriculum in question. Thus, an evolving technology adoption team corresponding to the curriculum must always be available watching new technological innovations, listening to the needs of teachers and students, thereby continuously adopting e-learning into the curriculum.

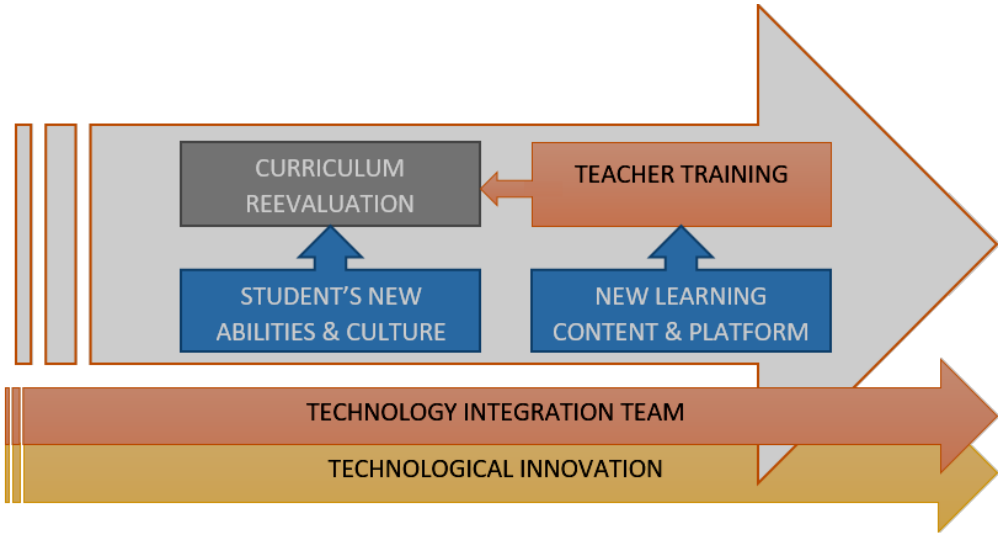

Figure 1. Continuous technology adoption approach

In this model, the task of e-learning adoption is participatory process that takes students' new culture and abilities, and trained teachers (learning content and platform) and results into an updated prescriptive curricular document for adopting technology into learning objective(s) of the subject matter(s) under review. The updated curricula serves as a binding rule to be enforced particularly regarding the adoption of technology into the learning practice.

The task of curricular re-evaluation is performed iteratively similar to the iteration in the agile software development (Paulk, 2002). The activities performed in an iteration include need identification for the adoption of technology into certain learning objectives, selection of appropriate off-the-shelf digital content for the learning objective, development of adoption guideline, pilot testing, and documenting the new curriculum which is potentially approvable. Thus, each iteration produces an approvable prescriptive curriculum in one semester duration.

In this model, we adopted the agile principles for software development (Paulk, 2002). Table 4 describes the adopted principles; which are the basis for the e-learning technologies adoption model. This model is different from the model suggested in (Tesar, & Sieber, 2010) in that the latter is based on the agile manifesto. In this model, the curriculum re-evaluation team is analogous to software development team while the primary customers are teachers and students.

When the adoption model is adopted, the tasks of curriculum re-evaluation, technology identification, and developing scenarios continuous as one mainstream business of the school through the curriculum's lifetime. Once certain learning objective is chosen for piloting, it enters into a fast track iteration of re-evaluation, technology selection, scenario design and pilot testing within one semester duration. The success of an agile iteration is determined by an approval of the pilot for full scale implementation as of the upcoming semester.

The agile model of e-learning adoption is composed of a set of principles, a process, and a set of phases. The set of principles shown in Table 4 leverage the agile e-learning adoption process. The set of activities constituting the process are initiating e-learning adoption for a curriculum; planning for adopting e-learning in one or more selected small chunk(s) of learning objective(s) to be implemented over a semester; perform weekly reviews aiming at removing backstopping; and conduct retrospective meeting to evaluate the process and demonstrate contribution of the adoption in learning. Once approved, e-learning will be formal integral part of the learning

objective for the upcoming semesters; subsequently other sets of learning objectives are selected for testing another adoption during the next semester; and so on.

Like the adoption models presented in the previous sections, the agile model has a set of phases. Since each adoption of e-learning in the chunks of learning objectives is well tested; and satisfies the characteristics that demonstrate successful e-learning adoption (Milton, 2003). That is, students and teachers involved in the selected learning objectives will be able to acquire a culture of innovation, define educational goals, use technology as learning tool, work in collaboration for learning, create own delivery strategies, and provide assessment and monitoring own progress. Thus, the phases in the agile adoption model represent the percentage of learning objectives re-evaluated for e-learning adoption (as per the requirements of the agile process) out of the total number of learning objectives constituting the curriculum in question; and the phases could be, for example, zero, twenty, fourth, sixty, eighty, and hundred percent completion.

Table 4. Agile principles for adopting e-learning into a curriculum

Principles	Descriptions
Priority	The highest priority is satisfying the needs of teachers and students through early and continuous delivery of re-evaluated curriculum, learning technologies and scenarios.
Change	Welcome curriculum, technology and scenario change requests at all times.
Delivery	Deliver re-evaluated curriculum, technology and scenario every semester.
Lifetime	Pedagogical experts and curriculum evaluators must work together throughout the lifetime of the curriculum.
Teaming	Build an adoption team of motivated individuals by providing convenience, support, and autonomy.
Conversation	The most efficient and effective method of conveying information to and within an e-learning adoption team is face to face conversation.
Measure	Pilot tested adoption scenario is the primary measure of progress.
Sustainability	The adoption team, teachers, students and principals must ensure sustainable technology adoption by maintaining a constant adoption pace indefinitely.
Attention	Continuous attention to subject matter expertise and new technology enhance agility.
Maximization	Identify and maximize the amount of learning objectives for which adoption scenarios that can be developed in the future.
Self-organization	The best scenarios emerge from self-organizing technology adoption teams.
Reflection	At regular intervals, adoption teams reflects on how to become more effective, and adjust behavior.

Overall, the agile adoption model takes advanced learning technologies and concepts which may be introduced in the future into account. Thus, it benefits the high schools in Ethiopia so as to effectively integrate advanced e-learning technologies and approaches such as mulsemedia, edutainment, and authentic learning into their curricula.

Results

Here, the contexts presented in the above sections are further discussed. Accordingly, the results corresponding to the accessibility of computing devices, usage experience, adoption experience, correlations, the mapping, and implications for the agile model are presented next.

Accessibility. The statistical data in the above section showed that respondents do not have severe shortage of access to digital resources. In fact, the mean responses on access for reading conventional documents (e.g., hypertext and pdf) is higher than for playing multimedia-rich content (e.g., videos); and their agreement on the regular hardware/software upgrade to support up to date multimedia content is generally lower than the mean. The respondents' agreements are perhaps because high schools are used to get computers from initiatives like supplementing practical sessions of the subject of information technology, empowering vocational information technology courses, and the SchoolNet initiative. Despite the increase in distribution, however, the culture of continuous refurbishment is not yet attained. On the contrary, respondents have easy access to multimedia content. Overall, the results signify that there is no acute shortage of access to e-learning resources which would hinder adoption into the curricula. However, issues like unavailability of state of the art digital resources, incompatibility, or insufficient specification (lack of upgrading) for accessing and sharing multimedia rich learning content; which all require a responsive mitigation approach.

Usage experience. The statistical data showed that respondents have the desired skills and attitudes towards document editing, data processing, searching for digital content, exploring online learning, and collaborative working with email; and the mean responses to all of the questions relating to usage experience specify agreement. This indicates that the degree of affinity of teachers and students towards technology (manifested by acquiring the necessary technical skills and attitudes for utilizing digital resources) is satisfactorily attained.

Experience in adoption. The experience of teachers and students on the use of digital resources in learning is generally limited to document editing and Internet searching. That is, teachers usually perform document editing and Internet searching for preparing lecture notes; and students for their assignments. Furthermore, the statistical result reveals that the experience of teachers in encouraging their students to utilize computers in their learning is low. The implication is that, in many cases, students utilize digital resources either as part of the subject of information technology or for social purposes. In general, the experience of teachers and students in adopting digital resources in learning as compared to the access and usage experience is low. This, perhaps, might be because of lack of prescriptive curriculum for e-learning adoption.

Correlation. Our statistical result showed low correlation between the accessibility of computing resources, and adoption experience, and skill of computer usage and adoption experience. This signifies that further effort is required to re-evaluate the curricula for successful e-learning adoption.

Mapping. Accordingly, our discussion of results (above) and the mapping of the current situation in the schools into the adoption models showed that having access to (and skill on) computers did not correspond to the adoption experience. Thus, the schools are found to resemble at most to the initial phases of the models implying that the development of new e-learning adoption model is paramount importance.

Agile model. As described in the section on agile adoption, the phases in the agile adoption model depend on the percentage of learning objectives (in a specific curriculum) which are re-evaluated for the adoption of e-learning. Thus, the status of the schools with respect to the model requires a study for an aggregate result of each learning objectives of the curricula corresponding to the schools.

Overall, the study reported in this paper showed significant insight into an advanced approach for successful agile and continuous e-learning adoption into the school curricula. However, the limitations of this research is that the impact of the agile adoption model is not yet tested in the context of specific curricular re-evaluation, and for integrating conventional as well as state-of-the-art technologies. Thus, it indicates that farther study is required on course re-evaluation, state-of-the-art technologies (e.g., mulsemedia) adoption challenges, the relationship between agility and e-learning adoption, and the status variations among schools (e.g., urban versus rural).

Conclusion

In general, our finding indicated that the experiences of teachers and students on e-learning resources is fair. However, there is only limited access to multimedia-rich resources, and premature practice of using them for the actual learning. The mapping of these results to the models for e-learning adoption also showed that the schools' status correspond to the initial phase. Moreover, since furnishing schools with computing infrastructure and e-learning resources does not necessarily imply successful adoption, schools need to consider continued maintenance and upgrade; re-evaluate their curricula for the adoption; and aim for the next level in the selected e-learning adoption model. Accordingly, we proposed an agile adoption model. The implication of this study is that schools will be able to reduce the failure rates of their e-learning adoption initiatives due technological changes and unintended adoption. Our results also prompt further study on approaches of course re-evaluation for multimedia adoption; the impact of multimedia on students' learning outcomes in terms of comprehension, creativeness, and problem solving; and the challenges of adopting edutainment, mulsemedia, virtual reality, gamification and other advanced technologies and concepts in terms of form factor, functionality and compatibility of the systems. In addition, our future research will also address more about the relationship between agility and e-learning, the status variations among schools (e.g., urban versus rural), and the progression in e-learning adoption in the upcoming years.

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