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Editorial

Academic communications – promise for the future

Donald G. Perrin

In this day and age of interactive social media including blogs, wikis, Facebook, Twitter, and Instagram, the traditional formats used in academic communications seem dry and antiquated. Perhaps the formats used in our lectures and publication media are obsolete in this era of Google searches, big data, instant interactive communications, artificial intelligence, and robotics. In lectures, most students assume a passive role. In traditional research journals, authors send out their messages and feedback is minimal to non-existent. Access to research information is limited by paywalls, corrupt copyright laws, cost of publication, and catalog card access inherited from a period that preceded computer-based information systems, the internet, open access, and social (interactive) media.

Social media fosters dialog among scholars. It opens up global opportunities for anyone who is interested for any reason to access, and even interact with the community of scholars as they research and develop new knowledge, ideas and technologies. Interaction invites participation, and the open more informal structure stimulates creative and practical responses. If we could redesign a lecture as a continually unfurling dialog, it would make learning a more immediate active and interactive experience. Participants can initiate new threads and pursue their own explorations; often they will be joined by others. From a student point of view, this dynamic experience transcends the fixed curriculum of the lecture and takes learning to a higher level.

In Cathy N. Davidson's book - *The New Education: How to Revolutionize the University to Prepare Students for a World In Flux* - we learn how traditional media can be made interactive using techniques from social media. Today's students are skilled users of these technologies. Most have smart phones, internet connections, and lots of experience in using applications and related technologies.

Mobil technologies and social media apps change the way people communicate. They communicate more often in a less formal more conversational style that is more interesting, highly interactive, and often more creative, with instant global access through the internet. Interaction can facilitate, motivate and clarify communication. It encourages more risk taking and creativity as participants expand, connect, construct, and produce new knowledge and ideas.

By eroding paywalls in favor of open access, social media and the internet promise to disrupt the tired, passive written communications, lectures and broadcast models used in education and replace them with interactive transmission of information using text, audio, visuals, and even video from the expert's laboratory experience or by mouth to the student's ear.

Things you can do with a smart phone.

The smart phone is designed for two-way picture and sound communications. It can do almost anything a computer can do including global access to the internet It can be used to research, analyze and interpret sounds, images and events. It can be used to search, record, store, organize and edit information and events in the form of text, sounds, images; and video; it can produce and distribute print, audiovisual, video and interactive media publications. It can change magnification and time-frames, alter or enhance colors, and be used to create graphics and animations to explain and make phenomena more visible.

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Editor's Note: The logistics of the flipped classroom releases faculty time for assisting individual students and time for students to work together and help each other. This is also productive for students with disabilities, and even for multiply handicapped students.

An instructor's experience in using a flipped classroom with deaf students: a self-study

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Abstract

The flipped classroom involves providing theoretical background information of the coursework before class and using the time in class to demonstrate and practice the skills learned. In an attempt to understand how to implement flipped classrooms with deaf students, this self-study was designed to document the author's understanding and experiences using flipped classroom while teaching graduate deaf students. Data collection methods and sources included field notes, use of "critical other" discussion notes, and student comments and responses during and at the end of the course. The study discussed emerging themes from the data.

Keywords: flipped classroom, deaf, higher education, self-study, deaf education, teacher training, 21st century classroom, educational technology.

Introduction

Technology trends in higher education are changing the traditional face-to-face class into a technology-enabled classroom. To the students, technology removes the barriers to education imposed by space and time while to the college professors, a change in their roles. The changing role of college professors represents the 21st century teaching and learning process in which the teacher is more of a knowledge facilitator than a content expert and students take a more active and participative role in their learning. The 21st century classroom features include student-centered learning, collaborative learning, active learning, problem-solving, and digital literacy (Christen, 2009; Goertz, 2015; Johnson, 2013; Saxena, 2013). Integration of technology has enabled the blending of the traditional three R's (reading, writing, and arithmetic) with the 21st Century four C's (critical thinking, creativity, communication, and collaboration) (Blair, 2012). In higher education, blended learning has gained popularity as part of the 21st century classroom that integrates technology. According to Bergmann and Sams (2012) flipped classroom is a critical component of blended learning. The flipped classroom instructional involve providing background information or new/unfamiliar concepts of the coursework before class and use the time in class to discuss, model and practice the skill learned (Halili & Zainuddin, 2015).

The purpose of the present study was to examine how one instructor implemented the flipped classroom technology with graduate deaf students. The present article describes the flipped classroom, provides an overview of self-study methodology and discusses the instructor's experience of the integration of the flipped classroom.

Flipped classroom instructional model

The flipped classroom model is the practice of inverting what has traditionally been the practice of lecturing in class to providing the lectures outside of class time. The class time becomes a time for discussion, active learning, exercise, and other practical applications of new knowledge (Bergmann, Overmyer & Willie, 2013; Milman, 2012). Using technology, students interact with the course material before class time, and are introduced to new or unfamiliar concepts or tasks (Davies, Dean & Ball, 2013; Lage, Platt, &Trelia, 2000). Asynchronous self-recorded video or video lessons replace the instructor's lectures. The use of technology allows learners to rewind, replay or slow the video to assist them to understand and to review the online information presented as many times as they want (Fulton, 2012b). Also, presenting material online provides flexibility for students to learn in their space and time (Muldrow, 2013).

The in-class time in a flipped classroom involves collaborative learning, active learning, problem solving (Jamaludin & Osman, 2014; Jensen, Kummer, & Godoy, 2015, Tucker, 2012a) which facilitates students to develop the 21st century four C's (critical thinking, creativity, communication, and collaboration) (Blair, 2012). The class time in a flipped classroom provides students opportunity to practice and apply the course material and the instructor to assess students understanding of the course material, identify challenging content and attend to students individual learning needs (Srivastava, 2014; Yujing, 2015).

Review of literature on the flipped classroom with students with disabilities indicates its effect on students' performance (Butterick, 2017; Chi & Liu, 2017). Butterick (2017) study on flipped classroom with students with learning disabilities taking an algebra course reported students' improvement on homework completion. Chi & Liu (2017) noted improved post-test scores and group discussions in a flipped math classroom for vocational high school students with intellectual disabilities. The use of the flipped classroom allowed the teachers to be prepared and provided additional tasks to students who were more advanced cognitively than others in the class.

Although, there are no studies on teachers' experiences with flipped classrooms with deaf students, there is evidence that technology is integrated to support deaf students learning (Lagarto, Mineiro, & Pereira, 2013; Long, Marchetti & Fasse, 2011; Long, Vignare, Rappold, & Mallory, 2007; Luetke, 2009; Richardson, Long & Foster, 2004; Roberson, 2001; Yoon & Kim, 2011). Luetke (2009) examined deaf university students taking an asynchronous web-based course and reported a high satisfaction from students, mainly on communication access. Lagarto, Mineiro, and Pereira, (2013) study showed that most of the deaf graduate students had limited experience with online learning and needed digital competence skills support. In Long, Vignare, Rappold, & Mallory (2007) both deaf and hard-of-hearing students reported an increase in the quality and quantity of instructor and peer interactions from inclusion of an online component. The online sessions provided deaf and hard-of-hearing students with opportunities to engage in direct communication with their hearing peers and instructors that were not available in the traditional in-class sessions. Overall, most deaf students reported they were very satisfied with a part of the coursework provided online.

Self-study and teaching

The goal of this self-study was to examine how the instructor implemented a flipped classroom model to enhance his or her own teaching practice and to document self-experience when using the strategy to teach deaf graduate students. There are several definitions of self-study. Hamilton, LaBoskey, Loughran, Pinegar, and Russell (1998) defined self-study, as the study of one's self, one's actions and one's ideas. According to Samaras (2002) self-study means a critical examination of one's actions and the context of those actions to achieve a more conscious mode of professional activity, in contrast to actions based on habit, tradition, or impulse.

Self-Study in Teacher Education Programs (SSTEP) enables the educator a new understanding of self and practice through discussion, debate, and analysis with other faculty referred as "critical other" (Bullough & Pinnegar, 2001.Three reasons for SSTEP are personal renewal, professional renewal, and program renewal (Anderson, Imdieke & Standerford, 2011; Kelchtermans, 2009; Samaras & Freese, 2006; Kosnik, Beck, Freese, & Samaras, 2006; Parr & Woloshyn, 2013). For instance, Anderson, Imdieke & Standerford (2011) student-to-instructor feedback in the online classroom self-study shaped their teaching of the online classes. In Parr & Woloshyn (2013), self-study was used to improve teaching a first-year reading course while implementing a new reading comprehension strategy.

In conducting self-study, a “critical other” is a vital agent of change who supports the instructor/researcher to make well-thought decisions, confront expectations, shape outcomes, and be alert to issues that emerge (Butler, 2011; Costa & Kallick, 1993; Doherty et al., 2001). A “critical other” is “a trusted person who asks provocative questions, provides data to be examined through another lens and offer critiques of a person’s work as a friend” (Costa & Kallick, 1993, pp.50). In the case of the current study, the critical other was a faculty member with experience teaching deaf students.

Methodology

Research design

This research represents a qualitative case study drawing upon principles of self-study. Self-study is considered "a critical examination of the self's involvement both in aspects of the study and in the phenomenon under study" (Marin, 2014). The choice of self-study research design was to examine self and the flipped classroom to share with other educators who planned to implement the similar instructional model.

The current research design was aligned to LaBoskey's (2004) five characteristics of self-study described as follows:

(a) *Self-initiated and self-oriented*: The researcher who is also a course instructor decided to conduct a self-study on the flipped classroom after researching and attending seminars on flipped classrooms.

(b) *Focus on improvement*: The goal of the study was to examine own understanding and application of the flipped classroom to improve the teaching and learning process.

(c) *Interactive*: The study process involved interactions with deaf students and a fellow faculty referred to as the “critical other.” For example, the researcher held a weekly meeting with the “critical other” to share what was happening before and after class sessions. Also, the researcher discussed with students about their comments during and at the end of the course.

(d) *Use multiple qualitative methods*: The researcher used various resources to collect data including own reflective journals, field notes, discussion notes with the critical other and content analysis of students' comments and evaluations shared during and at the end of course.

(e) *Validated by trustworthiness*: As a qualitative study, the trustworthiness of the data findings was based on Guba's four constructs including credibility, transferability dependability and confirmability (Guba, 1981).

Research context

Ethical clearance was sought from the IRB at the researchers' institutions before beginning the study. Students signed the informed consent forms before participating. The research setting was a fourteen-week term graduate class offered to second-year students taking a courses in deaf education. The course consisted of six face-to-face four-hour classes with the rest of the semester course work offered online.

The flipped classroom involved a virtual learning environment component using asynchronous teaching method. The instructor posted video-recorded lectures, electronic information and assigned readings using Blackboard Kaltura and Blackboard collaborate among other forms of technology. The Blackboard posting provided students with the background information related to the knowledge or skills to be learned in class. The instructor included reflective questions to guide the student in interacting with the posted content. Before coming to class, students responded to an online blackboard discussion post. In class, the professor spent the whole time interacting with the students, clarifying meanings, supporting their conception, answering questions and applying and practicing the skills to support their knowledge development. Figure 1 shows the four phases of the flipped classroom implemented in this study.

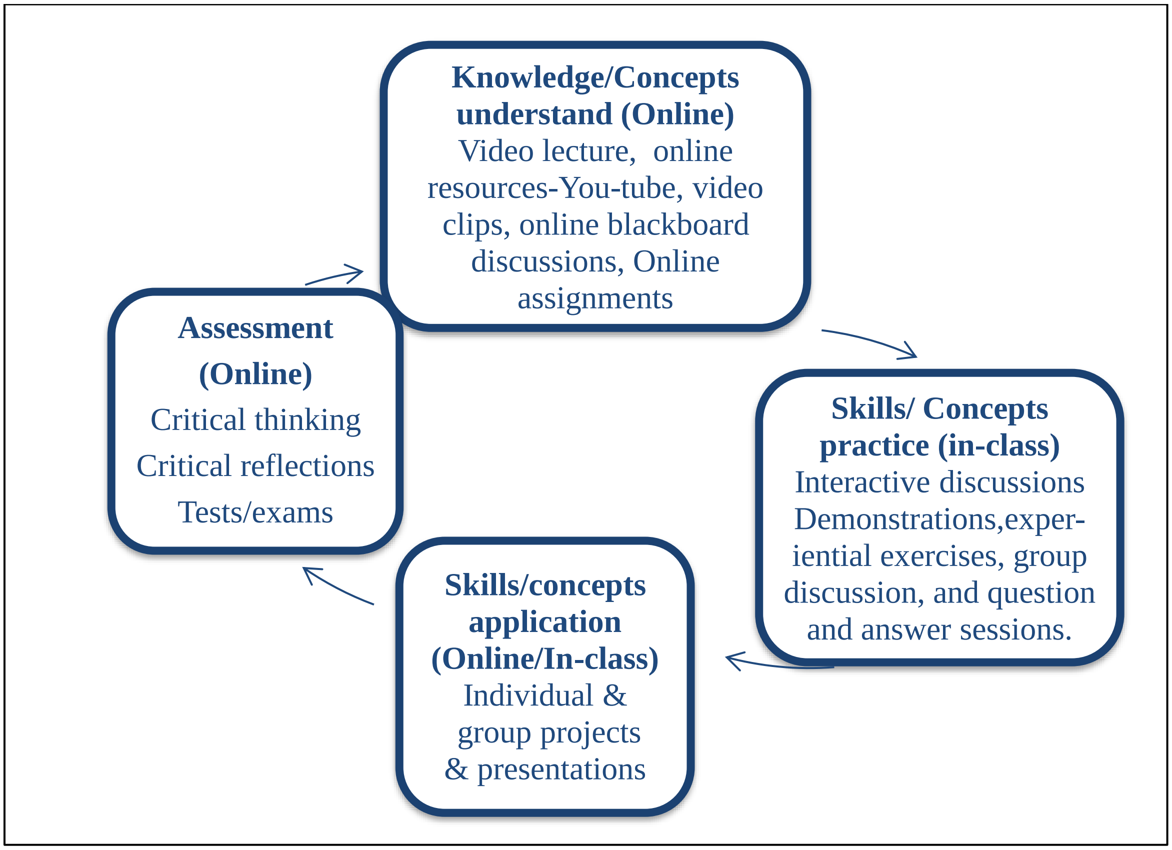

Figure 1. The flipped classroom phases implemented

Participants

Participants included six deaf graduate students enrolled in a teacher preparation master's program in deaf education. The students were aged 24-50 years. The students included one male and five females. All the participants responded to the questionnaires. All the participants were in their second year of study. Participation in this study was voluntary. Students' responses were collected at the end of the semester.

Data collection and analysis

Throughout the semester, the researcher's documented field notes and weekly reflections. The weekly reflective diary provided a written narrative of the researcher's experiences including class planning, online and face-to face class instruction, and students' evaluations. Cumulatively, there were over ten reflection entries. Researcher's field notes were written at the end of each face-to-face class session and supplemented the weekly reflections. Additionally, the researcher held bi-weekly conversations with the “critical other” to receive a critique on the researcher’s instructional practices, relate them to the literature, and develop succeeding classes. These research and “critical other” meetings were documented for subsequent analysis. Students completed a post-course questionnaire about their understanding and experience of the flipped classroom model. The triangulation of these multiple data sources served to strengthen the credibility of the self- study (Creswell, 2008)

In doing the content analysis, the researcher used open coding and axial coding (Corbin & Strauss, 2008). The researcher and a second coder reviewed and coded the researcher's reflections, field notes from meetings with “critical other,” and the students' evaluations and responses of questionnaires used during and after the class. The researcher and the second coder discussed the emerging codes. In doing axial coding, the research and the second coder used the agreed open codes to identify relationships among the codes and documented the emerging themes from the data. Data coding involved discussion until an agreement was reached and this was continued until the coders were satisfied and the analysis of the data gained some level of saturation (Corbin & Strauss, 2008). Four themes emerged from this process: (a) Teaching with a new approach (b) Change in Professor’s role (c) The learning process (d) Critical other in teaching (e) Time consumed.

Findings and discussion

a). Teaching with a new approach

The instructor used flipped classroom for the first time with the deaf students in the current study. The flipped classroom was a new learning environment for most of the deaf students. The data collected showed even though the professor had taught these students in previous courses without flipped classroom model, it was clear that the asynchronous learning environment, a part of the flipped classroom, presented different students’ learning needs and challenges. Some students had no prior or minimal experience with online learning. Some started to complain about the lack of the professors’ and peer’s presence in the video. As the reflective notes and field notes showed, graduate deaf students wanted more teacher and student interaction and peer to peer interaction, to ask questions or seek clarification which was not possible in asynchronous class.

Several deaf students had challenges with the flipped classroom when a video was not included in the online session and instead, students were assigned readings followed by a blackboard discussion or a written response. Another challenge expressed was on videos with captions. The instructor used captioned video from the library database, film on demand or googled from the internet. Finding captioned video was challenging for the instructor because some of the videos from the internet captioned word did not match the speakers’ words. Also, the students expressed taking more time to watch a captioned video because they had to read every word spoken. After the first two class sessions, the instructors offered the students an opportunity to express themselves through American Sign Language (ASL Vlogs) instead of written blackboard discussion. Some students presented longer and clearer discussions using the ASL Vlogs because they used their first language.

b). Change in professor’s role

Most higher education professors ‘role is to provide students with knowledge through lecturing. With the lectures online, the researcher’s role as professor changed to that of a mentor, facilitator, and consultant. The professor uploaded online material and guided students through interaction with the content and reflective thinking using a discussion forum. Similar to other asynchronous contexts, the instructor opted to use telephone, videophones, email, skype or Blackboard collaborate to answer their question during office hours or with an appointment. The instructor noted an increase in interaction with students and also students who rarely asked questions in class had opportunity to interact with the material at own pace and contact the instructor at own pace to ask questions. The instructor noted that most of the students' contact was either through the use of the videophone, skype or Blackboard collaborate which allowed them to use ASL to communicate.

Another change of role was related to student assignments. With assignments done in the flipped classroom, the new role of the professor was facilitating, modeling and guiding students with hands-on support in working on their assignments. There were increased interactions with students and their assignment. The professor role was not seen as someone who grades the work but of one working together with the students in the problem-solving process. Additionally, by doing the assignments in class, the professor introduced peer feedback. Hence, the professor became a co-assessor of the students' assignments as opposed to being the only evaluator.

Also, since most of the students were not conversant with the online tools used, the researcher role also changed from being a teacher to an online consultant, a specialist guiding the students on how to use the various online tools used in the class such as Blackboard Kaltura, Blackboard collaborate, Skype or KNOVIO. Previous research recommended understanding students' online readiness as an effective way to begin online teaching (Author, 2017a, b). In future, the instructor plans to assess students' online learning readiness before the class begins to understand how to support students.

c). The learning process

The flipped course on deaf with multiple disabilities was developed amid concerns about the lack of teachers with knowledge and skills to teach deaf students with additional disabilities (Dodd & Scheetz, 2003; Guardino, 2015; Author, 2016; Author, 2017c). The researcher's previous experience teaching the course as a traditional face-to-face class was the class meeting had limited time to model and practice the various strategies to teach deaf students with additional disabilities. The challenge with time prompted the researcher to explore the use of flipped classroom model to create more time for skill development.

The instructor observed that the flipped classroom provided opportunities for collaborative learning, engaging students, critical thinking and problem-solving skills tasks. Also, peer interactions increased in both online and in the face-to-face class. Some students who were already classroom teachers shared more on their daily experiences online and used their class scenarios to discuss and develop skills they needed. Students asked questions based on their experience and class readings, which motivated them and made the learning process more authentic and student driven. The teacher noticed a change of issues raised by the students in class. In previous classes, the instructor had to pause and respond to questions on the meaning of several words on the lecturing power points slides. With flipped classroom, students tended to take time to research on the meaning of vocabulary and own understanding of the material by searching the internet. Also, the blackboard discussions helped the instructor to know students' thinking through their questions and responses.

The instructor noted that the flexibility of flipped classroom model as in all asynchronous teaching and learning experience had the impact on interactivity. Some students who rarely participated in class increased their participation because they had an opportunity to learn at their pace and were able to ask questions and respond to the class discussions at their own pace. A negative aspect of the flexibility was noted by students who decided to access the material at their own time and hence accessed the online material the night before the face-to-face class or on the way to class making it challenging for other peers not to be able to comment on their postings. After the first flipped classroom session, a time frame for accessing the online material and participating in the discussion forum was set and communicated to the students.

As a result of flipping the classroom, the face-to-face classroom activities changed. Students were more engaged in hands-on activities and group work. There was more time to devote to modeling skills such as classroom behavior management, writing IEP goals and translating the goals into students learning objectives. mock-teaching, role-playing various and classroom scenarios Post evaluation questionnaire responses from students indicated the flipped classroom increased active engagement in learning, student to student interactions and student to instructor interaction. The instructor noted in her diary, the feeling of having taught after each face-to-face and the less pressure of balancing lecture time and demonstration time on students' practice time in class. Also, the instructor noted deaf students as visual learners tended to understand the concepts much faster with engaged learning than with lecturing.

d). Including a critical friend in teaching

The researcher felt in using a new approach, the flipped classroom model, she had to share with a critical other her concerns about teaching using flipped classroom model. The use of a critical other made the researcher more intentional in the "what," "how" and "why" of her teaching. The use of a critical friend was a new experience for the researcher to open up and share what she was doing, her challenges and fears related to her teaching. The critical friend did not come to the class. The discussion between the researcher and critical friend centered on what was happening in the class and what the instructor felt about each online and face-to-face session with a goal to improve the next class session. The sharing that comes from engaging in discussion and debate with a critical other led the researcher to question the assumptions and practices of flipped classroom model. In turn, she became more intentional, confident and consistent in her teaching.

e). Time-consuming

The researcher discovered that, in part, instructional planning was time-consuming. Finding appropriate captioned online resources accessible to deaf students was time-consuming. The researcher also discovered that creating the ASL signed video for each topic presented synchronously was time-consuming. Although time is a challenge, the researcher noted if the course's content is stable, the videos recorded during one academic year were applicable during the next one. Hence, no extra work would be required on the researcher's side to record videos in future.

Discussions

The study presented here provides insights for faculty who may want to implement flipped classroom model with deaf students. The findings suggest that implementing a flipped classroom is possible with a well-developed plan to provide information accessible to deaf students. The data showed that although deaf students experienced similar findings as those reported with hearing students in flipped classroom, some findings were unique for deaf students who used ASL. The article discusses first findings that are similar to what was reported in studies with hearing students.

First, in the current study, the flipped classroom model was a new experience for the instructor, and the students and throughout the semester they both engaged in self-reflection of their previous teaching-learning. These findings concur with Marina (2014) self-study experience that involved introducing the use of inquiry method in teaching mathematics. Marina and her students experienced similar tensions and reflected on their previous experiences as students of mathematics engaged in mathematical inquiry. Similar to the current study, Marina and her students had to ask themselves why, what and how they were using the new teaching and learning model.

Another critical aspect of the self-study was the change of role of the professor. Previous studies with hearing students have shown how a teacher’s role changed with the use of technology (Easton, 2003; Shelton, Lane, & Waldhart, 1999; Wake, Dysthe, & Mjelstad, 2007). In Wake, Dysthe, & Mjelstad (2007) new teacher roles emerged which indicated a change in the traditional role of the traditional teacher. The new roles that emerged included teacher, mentoring, administrator, consultant, negotiator to moderator, and learning to operate the digital system used in the class. According to Easton (2003), the instructor role became that of a mentor and facilitator. In particular, Easton noted the instructors' role involved course assessment, guiding and monitoring class discussion and responding to students' one-on-one questions. Student challenges with technology were also noted to change the instructors. Previous reports of both hearing students and deaf students in online learning forums indicated a need for technology competency skills training and support (Easton, 2003; Lagarto, Mineiro, and Pereira, 2013). These findings suggest the use of flipped classroom, like with other classes enhanced with technology, can be implemented with deaf students but not without effort and changes in the role of the instructor.

Additionally, the researcher recognized the importance of a "critical other" who guided her thinking through her teaching and preparation. In the absence of team teaching, discussion of one's practice with an informed other proved to be significant components for instructional planning and the continuation of the self-study. Previous research viewed a "critical other" as a vital agent of change in one's profession including teaching (Butler, et al., 2011) According to Butler and colleague (2011), as an agent of change; the "critical other" used a range of actions depending on the context, the individual and the change process occurring in a particular time. In the case of the current study, the context was a master's degree course class conducted in a 14 weeks' semester period. Similar to previous work on the use of a "critical other" in Doherty et al.,(2001) the "critical other" supported the researcher to make well-thought decisions, confront expectation, shape outcomes, and alert to issues that emerged. Hence, educators can learn to use flipped classroom model efficiently over time with each lesson enhancing the learning process through profound reflection of the practice.

The findings that were noted to be unique for deaf students focused on various aspects of the learning process. While pedagogically enriching, the implementation of a flipped classroom required time to develop the videos or find visually accessible online content for deaf students. Videos used in the class must include the use of ASL or captions to facilitate communication. Most students preferred video content that included the use of ASL. The challenge with captioned is associated with the task to read every word spoken and the need for the deaf students to continuously stare at the screen to access the information. The more time reported on watching captioned-only video materials could be associated with deaf students challenging reading comprehension skills (Allen, 1994; Karchmer & Mitchell, 2003 Traxler, 2000). Most deaf students graduate in high school with an average reading level between third to fourth grade level (Allen, 1994; Karchmer & Mitchell, 2003 Traxler, 2000). Also, although most deaf adult in the United States reading rate for captions is 145 words per minute (Jensema, 1998), the reading level of the deaf person influence their comprehension of captions (Burnham et al., 2008; Jelink Lewis & Jackson, 2001; Stewart, 1984).

Also, the students' reading skills may have influenced their participation in the online part of the flipped classroom that involved reading and responding to assigned reading. Some of the students' challenging English literacy skills affected their ability to comprehend some of the assigned reading, complete their assigned readings on time and participate effectively in posting written blackboard discussion. Additionally, previous research showed most deaf students experienced challenges with vocabulary development (Connor, Craig, Raudenbush,

Heavner, & Zwolan, 2006; Ouellette, 2006; Paul & Quigley, 1994). Vocabulary knowledge is correlated with word recognition, and reading (Ouellette, 2006). During a traditional lecture, students learning process can be affected by new concepts and vocabulary. With the flipped classroom, students had the opportunity to pause the video and find out the meaning of a word and go back without lagging behind or misunderstanding the information conveyed. This suggests that online instructors need to be sensitive to language delays and challenges expressed by deaf students that can impact their literacy skills and hinder participation in online activities involving reading and writing. The author suggests providing additional time for reading and posting online discussions to deaf students who may be experiencing English as a second language challenge.

The use of flipped classroom enhanced the use of an online component that provided the student with various ways to communicate with instructor and peers. This finding concurred with Long, Vignare, Rappold, & Mallory (2007) who reported that both deaf and hard-of-hearing students expressed an increase in the quality and quantity of instructors and peered communication and interactions by the inclusion of an online component. Similarly, Luetke (2009) acknowledged the importance of technology in supporting their communication during a web-based course. Other previous research indicated the benefits of online interaction among deaf students (Roberson, 2001; Wang, 2006).

Limitations of the study:

The researcher acknowledged limitations associated with the current research: participants were all deaf besides two hearing students; the mode of communication used in this class was primarily ASL; the study setting was a graduate course that focused on both knowledge and skill development, particularly teaching deaf students with additional disabilities. The researcher acknowledged the use of reflections as in the case of all self-report data, may reflect response bias and are restricted to the individuals whose reflection were included in the study.

Recommendations for future research

There is a need for continued research including multi-case studies involving more than one faculty using the flipped classroom with deaf students who use visual and auditory mode of communication. Also, future research needs to include quantitative measures to examine the impact of the use of the model to students' academic performance.

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Editors Note: This is a detailed and useful study of pros and cons of young children's educational development using.smart phones, television and computers and potential risks involved.

Parents' views of their young children's access and use of technological devices

Sinaria Abdel Jabbar and George Adel Tannous

Abstract

This paper presents parents' views of their young children's access and use of technological devices, the duration spent on technological devices and the benefits and risks associated with that. 500 parents completed a questionnaire and findings suggest that parents hold positive beliefs about technology with smartphones being the most used among their children and the most effective device, while e-reading was the least used. Findings indicated that parents believe technology benefits their children in developing intellectually, socially, physically and emotionally respectively, thus it enhances children's educational development through educational activities while they interact with peers at the same time; physical development was number 1 risk on children which was associated to health and mental development. Recommendations were given at the end of the paper to examine in depth how technological devices can used in educational settings in favour of children.

Keywords: touch screens, parents, children, devices, technology, risks, benefits, childhood, perceptions

Introduction

Since the 1980's, ICT has changed the world rapidly and the 21st century has been labelled as the 'digital era' and new challenges has surfaced in our societies (Li & Ranieri, 2010). Children's development levels and learning concepts are interrelated; children can learn certain concepts in some developmental periods easily (Recchia, 1997). While children are developing, and learning concepts, they are also interacting with their environments. Today, one fundamental part of children's environment is information and communication technologies (ICT), which is considered a preparation for the future of preschool children.

Literature review

Our modern society

The rapid technical and technological advancements in today's life bring about apparent changes. A study reveals that in 68% of American homes at least one parent works excessive hours outside the house and 40% of American parents spend less time with their children compared to their parents 30 years ago (Fox Cities, 2006). It is known that free time is usually spent with the family engaging in activities or watching TV and movies. Today, however, and as a result of the increase in technology, and economic constraints, children are returning to an empty home or one parent available and are practically spending hours on their devices. Due to this influx of new technology, children have more options to engage in virtual play versus traditional than any time before. Computers, tablets, video games, and cell phones are among the very least.

In today's modern society and lifestyle, technology may serve in the capacity of a babysitter in the home (Plowman, 2013). Plowman states that exhausted parents today see technology as an attractive way to keep their children busy and occupied while they do something else. The debate over children's use of technology over the past ten years has changed dramatically in the early childhood community and the public (Lentz, Seo & Gruner, 2014). Cautions about technology use with young children provide important guidance (American Academy of Pediatrics, 2011) but it is also evident that technology use with young children is expanding rapidly (Kaiser Foundation, 2010). The early childhood period covers the age of 0-8 and involves the physical, cognitive and social domains. This period is the ages when growth and development occur most rapidly (Ozmert, 2005). Children become familiar with technology in the early childhood years allowing them to access games in smartphones, DVD players, music players, entertainment purpose TV's, computers and the internet (Ekici, 2016). Contemporary studies indicate that children's ICT use is increasing day by day, the age of which they are becoming acquainted with ICT is decreasing and the applications they are using are diversifying (Holloway, Green and Livingstone, 2013; The Organization for Economic Cooperation and Development, 2011; Radyo Televizyon Ust Kurulu, 2013).

How much time is just right?

Experts state that infants and toddlers under two years of age should not be allowed screen time under any circumstances and children above two years of age should only be allowed two hours of leisure screen time only. In fact, children aged 2-5 years should have no more than an hour a day. This is because during the first years of life, a child's brain develops rapidly and thus it is advised that children interact with people, not screen (Early Childhood Ireland, 2015).

Technology benefits and risks

ICT in the preschool period can have both positive and negative affects to the development of children. For example, it has been stated that the use of ICT in the preschool period renders learning that is more meaningful and enjoyable (Akpinar, 2005); Ari Ve Bayhan, 2003) as well as develops creative thinking skills (Sivin-Kachala and Bialo, 2000). Moreover, it enables active learning by individualising learning when used in preschool teaching (Kucukoglu, 2013). In a study by Arrowood and Overall (2004) the use of ICT was seen to have increased the level of motivation of students in the writing process, in addition to being more motivated in computer supported activities (Chung and Walsh, 2006; Talley, Lance and Lee, 1997). Others argue that computers increase a child's independence and sense of control over their learning, which increases motivation and self-esteem (Ainsa, 1989; Burg, 1984; Clements & Swaminathan, 1995; Lee & Houston, 1987); for gifted children, ICT removes the information barrier that once hindered their learning and allows them to interact with distant mentors and peers who share the same interests (Siegle, 2005) ; for talented children, ICT provides a variety of authentic learning methodologies

The use of ICT in the early childhood period is very crucial in the development of social, cognitive and lingual skills of children which is in turn considered a tool in the learning-teaching process (Gimbert and Cristol, 2004). For example, Clements and Samara (2003) state that children who use ICT versus those who do not are more successful in mental development, the formation of information, problem solving skills and lingual skills. In a study conducted by Kumtepe (2006) pre-school children who use ICT show less problematic behaviours and have better social skills than those who do not. For example, the innovative work of Downes (2002) investigated the use of home computers by children in Australia with a focus on children's views. It was found that using a computer at home was a key factor in children's cognitive and social development, as well parents' views whom asserted the necessity of using computers for the future for education and for personal productive tools versus merely for entertainment (Downes, 2002, p.24).

While there are benefits to children's use of technologies there are risks associated to that in all developmental domains that are necessary for children's growth in this period. In a report prepared under the editorship of Cordes and Miller (2000), it was asserted that the use of computer at early ages may have various harms on pre-school children in physical, emotional, social, cognitive and moral terms. In regards to the social domain, there is an evident lack of social interaction with the surrounding environment since children spend that quality time on their technological devices. Stout (1983) was concerned that computers would turn children into miniature machines that completely lack in human emotions. Indeed, teachers and peers provide for a child's social and emotional well-being in ways that a computer cannot (Fein, Campbell & Schwartz, 1987; Lepper & Gurtner, 1989). It is thus feared that computers will isolate children and deprive them of the socialization and interaction with others which is significant at this age.

Pre-school children also face risks pertaining to the physical domain associated with the use of ICT including eye health issues due to children sitting closely to display applications for a long time, obesity due to lack of movement and exercise, problems with the skeletal structure, late development of features such as coordination of the sensory organs (Ekici, 2016), headaches, insomnia, tiredness, blurry vision, aggressiveness, muscle-skeletal dysfunction (Theodoto, 2010). Other health-related issues caused by technological devices include distress on joints, injuries, bad posture, (Andelic, Cekerevac & Dragovic, 2012); compulsive disorder called 'Computerphilia' (Joksimovic, 2004). For example, in a study of children ages 4-7 conducted by Epstein and colleagues (2008) it was found that reducing TV and computer use had a positive effect on lowering body mass index. Another study of more than 2000 children, ages 6-20 who spent two hours watching TV or using the computer were associated with cardiovascular risks even when adjusted for physical activity (Choi & Kong, 2011).

An emotional risk involving children's use of technological devices is addiction. It was found in a study conducted on 179 five years old children in Korea, that the younger the child started using the computer, the longer they used the computer playing games and the less supervised computer time, the higher the score on the Internet Addiction Scale for Young Children IASYC (Seo, et al, 2011). It was also found by Seo and colleagues (2011) that children who scored high on the IASYC had the lowest score on the Socio-Emotional Development Evaluation Scale that is used to measure traits as such: independence from teachers, self-control, peer interaction, adaptation to kindergarten and incentives for accomplishment and curiosity.

ICT was also considered a risk to preschool children's cognitive development. For example, in a study conducted on 6 parents (5 female, 1 male) whose children were between the ages of 3 and 5, it was found that parents feared the use of technological devices could be time consuming, lacks exposure to other things and hinders imagination and creativity (Deshelter & Slutsky, 2017). One parent also thought that her child is better focused when he gets out and exercises, while another one believed that her child could get into things "There is stuff they could get into"; this is because children are curious and thus they will be tempted to explore inappropriate content on the internet (Siegle, 2017); one parent was also concerned about his child not reading with electronic books but merely listening "trying to learn" how to read the words opposed to simply following along.

Parents and technology

A crucial point to be considered is the possible relationship between children's media and parental education, and values which can act as a catalyst to children use of technological devices. Anand and Krosnick (2005) examined whether the mother or father's education had an impact on the technology in which children engaged. It was found that children of both parents with less education watched more television; children of fathers who had some college education or graduated from college spent more time on computers than those who fathers had the lowest level of education. It was also found that the values that educated parents bring to child rearing motivate them to discourage television viewing and invest in other activities.

Importance of the study:

The rapid expansion of computer use, in educational settings and at home (ABS, 2011) signifies the need for a thorough examination of parents' perceptions of their children's use of technology.

There is a constant debate, however, about whether computer is harmful or beneficial to young children's development. Research around young children's technological use has been minimal and the focus has been on how teachers are using computers at school.

The research study

Specifically, this paper aimed to investigate the following research questions:

1. What technological devices are used by children under age 8?
2. What is the time duration spent on using different technological devices by children under the age of eight years?
3. What are parents'/caregivers' views of risks of their children accessing the emerging touch screen devices?
4. What are parents'/caregivers' views of benefits of their children accessing the emerging touch screen devices?
5. Is there a relationship between the role of parents in their children's use of technological devices (tech use, daily time duration) and the variables of the study (age, gender, educational level of the parent, nationality, political view, marital status, employment and number of children in the family)?
6. Is there a relationship between the role of parents in their children's behavior (risks and benefits associated with the four developmental domains: physical, intellectual, emotional and social) and the variables of the study (age, gender, educational level of the parent, nationality, political view, marital status, employment and number of children in the family)?
7. Are there statistically significant differences between the role of parents in their children's use of technological devices (tech use and daily time duration) and the variables of the study (age, gender, educational level of the parent, nationality, political view, marital status, employment and number of children in the family?
8. Are there statistically significant differences between the role of parents in their children's behavior (risks and benefits associated with the four developmental domains) and the variables of the study: age, gender, educational level of the parent, nationality, political view, marital status, employment and number of children in the family)

Research assumptions

- There is a correlation between the role of parents in their children's use of technological devices and the variables of the study (age, gender, educational level of the parent, nationality, political view, marital status, employment and number of children in the family).
- There is a correlation between the role of parents in their children's behavior (risks and benefits associated with the four developmental domains) and the study variables (age, gender, educational level of the parent, nationality, political view, marital status, employment and number of children in the family).

Methodology

The design of the paper was based on the descriptive analytical method; the field survey method utilized a questionnaire that consisted of both open and close ended questions. The questionnaire focused on gathering information about parents'/caregivers' views on their children's access and time spent on technological devices, and their perceived risks and benefits (associated with the four developmental domains: physical, intellectual, emotional and social) of the emerging touch screen devices. To ensure validity and reliability of the tool, the researchers depended on Cronbach's Alpha and the result of Cronbach's alpha is (0.833); this result indicates that the research tool is valid and reliable, according, to Santos & Reynaldo (1999) "Cronbach's Alpha Coefficient is acceptable if it is equal to or higher than (0.70)".

Participants

This study included a total of 498 adult participants (227males and 221 females). They were parents/guardians of children below 8 years of age; more than half adult-participants were above 37 years old (72.3 %), and had attained university qualifications (52.2 %). Table 1 below shows the distribution of the sample based on demographic data which includes: age, gender, education, nationality, political view, marital status, employment and number of children.

Procedure and data collection

The researchers adopted different ways to distribute the questionnaire to achieve a higher response rate. Some questionnaires were sent to parents/guardians via social media such as Facebook and WhatsApp, others by email, a small number by artificial intelligence platforms while the rest were distributed to teachers in public and private schools in Amman to give to the parents. Parents/guardians participated voluntarily in data collection, and they were also informed that they could refuse their participation in data collection without any explanation, penalty, or disadvantage to them. A total of 500 questionnaires were distributed to parents/caregivers, and were asked to return them to the researchers within a period of 2 weeks (response rate 100 %).

Data analysis

The paper tries to identify parents'/guardians' views of their children's (aged below 8 years) access and time spent on technological devices and their views on the risks and benefits associated with the use of the emerging touch screen devices. Therefore, the researchers developed hypotheses to explore this role and analysed data by the statistical package for the social science (SPSS) version 23.0 software. The statistical methods used to analyse data are: Cronbach's alpha, frequencies and percentages, and Chi-square.

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Table 1
The Sample's Demographic Data

Demographics Data	Variable(s)	Frequencies	Percentages
Parent/guardian age	less than 25	3	0.6
	26-36	135	27.1
	more than 37	360	72.3
Parent/guardian gender	male	277	55.6
	female	221	44.4
Parent/guardian education	high school or less	91	18.3
	some school	82	16.5
	bachelor's degree	265	53.2
	graduate degree	18	3.6
	post-graduate	42	8.4
Parent/guardian nationality	Middle East	433	86.9
	Western Countries	56	11.2
	Asia Countries	9	1.8
Parent/guardian political view	Very Conservative	17	3.4
	Conservative	58	11.6
	Moderate	362	72.7
	Liberal	61	12.2
Parent/guardian marital status	Married	458	92.0
	Divorced	40	8.0
Parent/guardian employment	Employed	325	65.3
	Employed(part-time)	34	6.8
	Stay at home	103	20.7
	looking for work	12	2.4
	Retired	18	3.6
	Student	6	1.2
Number of children	1 child	171	34.3
	2 children	269	54.0
	3 children	58	11.6

Findings of the study

Main hypotheses emerging from the results

1. 1.There is a statistically significant difference between the role of parents represented by independent variables (age, gender, education, nationality, political views, marital status and number of children) and the study variables: children's technology use (technology use and daily time duration); and children's behaviour (risks and benefits) associated with the four developmental domains: *physical, intellectual, emotional, and social*.
   Table 2 below summarizes the results found by the researchers.

Table 2
Summary of Findings

Independent Variable(s)	Dependent variable	Parameter	χ^2 value	DF	Sig (P value)	Details
Parent/guardian age	children technology use	Tech. use	15.531	18	.209	Not significant
		Daily time duration	13.739	14	.469	Not significant
	children behaviour	Risks	11.806	10	.298	Not significant
		Benefits	15.694	8	.047*	**significant**
Parent/guardian gender	children technology use	Tech. use	3.966	9	.914	Not significant
		Daily time duration	17.181	6	.009*	**significant**
	children behaviour	Risks	5.753	4	.218	Not significant
		Benefits	3.898	4	.420	Not significant
Parent/guardian education	children technology use	Tech. use	51.507	36	.045*	**significant**
		Daily time Duration	20.404	24	.674	Not significant
	children behaviour	Risks	4.676	16	.997	Not significant
		Benefits	15.310	16	.502	Not significant
Parent/guardian Nationality	children technology use	Tech. use	14.486	18	.697	Not significant
		Daily time Duration	8.316	12	.760	Not significant
	children behaviour	Risks	9.257	10	.508	Not significant
		Benefits	11.127	8	.195	Not significant
Parent/guardian political view	children technology use	Tech. use	38.871	27	.044*	**significant**
		Daily time Duration	13.378	18	.769	Not significant
	children behaviour	Risks	11.824	15	.692	Not significant
		Benefits	11.075	12	.523	Not significant
Parent/guardian marital status	children technology use	Tech. use	18.377	9	.031*	**significant**
		Daily time Duration	.351	6	.999	Not significant
	children behaviour	Risks	13.775	4	.008*	**significant**
		Benefits	4.130	4	.389	Not significant
Parent/guardian employment	children technology use	Tech. use	81.678	45	.001*	**significant**
		Daily time Duration	42.124	35	.019*	**significant**
	children behaviour	Risks	19.680	20	.478	Not significant
		Benefits	52.726	20	.000	**significant**
Number of children	children technology use	Tech. use	26.515	27	.490	Not significant
		Daily time Duration	16.155	21	.761	Not significant
	children behaviour	Risks	19.273	15	.202	Not significant
		Benefits	21.770	12	.040*	**significant**

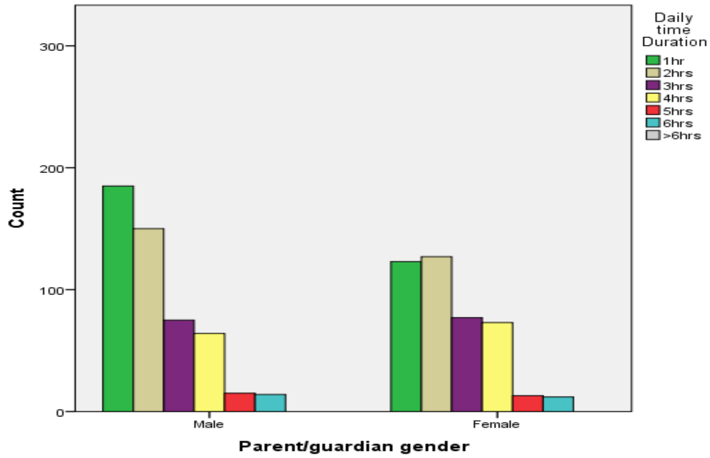

Figure A.1, Distribution of the sample according to the variable parent/guardian age and its relationship with children's behaviour (Benefits)

From Table 2 above the main results are as follows:

A. There is a statistically significant difference between demographic characteristics "parent/guardian age" and children's behaviour "benefits" chi-square (15.694,8); P value (.047) significant value at (0.05) level of significant; to recognize which (parent/guardian age) group represents the source of difference, see Figure A.1 below.

   Figure A.1 shows that the source of difference comes from parents whose age category is "more than 37" in which the highest class frequency in children's behaviour "benefits" is the intellectual domain (the most effective) followed by social, physical and emotional; this means that the parent age category and the intellectual domain is the main source of difference in relationship between parent age and children's behaviour "Benefits."

B. There is a statistically significant difference between demographic details parent/guardian "gender" and children's technology use "daily time duration"; chi-square (17.181, 6) P value (.009) is significant value at (0.05) level of significant.

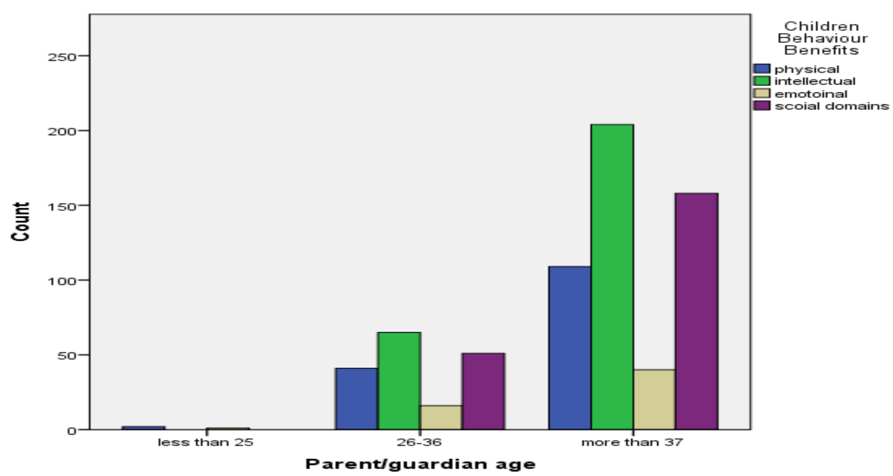

Figure B.1. Distribution of the sample according to the variable parent/guardian gender and its relationship with technology use (daily time duration)

Figure B.1 shows the source of difference comes from parents' gender category "Male" parents and the highest class frequency in children's technology use "Daily time Duration" is 1 hour; while “female” parents children spend 2 hours on technological devices. This means that almost half of the sample (children) use different technologies 1 hour daily.

C. There is a statistically significant difference between demographic characteristics parent/guardian “education” and children’s technology use “tech. use” chi-square (51.507, 36); P value (.045) is significant value at (0.05) level of significant. See Figure C.1 below.

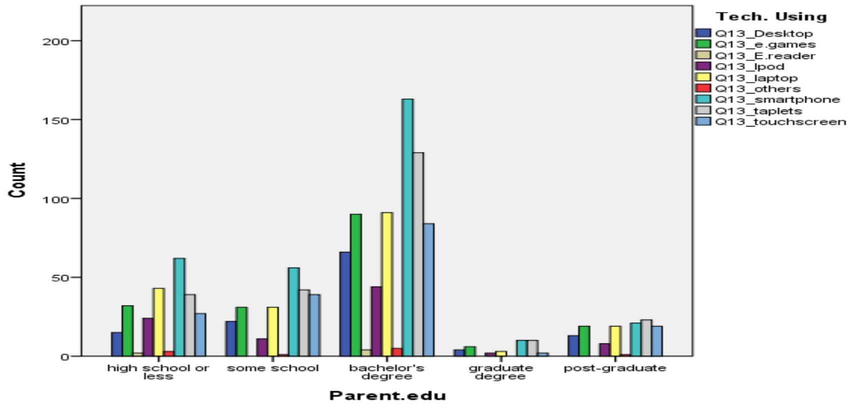

Figure C.1 Distribution of the sample according to the variable parent/guardian education and its relationship with technology use.

Figure C.1 shows that the source of difference comes from parent education category “Bachelor’s Degree”, and the highest class frequency in children’s technology use “Tech. Use” is smartphones which indicates that smartphones are the most used technological devices used by children for various activities (games, chatting, etc.) and the most effective regardless parent education.

There is a statistically significant difference between demographic characteristics parent/guardian “political view” and children’s technology use “tech. using” chi-square (38.871, 27); P value (.044) is significant value at (0.05) level of significant. See Figure D.1 below.

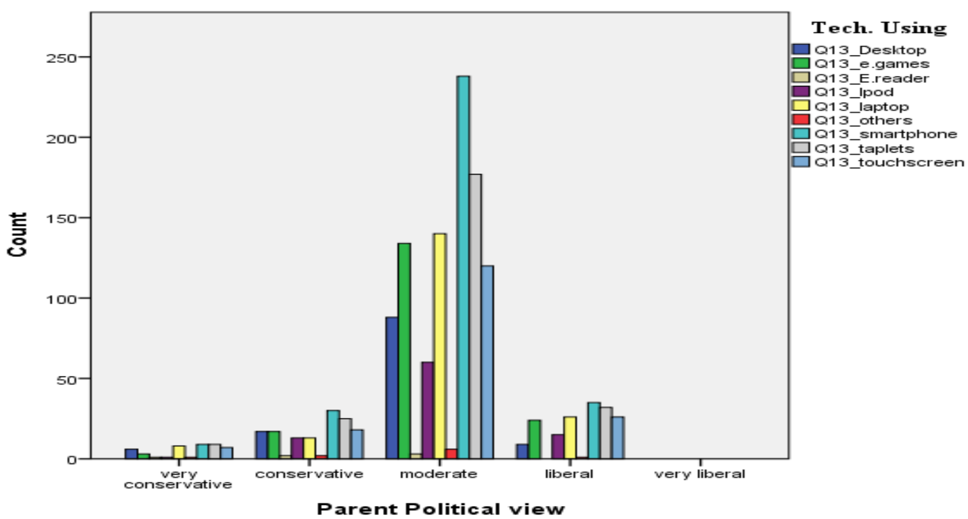

Figure D.1. Distribution of the sample according to the variable parent/guardian political view and its relationship with technology use.

Figure D.1 shows that the source of difference comes from parents’ political view “moderate” followed by liberal then others political view category. The highest class frequency in children’s technology use” Tech. Use” is smartphone which indicates that smartphones are the most used technological devices by children for various activities (games, chatting, etc.). The more conservative the parents, the less technological use among children.

E.1 - There is a statistically significant difference between demographic characteristics parent/guardian "marital status" and children's technology use "tech. using" chi-square (18.377, 9); P value (.031) is significant value at (0.05) level of significant.

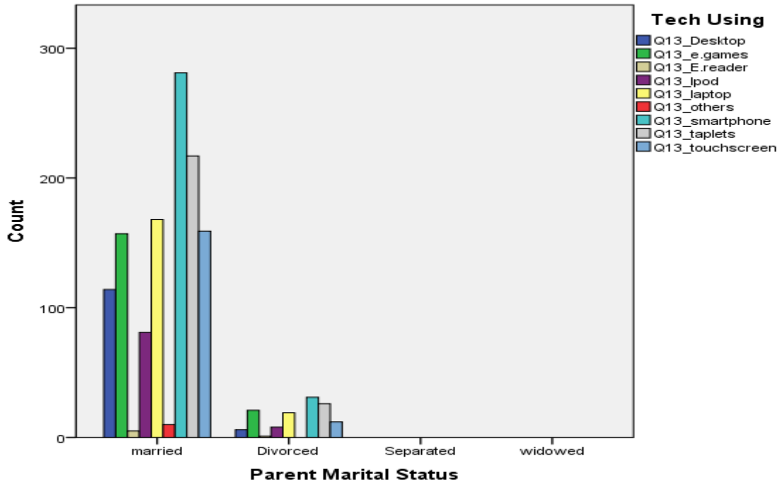

Figure E.1. Distribution of the sample according to the variable parent/guardian marital status and its relationship with technology use

Figure E.1 shows the source of difference come from parents' marital status "married" followed by divorce. The highest class frequency in children's technology use" Tech. Use" is smartphones which indicates that smartphones are the most used technological devices by children for various activities (games, chatting, etc.). Children for all parents regardless marital status use smartphones the most and e-reading the least.

E.2. There is a statistically significant difference between demographic characteristics parent/caregiver "marital status" and children's behaviour "Risks" chi-square (13.775, 4); P value (.008) is significant value at (0.05) level of significant.

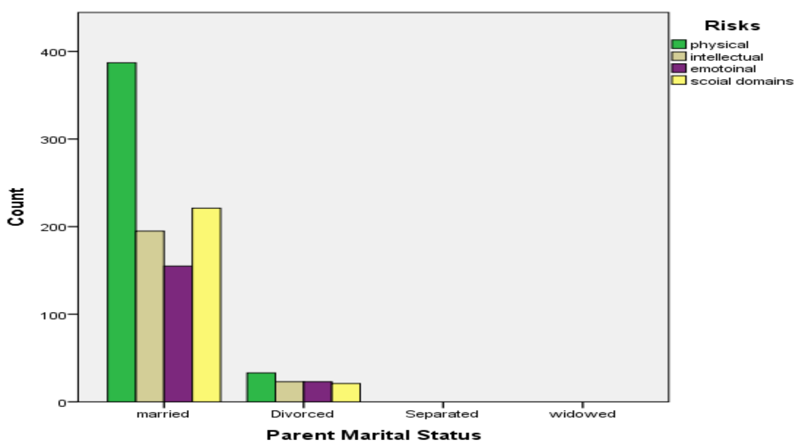

Figure E.2. Distribution of the sample according to the variable parent/guardian marital status and its relationship with children's behaviour (risks)

Figure E.2 shows the source of difference comes from parent's marital status category "married" followed by "divorce". Figure E.2 indicates that the highest class frequency in children's behaviour: "Risks" is physical which indicates that the physical developmental domain is considered number one risk that faces children when they use technological devices from parent's point of view.

F.1. There is a statistically significant difference between demographic characteristics parent/guardian "Employment" and children's technology use "Tech. use" chi-square (81.678, 45); P value (.001) is significant value at (0.05) level of significant.

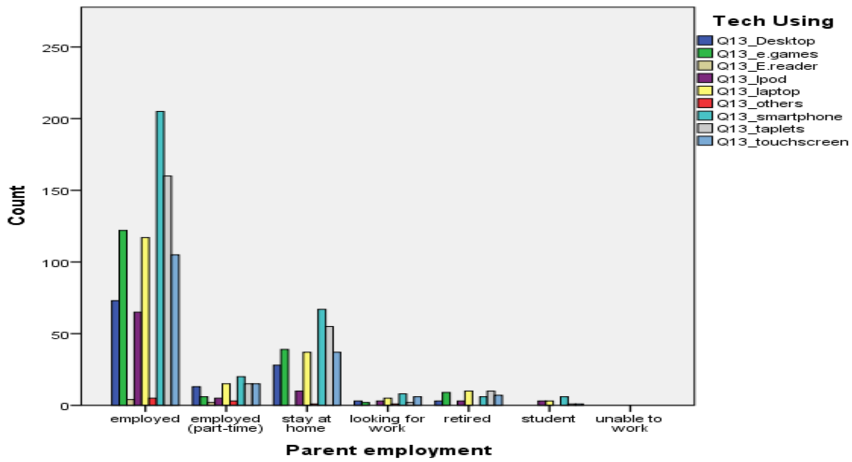

Figure F.1 shows the distribution of the sample according to the variable parent/guardian employment and its relationship with technology use

Figure F.1 shows the source of difference comes from "parent employment" category "employed" followed by "stay at home" then "employed part time" then "other". The highest class frequency in children's technology use" Tech. Use" is smartphones which indicates that smartphones are the most used technological devices by children for daily activities (games, chatting, etc.).

F.2. There is a statistically significant difference between demographic characteristics parent/guardian "Employment" and children's technology use "Daily time Duration" chi-square (42.124, 35); P value (.019) is significant value at (0.05) level of significant. See Figure F.2 below.

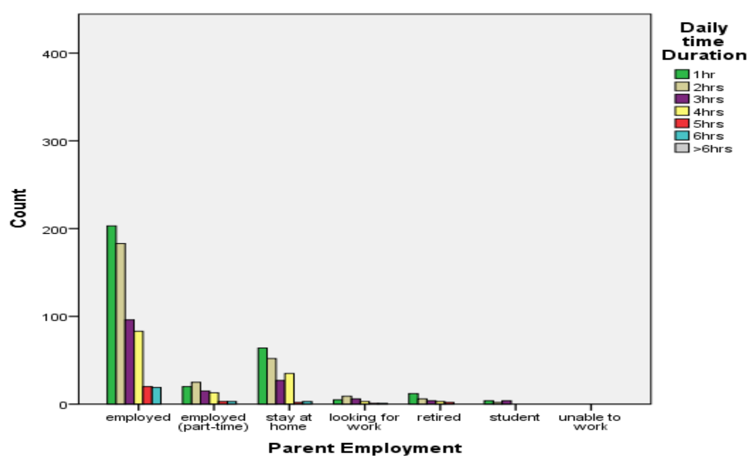

Figure F.2 shows the distribution of the sample according to the variable parent/guardian employment and relationship with technology use (daily time duration)

Figure F.2 shows the source of difference comes from “Parent Employment” category “employed” followed by “stay at home” then “employed part time” and lastly “other”. The figure indicates that the highest class frequency in children’s technology use” Daily time Duration” is 1 hour, which means that almost half of the sample uses different technologies for 1 hour daily followed by 2 hours daily, 3 hours daily, 4 hours daily, etc.

Children whose parents are full-time employees, stay at home or retired, believe that their children should not spend more than 1 hour on technological devices, while part-time parents believe it can be up to 2 hours.

F.3. There is a statistically significant difference between demographic characteristics parent/guardian “Employment” and children’s behavior “Benefits” chi-square (52.726, 20); P value (.000) is significant value at (0.05) level of significant. See Figure F.3 below.

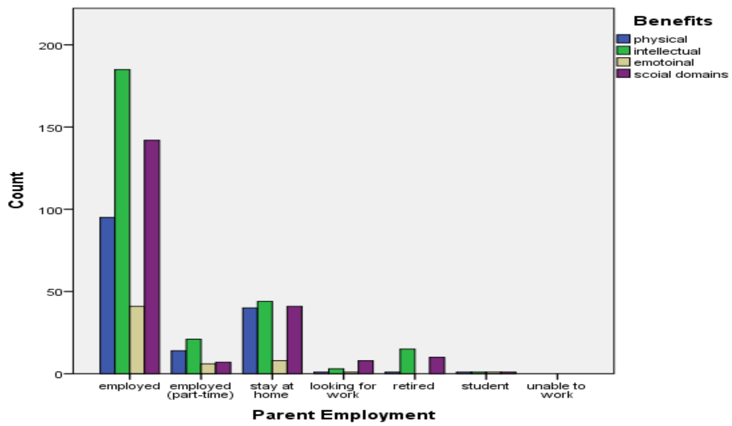

Figure F.3. Distribution of the sample according to the variable parent/guardian employment and relationship with children’s behaviour (benefits).

Figure F.3 shows that the source of difference comes from parent employment category “employed” followed by “stay at home” then “employed part time” then others. The figure shows that the highest class frequency in children’s behaviour “Benefits” is the intellectual domain which indicates that children’s most benefit they get from technology is intellectual development followed by social development. Parents in all employment categories believed that their children benefit intellectually the most, followed by socially and physically.

G.1 There is a statistically significant difference between demographic characteristics parent/guardian “number of children” and children’s behaviour “Benefits” chi-square (21.770, 12); P value (.040) is significant value at (0.05) level of significant. See Figure G.1 below.

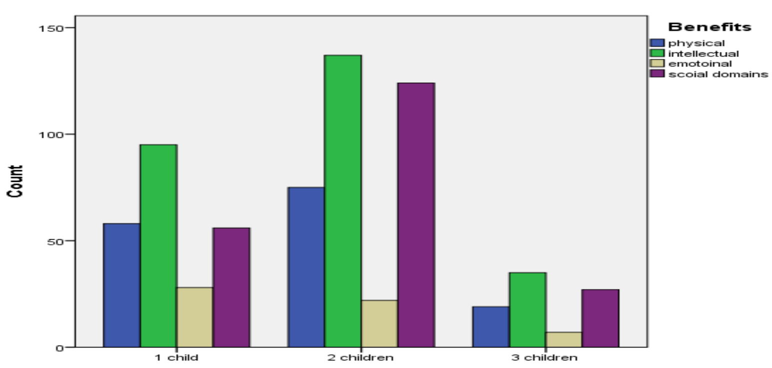

Figure G.1. Distribution of the sample according to the variable parent/guardian number of children and its relationship with children’s behaviour (benefits)

Figure G.1 shows the source of difference comes from parent/guardian “number of children category, “2 children” followed by “1 child” then “3 children”. The Figure shows that the highest class frequency in children behaviour category “Benefits” is the intellectual domain which indicates that children benefit the most intellectually from technologies, followed by socially.

Table 3

The four most frequent developmental domain risks for children in using technological devices as identified by parents/guardians

Developmental Domain	Risks
Physical	- Neck and back pain - Exhaustion - Health problems/ mental problems - Sight problems/Impaired vision - Fingers and joints pain - Laziness - Obesity and related diseases, carpal tunnel or tendinitis - Immobility - Lack of exercise - loses interest in traditional playing
Intellectual	- Difficulty paying attention or focusing - less creative skills or games - Shortens attention span - Degrades verbal and communications skills. - Mental risks -Teaches impatience - Being exposed to videos of pornography, violence, animals, real life car accidents. -Delay in some developmental areas -Tasks can be solved by using an application instead of making an effort. -Impacts cultural values
Emotional	- Addiction, obsession - Emotionally bonding - Increased aggression - Creates dependence - Emotional rollercoaster. - Mixed feelings: laughing, crying. - Develops rage or bad temper. - Postponing praying time -Affects their emotional wellbeing

Social	-Lack of communication with parents and friends - Limits their exploration of the world around them. -limits their interaction with others or among themselves - Less desire to play outdoors - Social isolation -Anti-social -Inability to interact with people and solve problems. - Inability to choose the appropriate vocabulary for social attitudes. - Blocks external world/separates them from the world around them

Table 4

The three most frequent developmental domain benefits for children in using touch screen devices as identified by parents/guardians

Developmental Domain	Benefits
Physical	-educational games that help hand-eye coordination - Applications that require physical activity
Intellectual	-Educational cartoons or games or videos helps in discipline. - learn from cartoon characters of certain shows good behavior and manners. - More aquatinted with things an adult might not know - makes children smarter - Willing to search and investigate more. - Access to interactive educational material. - Technologically savvy for a globalized world - learning alphabets, spelling words, singing songs - Enriches knowledge - Enriches language - learning through play and being exposed to different teaching strategies - Open to new cultures - Allows imagination to expand - Used as a research tool
Emotional	No emotional benefit from the sample’s view point
Social	- Exposed to the world - Connecting with family members living abroad. -Interacting with peers -Peer interaction -Social applications

Discussion and conclusion:

With the advent of technology, young children are consistently being exposed to technological devices at home and in school. There is a sharp disagreement about whether technological devices are harmful or beneficial for children. Thus, this study explored literature review regarding the impact of technology on children's intellectually, social, physical and emotional development, from parents' points of view.

Despite concerns that technological devices have risks on children, the findings of the study have found this to not be primarily the case. In fact, parents concurred that technological devices benefit children in developing intellectually and socially. The former coincides with studies conducted by (Gimbert & Cristol, 2004), (Clements and Samara, 2003) and (Downes, 2002), while the latter is in agreement with studies conducted by (Kumtepe, 2006) and (Downes, 2002). This is evident through social applications that children install on their technological devices, such as Facebook, WhatsApp, Snapchat and peer interaction. This is also evident in Erikson's theory of psychosocial development (1963, 1982) which has implications for early technology use stating that appropriate softwares provide children with an abundance of choices that can be easily used and manipulated by children; and allows them to take initiative in their learning and increases their self-esteem. Lee Vygotsky (1978) also asserted that the technological environment provides for peer scaffolding, by allowing children to work together in a 'shared problem space' in which they complete tasks and solve problems together (Freeman & Somerindyke, 2001).

Parents concurred that technological devices could also have risks on their children's physical development which was number one and could be attributed to the fact that children spend a wealth of time on their smartphones. This coincides with the studies conducted by (Epstein, et al., 2008) and (Choi, & Kong, 2011).

Smartphones were the most used technological devices and the most effective in the sample regardless, the educational level of the parent, age, employment, gender and number of children, which indicates that our modern society is based on smart technology. E-reading, surprisingly, was the least used by the sample, which indicates that the culture we are living in, is smartphones.

Overall, in this study parents seemed to be supportive of children's access and use to technological devices under some limits pertaining to the duration which should not exceed according to them and the literature to two hours daily. Parents appeared to know the potential risks of technological devices but they did not seem to be aware of the importance of their own engagement, guidance and support which could prove to be useful in hindering the risks and negativities associated with technology. Further research is warranted to examine the impact of technology on children in school settings.

Recommendations:

- Parents should encourage their children to read via e-reading, and provide the necessary time and environment for their children to engage in such enriching activities.
- Parents should determine the time period for children who are allowed to use technological devices from 1 hour to 40 minutes on average. Parents should allocate the 40 minutes to e-reading and other educational activities.
- Schools should invest in providing parents with awareness sessions on their children's technological use, the benefits and risks associated with technology and how to integrate ICT in educational settings.

- Parents need to supervise their children regularly and be more involved in their children's use of technological devices by establishing screen free zones at home by making sure there are no technological devices in bedrooms, during family time and dinner time.
- Technology use could be beneficial for children over 3 years of age if monitored properly and if educational activities are utilized instead of games, chatting etc.
- Installing applications that increase emotional needs of children.
- Smartphones were the most used technological devices for fun activities but e-reading was totally disregarded; thus, educators need to increase the awareness of parents to help them install applications that will in turn increase e-reading skills for children to change the culture that does not promote reading.

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Editor's Note: Interaction plays an important role in building motivation, participation, and in confirming what is the correct answer.

Interaction in Distance Education

Maha Alfaleh

Abstract

Distance education plays an important role in facilitating the process of learning all across the globe. It provides the tremendous opportunities of learning to students, as a result of which they become able to access learning materials at any time and from any part of the world and interact with their peers, teacher as well as the content. In this research paper, four important dimensions of learning are explored including interaction among learners, interaction between learner and instructor, interaction between learner and interface and the interaction between learner and content. It has been found that all of these four dimensions have been positively linked with the learning process. These factors play a significant role in the development and maintenance of sustainable communities of distance learning. Also, the purpose of the interaction is examined as well as important motivation factors for interaction in distance learning.

Keywords: distance education, interaction, learning, instructor, learners, content, motivation, learning materials, interaction types, benefits and interface.

Introduction

learning and define as an educational system in which students and instructors do not make face-to-face interactions; rather both parties adopt modes of distance learning to communicate and interact with one another. Moreover, distance education has lots of benefits such as giving learners a chance to learn at their own space and promote the interaction. However, Moore (1989) stated "Interaction is another important term that carries so many meanings as to be almost useless unless specific sub-meanings can be defined and generally agreed upon" (p.1). What he meant by sub-meanings are the interaction between learners and the instructor, the interaction among learners, the interaction between learners and content, and there is another interaction considers new kind of interaction called interaction between learners and technology (interface).

With the emergence of web-based technologies and the Internet, has given rise to the tremendous opportunities to students in gaining education, through online mode of communication and interaction. In programs and course of distance education, the interaction among learners, learners and teacher occurs and the materials of courses are delivered in synchronous or asynchronous manner, over an extensive range of evolving and existing media (Sufiana, 2015). Also, online environment motivate and encourage the social engagement among learners, learners and their instructors, learners and the content if there was motivation factors that encourage them to interact, which can greatly lead to an effective teaching experience.

Purpose of paper

The basic purpose of the paper is to:

- Describe different types of interaction in distance education.
- Investigate the importance of learners\learners interaction, learner\instructor interaction, learner\ content interaction and learners\interface interaction.
- Investigate the relationship between the types of interaction and the motivation factors.
- Recognize the benefit of distance education.

Significance

Distance education is perceived to have great potential in the modern world because it gives a chance to facilitate interactions between students\students, instructors\ students, students\contents and students\technology which leads to improvement in learning through the use of modern and appropriate computer technology. According to Thurmond (2003), “the goal of interaction is to increase understanding of the course content or mastery of the defined goals” (p. 4).

Distance learning is an important tool in progressing the field of education. It is rapidly becoming an important part of the educational hub in developing as well as developed countries across the globe. The tool of distance learning has been globalized to offer unique learning opportunities to large number of students across the world. The progress in technology and growing has led to the needs for the up-gradation of new skills, has increased the interest of learners in distance education and their interaction with the online environment (Marija, 2012).

Literature review

In the settings of distance education, according to Saba (1999), “What is important is communication and construction of knowledge” via online interaction (para. 6). Interactions can be divided into numerous ways. In distance education, interactions can be classified into three different ways (Moore, 1989), which consider important part and integral part of the cross-reactivity process via distance education. These mainly include 1) interaction between two learners, 2) interaction between instructor and learner and 3) interaction between content and learner (Moore, 1989). Another new kind of interaction, which is also called as the interaction between interface and learner was later on suggested in the research literature. Also, some studies said that the “vicarious interaction” considers also new kind of interaction but there is not much discussion about it in the current literature. Sutton (2000) defines vicarious interaction as occurring “when a student actively processes both sides of a direct interaction between two other students or between another student and the instructor” (p. 4).

It has been theorized by Meg (2013), that “deep and meaningful formal learning is supported as long as one of the three forms of interaction (student/teacher, student/student, student/content) is at a high level” and that “the other two may be offered at minimal levels or even eliminated without degrading the educational experience” (p. 19).

What does interaction in distance education mean?

Wagner (1994) said, “Interactions are reciprocal events that require at least two objects and two actions. Interaction occurs when these objects and events mutually influence one another” (p. 8). So, in this case interaction will not happened if there is no at least two type of interaction. Interaction is not limited to as before on classroom just. Those days, interaction became one of the important parts on the distance education environments to get effective and useful outputs if the instructions were designed well. Also, Daniel and Marquis (1988) stated that the interaction is “the student is in two-way contact with another person in such a way a to elicit from them reactions and responses which are specific to their own requests and constructions” (p.32).

Types of iInteraction

Learner-interface interaction

Hillman, Willis, and Gunawardena (1994) described a type of interaction called “Learner/interface interaction” and they defined it as the “Process of manipulating tools to accomplish a task” (p. 34). They meant that learners deal with the technologies to be able to interact with their peers or their instructors. For that learners and instructors must be skilled on using the technology to be able to interact effectively on the distance-learning course. Also, Hillman, Willis, and Gunawardena (1994) pointed out this kind of interaction considers the most challenges one because the learners have not faced this kind of interaction in their face-to-face classroom.

The interaction between interface and learner is considered to be an important variable in the field of distance education. It is a construct that examines the association between technological skills of the learner and the capability of technology to bear content of course and its easy retrieval. It has been suggested by past research studies that constructive and frequent interaction between students and instructor and a flexible discussion among learners can impact the success of distance education (Kyung, 2005).

In distance education, a number of computer technologies used instructional software such as Blackboard and Canvas. Also, the tools of the Internet are classified in relation to the kinds of interaction made between learners in the process of education. These mainly include: interaction between instructor and students in the process of education, interaction between instructor and students while information is searched by them, through the use of internet. According to Hillman et al. (1994) "the interaction that occurs when a learner must use these intervening [internet communication] technologies to communicate with the content, negotiate meaning, and validate knowledge with the instructor and other learners" (p. 30-31). Also, Anderson and Garrison (1998) note "the opportunity for learners to interact with the learning content provided by other teachers is increasing dramatically as a result of the WWW" (p. 108).

Interaction among learners

Interaction among learners means, "Student/student interaction includes communication among classmates for the purpose of completing a course related activity and informal discourse about class subject matter" (Meg, 2013, p.15). The communication and interaction could be between two, three or more than that among learners in specific online course or materials.

The learner-learner interaction takes place online, face-to-face as the premises of a traditional classroom (Stuart, 2013), but in distance education, all the interaction will be online only either synchronous or asynchronous inside the educational environment. It has been reported by Aggeliki (2017) that feelings of the students about making interactions with their classmates online, impact the level of their cooperation with them. In this scenario, the learner does not readily acquire the autonomy.

The good course design theme was, the better results of the interaction between learners would appear. For instance, instructors, as apart of grade, required learners to read each other post and make arguments about what they like, what they do not like and why? In this way, the instructor will involve, engage and include all learners in interaction.

Interaction between learners and content

The interaction will be between the format of learning course that provides by instructors or trainer via for example video or audio format, reading articles or journal in digital format, completing activities and between learners. If the learning course or the content built effectively and build based on the difference of learning style for the learners so, that will impact positively on the learner understanding about the specific subject (Kyung, 2005).

Brown and Voltz (2005) illustrated that "educational materials that have been effectively designed will facilitate the achievement of desired learning outcomes for students" (p.1). In online course, to sure that students or learners will complete the online course successfully the online contents must be completed (including assignment, activities, supporting materials, scenario motivates learners to perform, feedback, etc.) and include all the information learners need (detailed content) to be able successfully pass the course (Siragusa et al., 2007).

Interaction between learners and instructor

The interaction between instructor and learner includes, but is not particularly restricted to general dialogue and the techniques of a question and answer session that is relevant to the specific topic (Stuart, 2013). It calls upon the need, where instructor makes necessary effort to modify their personal objective with respect the objectives of learners. In this relationship, the instructor usually leads and trains learners to take the control of their own studies (Aggeliki, 2017). Daniel and Marquis (1988) note that the interaction between learners and instructors "tend to increase in direct proportion to the number of students" (p. 342) in a given specific distance course.

Moreover, developing face-to-face interaction in online course via using Webex (video) for example is an important factor in creating educational community of learners. Instructors are believed to an important source of facilitating interaction; therefore they are called as interaction and communication facilitators. They play an important role to facilitate, encourage and foster communication and interaction among learners.

Purpose of interaction

The purpose from learner-interface interaction is to help learners reach to the content easily from anywhere and anytime as well as interact and communicate with their peers to exchange the information. Also, via learner-interface interaction, learners can reach and interact with their instructors. In case the students do not know how to deal with technology interface so they will not be able to interact with the content, their peers and their teachers.

The purpose from learner-instructors interaction from the perspective of distance education, an important role has been played by the instructor in developing and promoting an effective pattern of communication and interaction between students. This helps them to promote a sense of community in an educational setting. Also, the purpose from learner-instructors interaction an immediacy behavior of the teacher such as dialog, feedback, and motivation, can give rise to the individualized form of instruction. Moreover, instructors play important role by encourage, motivate, support, stimulate interest for each student to learn. Additionally, the interaction between learners and the instructor can help learners to develop positive emotions of relief, satisfaction, and excitement, which assist them to achieve the goals of learning in short time span (Aggeliki, 2017).

The purpose from learner-content interaction will help the learners to build new information under certain process in distance education and According to Moore and Kearsley (1996), "every learner has to construct knowledge through a process of personally accommodating information into previously existing cognitive structures" (p. 128). This kind of interacting will leads to "changes in the learner's understanding, the learner's perspective, or the cognitive structures of the learner's mind" (Meg, 2013, p.25).

The Purpose from learner-learners interaction has been indicated in past research studies that learner-learner interaction finds its worth in the distance education in the application and evaluation. This kind of interaction enables the direct pattern of communication between students or learners, in which each learner becomes able to share the thought, opinion, ideas, information, and receive feedback about a particular topic given by instructors with each other. Damon (1984) observes that "intellectual accomplishments flourish best under conditions of highly motivated discovery, the free exchange of ideas and the reciprocal feedback between mutually respected individuals" (p. 340).

Motivation factors in interaction

The relationship of motivational components with academic performance and self-regulated learning has been studied by Pintrich and De Groot (1990). They classified the components of motivation to be of three types:

1. Expectancy component: It pertains to beliefs of students about the possibility of success in executing a task or activity.
2. Value component: It refers to the beliefs and appreciation of students to which they consider a task to be important for them.
3. Affective component: It involves the emotional reactions of students towards a particular task.

Pintrich and De Groot (1990) stated that the three components of motivation are related to the academic performance and cognitive engagement of students (Sheila, 2013). However, some previous researches said that those three main components could be expanded to six motivation variables which are intrinsic and extrinsic goal orientation, self-efficacy, control beliefs, task value and test anxiety. However, if the motivation factors are not present so the types of interaction will not work well as the way it should be on it.

Instructors need to build an interesting and useful course or content to learners to encourage and motivate them to participate in the course. According to Moore (1989), during student-instructor interaction, the instructor seeks ‘‘to stimulate or at least maintain the student’s interest in what is to be taught, to motivate the student to learn, to enhance and maintain the learner’s interest, including self-direction and self-motivation’’ (p. 2).

When learners participate and interact in a specific task, there are many reasons motivated them to do that such as the course is interesting and carry lots of useful information for them, want to gain grades, need someone to measure their performance and evaluate their work. Also, what motivate them to engage in the task that they are willing to challenge themselves to do all the required task and deliver it on time. If the course offers useful information for learners, learners will feel that their efforts to engage in the course will result in positive outcomes.

The benefits from distance education

All around the world, the system of higher education has been converted to a new mode that makes extensive use of social media and tablets, mainly for the purpose of carrying out a wide range of learning and teaching activities. It has been reported by Kim & Bonk (2006) that an important role has been played by technology in the expansion and development of online education. The way technology is used for learning and teaching activities has positively influenced the process of education. Such kind of technology adoption has enhanced ODL’s (Open and Distance Learning) popularity among students, as it provides accessibility and flexibility to a large number of learners across the globe.

With the use of various technology tools, it becomes easier for the college administration to deal with a large number of students all across the globe (Botham & Mason, 2007). Through the use of technologies, higher education can be transformed in different ways. Fundamental shifts in assessment, content, and methods of instruction are enabled by the use of digital technology (West, 2012). For online learning and teaching, the benefits of technology’s use are well documented in past researches. A few of them are enlisted as follows.

Self-paced learning

Through distance learning, an opportunity is offered to learners so that they may become able to learn anywhere and at any time. It has been reported by Hegarty (2006) that the benefits of using various technologies of learning have been identified by students. These mainly include the ability to learn with fun, to learn independently and at their own pace. With the use of online learning technologies, it becomes easier for students to access learning materials through mobile devices or computer. This trend has offered greater learning opportunities to students from all across the globe.

Promotes interaction

Through the use of online technological tools, various opportunities are offered to learners that encourages interaction between instructor and learners. The use of such technological tools proves to be of great help in strengthening the interaction between students. It has been demonstrated in past research studies that learning process is improved, when interaction is developed between different subjects in an educational institution (Mayes, Luebeck, Ku, Akarasriworn, & Korkmaz, 2011). Moreover, interactions prove to be of great help in achieving the outcomes of learning, as a result of which successful pattern of learning is ensured.

The two-way communication and the use of interactive technology have proven to be effective in developing and strengthening the strong relationship between online learners (Hyo-Jeong, 2010). Interaction among learners can improve the process of learning and promote motivation among students. It has been reported by Ivy (n.d.) that online programs (with high interactivity level) can result bring improved outcomes of learning for students.

It has been demonstrated in past research studies that learners show best academic performance when they become actively engaged with the content and curriculum of online courses. The outcomes are the learners with greater levels of engagement and motivation.

Opportunities for real-time student assessment

Technology enables the instructor to examine, evaluate and monitor the content of their learners on a frequent basis. It also helps them to measure the performance of students in terms of the participation of students in the forums of discussions. The performance of learners can also be measured through the amount of time that is spent by a learner on the platform of virtual education. With the help of digital technology, it can easily be examined that how much time is spent by learners in gaining a mastery of important concepts (West, 2012).

Conclusion

With the evolution and growth of distance education learning, a better insight is to be gained by educators, in having better knowledge about the effectiveness of developing interaction between learners, between instructor and learners and between learners and the content of online education. Four important dimensions of interaction have been reported to affect the learning and engagement of learners in a positive way because “the goal of interaction is to increase understanding of the course content” (Thurmond, 2003, p. 4).

Some learners face problems using distance education courses because some teachers have lack knowledge about how to make the online course effective and make learners benefit from this course by interaction. There are many ways to facilitate interaction in distance learning but that depends on how the instructors design the instructions and how to “adapted to integrate various types of interactions, each with a specific purpose and intended outcome” Moore (1989, p. 2). However, increasing awareness and understanding of the design process maybe help and provide framework why and when we need to corroborate interaction in distance education. So, it would be better to emphasis instructional design process as a way to consider when interaction maybe helpful and feasible.

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Editor's Note: Energy savings are becoming a critical item in selecting how and when to use one technology as compared to another. This example compares energy requirements for online as compared to regular on-campus academic programs.

A comparison of the environmental costs of UK campus-based and online academic programmes

Chris Garbett

UK

Abstract

This paper considers the environmental costs of online University programmes compared to the environmental costs of traditional campus-based face-to-face courses. Using both qualitative and quantitative analysis, it was found that the online programmes have much lower environmental costs than face-to-face programmes. The environmental savings come from; reduced fuel emissions including reduced commuting costs, reduced emissions from buildings, and reduced waste.

Keywords: distance learning, environmental costs, emissions, costings.

The aim of this paper

Whilst there has been some research undertaken into the relative costs of face-to-face campus-based courses compared to distance learning courses; there has been little research into the externalities or environmental costs of the two alternative modes of delivery.

An earlier paper by the Author (Garbett, 2017) comparing the different overall operational costs of traditional campus-based Institutions and distance learning institutions found a significant institutional cost saving for distance learning institutions. The aim of this paper is to use published data from the UK to compare environmental costs incurred by different institutions.

Literature review

In a study by the University of California and Humboldt State University 500 students on three different campuses were surveyed as to their car use in driving to campus. The study found significant environmental benefits in distance learning courses arising mainly from reduced travel costs. (Campbell, 2011).

The major work considering the comparative environmental costs of distance learning and campus-based courses were considered in depth by the Open University (Roy & Potter, 2008). It is worth quoting a summary of their findings

> *"Distance learning, HE courses involve 87% less energy and 85% lower CO2 emissions than the full-time campus-based courses. Part-time campus HE courses reduce energy and CO2 emissions by 65% and 61% respectively compared to full-time campus courses. The lower impacts of part-time and distance compared to full-time campus courses is mainly due to a reduction in student travel and elimination of much energy consumption of students' housing, plus economies in campus site utilisation. E-learning appears to offer only relatively small energy and emissions reductions (20% and 12% respectively) compared to mainly print-based distance learning courses, mainly because online learning requires more energy for computing and paper for printing."*

Methodology

This paper utilises qualitative and quantitative data.

Primary qualitative research was by means of Focus Groups in the author's home institution. The focus groups consisted of experienced Higher Education Teaching practitioners, all of whom have been recognised by the University as Teaching Fellows. The Focus Group was asked firstly to identify cost headings. The group was then asked to comment on the comparison between costs of different forms of delivery. The responses have been reviewed using a Red, Green, Amber (RAG) analysis.

Quantitative research was undertaken by analysing UK data from Higher Education Statistics Authority (HESA). HESA produces very detailed data on Institutional costs for UK HEI. UK data has been used as: it is readily available, and the author has first-hand experience of the UK HEI environment. Data analysis was restricted to UK data as it is beyond the capacity of the author to undertake similar analysis of non-UK data.

Qualitative data

A first iteration of the cost headings was distributed amongst the focus group. From the feedback from this focus group; the following cost classifications were produced:

Environmental Costs (externalities)

This cost heading considers the costs borne by the community at large. Essentially, these are the environmental costs of students undertaking their studies.

Included in this heading are:

Environmental costs of the University premises

Environmental Costs of server and on-line storage

Printing

Travel costs

First Iteration

Modelling the costs

As a first iteration, the cost headings were tabulated to compare the web-based distance learning costs against the traditional face-to-face delivery costs.

Table 1
Cost Identification

Costs incurred for web-based distance learning	**Costs incurred for face-to-face delivery**
Environmental Costs	
Servers, on-line storage	Servers, online storage
Student printing	Staff printing, hand-outs
Property-related energy costs/emissions	Property-related energy costs/emissions
Journey to University (staff)	Journey to University (Staff and students)

Second iteration

Comparing costs

The various cost items are then compared using a Red Amber Green (RAG) methodology.

Where the costs are considered to be the same between the two modes of delivery, the item is coded green. If there is a significant difference in costs between the two modes, the higher cost mode is coded red. If there is a slight difference in costs between the two modes, the higher cost mode is coded orange.

Table 2
Distance learning costs compared to face-to-face delivery costs

Costs incurred for web-based distance learning	Costs incurred for face-to-face delivery	Comments
Environmental Costs		
Servers, on-line storage	Servers, online storage	Arguably, there may be less on-line storage required for face-to-face programmes than for distance learning programmes. However, as all programmes use the VLE, any incremental increase will be *de minimus.*
Student printing	Staff printing, hand-outs	This is a transfer cost. Face-to-face students may be supplied with printed hard copy hand-out. Distance learning students may or may not opt to print materials themselves.
Property-related energy costs/emissions	Property-related energy costs/emissions	Distance Learning (DL) programmes have little or no requirement for teaching or student accommodation.
Journey to University (staff)	Journey to University (Staff and students)	DL courses incur no travel costs because student commutes. Staff may work from home and, again, incur little or no commuting costs.

Even without populating the cost model; it is clear from the table that there are significantly more costs associated with face-to-face delivery, than with distance learning delivery.

As the programme is delivered off-campus, the only accommodation costs incurred are those of staff accommodation. As was pointed out by some members of the focus group, even these costs may be eliminated from the overall cost matrix, if staff work from home. (clearly there will still be a cost in that staff member will need to heat and light their room at home, but this element is considered de minimus to the overall cost matrix).

Quantitative data

Quantitative research was undertaken by analysing UK data from Higher Education Statistics Authority. The UK Open University exclusively delivers distance learning education. Data from the Open University is compared to data from other institutions. It is fair to say that most other HEI now also provide some distance learning programmes, but for the purposes of this comparison, the effect of distance learning programmes on the overall environmental costs of HEI, other than the Open University, is minimal.

HESA statistics

HESA collects environmental data under 205 different cost headings, for each Higher Education Institution (HEI). For the sake of simplicity, this paper will consolidate the environmental data into five different headings:

- Total Energy Consumption in kWh
- Total Scope 1 & 2 Green House Gas (GHG) Emissions
- Carbon Emissions other than from Staff and Student Commuting
- Total Waste.

GHG emissions are classified by the Greenhouse Gas Protocol as:

- "Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities (e.g. T&D losses) not covered in Scope 2, outsourced activities, waste disposal, etc." (GreenHouse Gas, n.d.)

Data selection

The HESA statistics cover all UK HEI. In order to compare like with like, and in accordance with the previous paper, it was decided to exclude certain institutions from the data sets. Some Higher Education Programmes incur more costs than others; or are inherently not suitable for distance learning. Institutions providing courses in the following subjects were excluded from the comparison.

- Medicine
- Veterinary Medicine
- Agricultural studies
- Fine and Performing Arts
- Aeronautical Engineering
- Nautical Studies.

Data has been analysed over three academic years to provide a longitudinal study.

- First Iteration of Data
- 2013/14 Academic Year.

NB. HEFCE statistics for student headcount excludes distance learning students. The data for Open University student headcount is taken from the author's previous paper (Garbett, 2017) and ultimately from the Annual Reports

Table 3
Environmental costs of UK HEI 2013/2014

UKPRN	Teaching student headcount	Total energy consumption (kWh)	Total scope 1 and 2 carbon emissions (Kg CO_2e)	Total Emissions from fuel	Total Scope 3 emissions other than commuting	Total waste mass (tonnes)
10000571	6355	8,607,749	2,773,193	5,516,244	56	237
10007850	11035	64,732,746	19,230,813	40,553,118	374	2,974
10007152	14305	20,389,218	7,393,167	14,765,626	28,891	1,221
10007760	14420	11,032,200	3,916,364	7,832,729	70	282
10007140	20090	38,939,250	12,425,798	24,832,478	30,145	3,159
10000712	4485	12,064,495	4,248,498	8,487,887	72	1,759
10007811	2230	3,246,722	1,040,857	2,066,075	461,272	472
10006841	5160	10,109,886	3,096,887	6,190,236	48	1,035
10000824	13175	18,146,093	6,577,017	13,149,545	28,879	5,412
10007785	10940	28,859,085	7,863,318	15,688,019	21,955	745
10000886	18185	36,702,206	11,414,954	22,755,631	28,743	1,309
10000961	11125	60,592,205	18,690,634	37,351,786	26,800	1,347
10000975	7630	10,797,400	3,971,084	7,935,490	55	533
10001143	14320	21,473,319	7,357,115	14,690,800	40,088	951
10007848	11720	31,248,543	8,835,408	17,919,060	120	31,124
10007137	5110	9,493,183	2,853,004	5,685,925	69	587
10001478	14020	20,414,398	7,959,161	15,910,837	1,204,969	1,192
10001726	23315	39,119,647	12,459,756	24,881,722	120	1,371
10007842	8165	18,357,258	5,158,709	10,276,760	61	1,901
10001883	16450	28,076,669	9,656,890	19,886,133	17,236	889
10007851	13310	30,319,123	9,793,712	19,502,601	138	1,443
10007143	14810	109,414,216	32,250,990	64,388,527	656	3,433
10007144	15090	21,203,585	7,724,350	15,421,275	14,728	861
10007823	14885	25,078,672	7,155,299	14,269,933	126	773
10007791	9830	51,173,855	16,068,054	32,107,384	21,169,82 2	3,204
10007792	3845	13,006,931	4,532,695	9,005,533	1,699	685
10008640	6890	11,553,451	3,493,511	6,962,742	7,600	409
10007145	7645	18,880,825	5,333,164	10,660,004	122	2,439
10002718	16425	26,944,053	8,734,353	17,423,092	60,661	984
10007146	19725	41,295,817	21,922,846	37,026,640	30,253	10,893
10007147	635	2,654,195	803,545	1,607,090	9	399
10007765	15815	26,519,795	9,381,741	18,734,237	64	448
10007148	15605	58,956,909	17,389,468	34,723,819	33,770	3,234
10007149	4310	8,698,529	2,851,029	5,527,378	48	198
10007150	16555	54,225,164	15,821,109	30,628,199	435	2,228

10003645	22890	124,307,843	42,607,003	85,206,233	197,811	3,559
10003678	19060	40,954,220	13,564,871	27,100,407	75,302	1,005
10003861	22240	41,517,807	14,409,835	28,672,073	19,978	3,122
10003863	3240	7,314,778	1,997,631	3,916,318	55	171
10007151	12355	24,923,821	8,224,863	16,436,847	35,698	2,252
10003956	5825	16,207,257	4,767,573	9,521,942	8,645	707
10007769	1590	9,231,041	3,357,342	6,714,131	39	411
10004048	14345	20,610,288	6,586,457	13,698,744	11,960	882
10004078	16415	26,486,187	8,924,354	17,839,144	59,204	689
10004063	9805	40,355,061	13,860,058	27,720,115	41,397	1,878
10004113	13030	89,771,834	23,792,852	47,478,185	48,399	2,770
10004180	29485	51,762,213	17,555,901	35,085,325	39,717	7,195
10004351	16655	16,584,420	6,022,932	12,391,482	24,266	440
10007799	19085	136,557,904	43,965,219	87,503,206	40,677	2,339
10007832	2835	4,373,781	1,247,200	2,494,400	16	76
10007138	11305	24,217,159	7,048,112	14,093,115	120	761
10001282	23885	58,367,140	19,392,993	38,729,616	65,302	1,342
10004797	22930	51,276,626	16,949,528	33,803,473	35,132	5,714
10004930	14335	49,310,785	14,552,494	29,041,172	439	2,078
10007155	18725	39,988,914	14,447,753	28,754,001	311	1,422
10005389	1850	3,703,502	1,583,972	3,167,943	2	86
10007776	8180	22,109,088	6,563,519	12,751,231	130	2,089
10005523	620	1,733,441	558,303	1,116,606	122	131
10005553	8480	37,137,475	11,927,677	23,767,637	182	910
10007843	4940	11,106,259	3,118,901	6,229,835	523	600
10007156	16380	38,676,582	12,650,288	25,256,343	4,292	1,073
10007780	4670	5,706,404	1,837,260	3,674,521	44,658	621
10005790	27275	33,676,219	12,565,748	25,093,985	175	791
10006299	13510	30,757,542	11,062,737	21,419,672	143	834
10037449	2520	8,642,702	2,606,632	5,206,237	945	268
10014001	3450	5,241,801	1,850,165	3,699,289	6	203
10007159	12535	27,801,489	9,589,537	19,160,274	144	761
10007161	13960	24,772,306	8,109,741	16,191,407	74	475
10007784	23180	187,564,821	63,341,590	126,675,575	1,387,455	4,581
10007164	22905	52,944,647	17,428,349	34,806,401	353	12,640
10006566	9750	7,753,313	3,260,821	6,524,485	27	573
10007165	18425	41,273,308	13,128,475	25,816,218	32,238	4,773
10003614	6385	11,505,945	3,593,136	7,134,148	114	692
10007166	16690	40,678,838	12,140,090	24,084,373	26,031	2,514
10007139	8300	15,198,411	4,636,027	9,239,836	7,950	633
10007657	765	6,515,630	2,011,655	3,923,380	50	876

10007713	5635	11,294,369	4,037,370	8,065,372	1,762,923	486
10007857	9840	34,667,713	11,668,868	23,145,585	364	792
10007854	9185	17,087,550	5,312,072	10,464,540	80	681
10007833	6295	12,088,204	3,652,826	7,620,639	33	294
10007858	9605	27,355,041	7,734,838	15,469,675	55	871
10007793	23405	48,064,230	15,026,763	29,984,982	166	1,258
10007849	4570	10,773,422	3,244,054	6,470,333	18	
10007772	10505	17,917,198	6,048,218	12,281,018	147	2,095
10007762	14575	21,655,497	6,396,591	12,782,640	218	547
10007764	7700	56,361,660	16,987,356	33,818,741	22,455	1,945
10005337	4875	6,084,322	2,515,186	5,029,431	21	114
10005500	8790	35,343,386	10,792,147	21,569,940	383,321	1,602
10007804	8540	45,408,053	13,671,383	27,252,503	9,823	1,001
10007805	17255	92,098,660	29,313,479	58,586,736	52,721	
10007800	13860	28,801,172	8,721,612	16,310,897	81	
10008026	1185	2,219,237	769,079	1,535,701	7	86
10008010	1495	8,850,173	1,977,750	4,017,455	28	93
10007807	18155	50,119,199	14,613,993	29,207,058	32,939	825
Mean Average Excluding Open University		31,990,801	10,313,848	20,522,523	294,528	1,953
10007773 The Open University	206,300	37,606,230	12,992,233	25,900,145	68	1,617
Open University C/F Average		117.55%	125.97%	126.20%	0.02%	82.78%

2014/15 Academic Year.

UKPRN	Teaching student headcount	Total energy consumption (kWh)	Total scope 1 and 2 carbon emissions (Kg CO_2e)	Carbon Emissions from Staff and Students commuting (tonnes CO_2e)	Total waste mass (tonnes)
10000571	6475	12,579,084	3,549,000		314
10007850	11365	69,857,847	23,183,951		2,236
10007152	12560	21,474,655	6,899,678	1,650	1,179
10007760	12920	10,506,595	3,659,994		140
10007140	20825	40,004,130	11,993,389		4,450
10000712	4415	13,405,060	4,532,658		2,197
10007811	2210	3,317,629	996,589		681
10006841	4905	10,945,603	3,120,625		1,068
10000824	13145	18,516,142	6,396,023		4,074
10007785	10080	28,601,737	7,726,497	3,432	513
10000886	18705	35,871,895	10,737,353		1,368
10000961	10740	62,427,628	18,210,955	4,662	1,280
10000975	7495	11,325,918	3,902,634		598
10001143	13280	23,272,477	7,348,201	490	1,038
10007848	12155	63,575,126	17,582,024		1,139
10007137	4990	10,192,910	2,865,950	2,288	1,073
10001478	14475	28,868,848	7,174,744		1,375
10001726	24955	41,781,765	12,823,203		1,690
10007842	7630	18,772,518	4,964,015		1,125
10001883	16330	27,402,659	9,033,254	6,157	831
10007851	12930	31,566,699	9,734,390		776
10007143	15380	113,177,627	31,654,424		2,908
10007144	13170	21,502,248	7,311,470		836

10007823	13855	25,451,286	7,217,149		1,268
10007791	10795	48,669,377	14,392,129		1,746
10007792	17980	69,530,637	21,776,282		972
10008640	4125	11,152,488	3,721,091		298
10007145	6770	12,353,693	3,560,291	2,864	401
10002718	7720	17,430,147	4,808,764	518,923	1,901
10007146	15995	31,059,784	9,868,769	2,678	914
10007147	19945	56,615,419	24,327,670	53,745	6,033
10007765	570	2,766,002	815,372		454
10007148	15915	26,436,382	8,675,927	1,474	414
10007149	14640	63,838,773	17,698,766		9,241
10007150	16550	55,633,726	15,566,060		2,197
10003645	23960	120,167,977	39,416,011		1,206
10003678	18535	38,362,724	12,176,295	10,665	958
10003861	23045	39,581,170	13,150,253	5,878	2,761
10003863	3250	7,686,962	1,814,009	1,863	176
10007151	11320	26,218,433	7,952,316	5,317	1,116
10003956	5385	16,386,985	4,544,713	2,317	6,078
10007769	1645	9,613,148	3,070,412		395
10004048	12160	20,546,622	6,554,474		483
10004078	15880	26,250,605	8,327,384		725
10004063	10195	40,531,531	12,998,344	1,367	2,194
10004113	12755	91,477,305	23,610,182	2,848	2,318
10004180	234615	53,847,111	17,655,571	13,079	2,197
10004351	14980	20,569,312	7,239,152	34,714	425
10007799	19615	132,499,869	41,028,990	2,933	2,832
10007832	2645	4,620,401	1,209,514		76
10007138	11340	26,051,303	7,072,128		788
10001282	23165	63,158,507	19,786,997		1,234

10004797	23505	46,133,923	14,902,315	7,857	1,305
10004930	14035	46,926,561	13,141,600	15,308,680	1,543
10007155	18585	41,349,718	13,961,189		1,226
10005389	2025	4,452,045	1,651,492		88
10007776	7585	21,796,396	6,145,139		2,053
10005523	660	1,716,432	521,086	167	128
10005553	8820	39,850,652	11,855,280		1,338
10007843	5135	11,090,151	3,024,011		643
10007156	16870	37,564,885	11,970,261		1,043
10007780	4620	5,925,881	1,549,390		506
10005790	26585	35,996,037	12,531,838		1,041
10006299	11400	35,477,253	11,008,583		956
10037449	2300	8,621,014	2,413,949	847	225
10014001	3350	5,301,559	1,753,779		119
10007159	11745	27,013,576	8,786,073	6,658	774
10007161	12815	25,675,504	8,093,069		462
10007784	29050	217,697,759	68,697,500		5,473
10007164	23010	54,060,058	16,743,469	180	23,869
10006566	9435	10,469,910	3,620,229		1,171
10007165	18845	40,289,089	12,021,361	1,817	1,160
10003614	7040	10,903,411	3,280,063		766
10007166	16580	44,939,164	12,321,350		2,603
10007139	8025	14,917,695	4,407,025	5,683	777
10007657	745	6,614,897	1,944,258		880
10007713	5795	12,049,207	4,258,083		512
10007857	9915	36,321,936	11,459,218		748
10007854	9220	16,453,458	4,887,922		652
10007833	5110	12,207,959	3,730,029		294
10007858	8530	27,077,706	7,442,535		687

10007793	21060	49,394,228	15,920,033		1,322
10007849	3945	12,157,839	3,315,173		
10007772	10720	18,268,503	5,763,452	21,884	2,096
10007762	14255		6,686,028	16,607,950	670
10007764	7940	58,031,644	16,575,515		6,179
10005337	4760	10,621,075	2,764,575		221
10005500	8705	29,960,674	8,881,129		1,233
10007804	8600	39,774,435	12,155,988		1,136
10007805	19035	98,406,986	29,791,659	18,441	588
10007800	14010	28,767,671	8,294,263		447
10008026	1150	2,023,915	627,573		89
10008010	1550	9,486,687	2,164,219		112
10007807	20430	51,257,959	14,084,354		777
Mean Average Excluding Open University	14102	34,241,935	10,431,724	1,020,610	1,641
10007773 The Open University		37,590,754	12,100,564		1,593
OPEN University C/F Average		109.78%	116.00%		97.07%

Table 4
Environmental costs of UK HEI 2014/2015
2015/16 Academic Year.

UKPRN	Teaching student headcount	Total energy consumption (kWh)	Total scope 1 and 2 carbon emissions (Kg CO_2e)	Carbon Emissions from Staff and Students commuting (tonnes CO_2e)	Total waste mass (tonnes)
10007849	3745	10734720	2812733.0		59.85
10007857	9810	38550858	11190139.8		856.7
10000571	6980	12837860	3332746.5	3251.326	383.197
10007850	12210	71726548	21094499.8		2117.2

10007152	11840	20495573	5945999.0	1650.33	445.058
10007760	11475	10841457	3258751.5		199.681
10007140	21275	41287398	11403960.0		35181.52
10000712	4570	13001500.7	4009624.1		2287.3
10007811	2205	1575247	607814.8		330.321
10006841	4900	11163572.39	3047192.5		1074.3
10000824	14775	17953860.23	5489703.1		1031.26
10007785	9720	30898058	7749068.9	3432	351.7
10000886	18860	34866224	9796153.9	6284.403	11695.428
10000961	10715	59962373	16597222.9	4570	1469.83
10000975	6835	11957125	3617049.2		432.238
10001143	13395	23938758.37	7079024.1	450	974.07
10007854	9355	15909605	4463292.7		671.099
10007848	12480	49538264	13689228.3		869.166
10007137	4990	10221720.6	2701726.0	3400.541	551.76
10001478	14860	30567376	7643568.1		937
10001726	26905	48034543.5	12660085.5		1965.24
10007842	6490	17334488.28	4367504.2		1178.721
10001883	17535	29428770.63	8882424.4	6138	651.12
10007851	13105	32626240	9342355.1		848.54
10007143	15570	114153428	30009226.4		3325.927
10007144	11635	20413989.68	6511954.5		641.81
10007823	12570	26020287.16	6995536.2		1353.924
10007772	10410	19376523	5489311.8	21883.9	2645.1
10007791	10900	49241311.26	13807161.0		1480
10008640	4515	12620843	3831066.2		
10007762	10735	19159563	7475809.2	9026.86	467.49
10007145	6925	10802826	2970048.4	2858.703	437.939
10007833	4510	12058887	3391140.6		226.519
10002718	8000	15348171.31	4062001.2	518923	1497.259

10007146	15860	29224772	8614279.6	2647.671	1026.491
10007764	8095	57178508.6	15380854.5		3194.51
10007147	19790	43676462	19544733.3	54759	3315.77
10007765	460	2320743.85	673639.7		441.914
10007148	15955	26207578	8151825.7		523.872
10007149	14630	64146590	16628805.7		8849.453
10007150	16825	57033869.03	14917760.8		2292.175
10003645	23600	127972473	39012827.2		2863.92
10003678	17675	35416170	10280021.9	9451.275	1055.76
10003861	22985	37315285.48	11565565.9	4539.825	3212.548
10003863	3550	8160223	1951418.5	1862.679	167.518
10007151	11695	26658669	7965796.1	6446	19908
10003956	4620	15592716	4133275.7	1648.156	118744.66
10007769	1720	9359142	2862456.4		379.67
10004048	11235	19334451.3	5782146.7	16.899	723.996
10004078	15550	23566541	6843198.8		949.115
10004063	10235	36536115	10948600.2	1369.7	13619.673
10004113	13730	90771703	22220235.4	2202.297	2234.18
10004180	255707	52480904.3	15779784.0	13002.257	6958.366
10004351	16360	18557300	5926780.5	3219	419
10007799	20375	123451073	35427599.8	2869.782	3183.078
10007832	2750	4273372	1063595.5		76
10007138	11135	24573764	6411939.4		726.61
10001282	22765	58847992	16864530.6		1288.21
10004797	24600	46600769.38	14013991.2	7857.31	1732.857
10004930	14635	47713467.43	12379799.3	15308.68	1409.044
10007155	18950	41191796.06	12799787.4		1102.991
10005337	4730	11602226	2227822.3		214.711
10005389	2155	4452411.48	1502093.0		88.984
10005500	8665	30836705.34	8327772.2		990.26

10007776	7860	21215286	5833597.3		14617.966
10005523	655	2533460	667207.3	160	157.5
10005553	8905	40345166	11056608.8		1551.305
10008026	1025	2497361	585703.0		90.77
10007843	5280	10929592.99	2817860.7		741.33
10007156	17845	30404242	9157063.0		6658.589
10007780	4795	5700453	1524327.9		526.709
10005790	27105	37762646	11784319.9	120623.199	834.904
10006299	10530	27704334	8322029.7		2287
10007804	9315	49502141	11718899.6		1324.8
10037449	2265	8738903	2270877.7	762.101	193.891
10008010	1435	9201059	2041058.7		75.093
10007805	18075	100650802	28307051.9	18441	588
10014001	3370	6151539	2032563.2		126.117
10007159	10505	26338951.68	7909025.3	6657.858	7490.054
10007161	13100	25897096	7585901.0		534.135
10007858	8075	25755469	6693130.4		546.73
10007807	19920	49443137.2	12964484.9		659.96
10007784	29865	222626370.8	66780500.4		5628.784
10007793	18875	40055703.28	11573840.0		1506.64
10007164	23425	48761679.64	14565321.5	1016	1510.108
10007800	14925	28196575.24	7606524.9		393.914
10006566	9060	11090508	3531402.1	988.73	589.752
10007165	18750	40403893.65	11306976.6	1043.98	1040.33
10003614	7060	10852344	3032484.0		626.18
10007166	17270	45003158	11875778.9		2138.225
10007139	8095	16206579	4343598.0	6595.947	796.636
10007657	785	6491273	1788043.0		1055.996
10007713	5425	10672293	3518230.8		632.38

Mean Average Excluding Open University	14187	33127245	9448629	24038	3644
10007773 The Open University		35860347	10699090.5		2259
Open University C/F Average		108.25%	113.23%		61.99%

Table 5
Environmental costs of UK HEI 2015/2016

As can be seen from the above data, although the Open University scores below the average, each year, for total emissions other than commuting, and for waste. In other categories, surprisingly, the OU scores above the average.

Although this finding is surprising, it can be accounted for by the fact that the OU is one of the largest Universities, and the overall data includes many smaller institutions who, naturally, will have smaller footprints, thus reducing the overall average. The Open University ranked as the 12th largest institution, by student headcount in 2013/14.

Revising the data, ranking by total student headcount, and excluding the smaller institutions presents a Second Iteration of Data.
Largest HEI by student headcount.
2013/14 Academic Year.

UKPRN	Teaching student headcount	**Total Energy Consumption/ Total Teaching headcount**	**Total Scope 1 &2 carbon emissions/Total Teaching headcount**	**Total Scope 1&2 emissions from fuel/Total Teaching Headcount**	**Total Scope 3 emissions other than commuting/Total Teaching Headcount**	**Total waste mass (tonnes)/Total Teaching Headcount**
10004180	29485	1,756	595	1,190	1.35	0.24
10005790	27275	1,235	461	920	0.01	0.03
10001282	23885	2,444	812	1,622	2.73	0.06
10007793	23405	2,054	642	1,281	0.01	0.05
10001726	23315	1,678	534	1,067	0.01	0.06
10007784	23180	8,092	2,733	5,465	59.86	0.20
10004797	22930	2,236	739	1,474	1.53	0.25
10007164	22905	2,311	761	1,520	0.02	0.55
10003645	22890	5,431	1,861	3,722	8.64	0.16
10003861	22240	1,867	648	1,289	0.90	0.14
10007140	20090	1,938	619	1,236	1.50	0.16
10007146	19725	2,094	1,111	1,877	1.53	0.55
10007799	19085	7,155	2,304	4,585	2.13	0.12
10003678	19060	2,149	712	1,422	3.95	0.05
10007155	18725	2,136	772	1,536	0.02	0.08
10007165	18425	2,240	713	1,401	1.75	0.26
10000886	18185	2,018	628	1,251	1.58	0.07
10007807	18155	2,761	805	1,609	1.81	0.05
10007805	17255	5,338	1,699	3,395	3.06	
10007166	16690	2,437	727	1,443	1.56	0.15
10004351	16655	996	362	744	1.46	0.03
10007150	16555	3,275	956	1,850	0.03	0.13
10001883	16450	1,707	587	1,209	1.05	0.05
10002718	16425	1,640	532	1,061	3.69	0.06
10004078	16415	1,614	544	1,087	3.61	0.04
MEAN AVERAGE EXCL OPEN UNIVERSITY		2,744	914	1,810	4	0.15
10007773 The Open University	206,300	**182**	**63**	**126**	**0.033%**	**0.01**
OPEN UNIVERSITY C/F AVERAGE		**6.64%**	**6.89%**	**6.94%**	**0.01%**	**5.31%**

Table 6
Environmental costs of largest UK HEI 2013/2014
2014/15 Academic Year.

UKPRN	Teaching student headcount	Total Energy Consumption/ Total Teaching headcount	Total Scope 1 &2 carbon emisions/Total Teaching headcount	Total Scope 1&2 emmissions from fuel/Total Teaching Headcount	Total Scope 3 emissions other than commuting/Total Teaching Headcount	Total waste mass (tonnes)/Total Teaching Headcount
10007784	29050	7494	2365	4482	8.08	0.19
10004180	28735	1874	614	1227	0.51	0.08
10005790	26585	1354	471	941	0.11	0.04
10001726	24955	1674	514	1025	0.01	0.07
10003645	23960	5015	1645	3290	5.72	0.05
10004797	23505	1963	634	1264	2.10	0.06
10001282	23165	2726	854	1706	0.23	0.05
10003861	23045	1718	571	1139	1.13	0.12
10007164	23010	2349	728	1454	1.73	1.04
10007793	21060	2345	756	1509	0.01	0.06
10007140	20825	1921	576	1151	2.27	0.21
10007807	20430	2509	689	1377	0.01	0.04
10007147	19945	2839	1220	2148	4.28	0.30
10007799	19615	6755	2092	4153	3.21	0.14
10007805	19035	5170	1565	3128	3.77	0.03
10007165	18845	2138	638	1275	2.20	0.06
10000886	18705	1918	574	1146	1.32	0.07
10007155	18585	2225	751	1497	0.02	0.07
10003678	18535	2070	657	1312	3.03	0.05
10007792	17980	3867	1211	2411	0.02	0.05
10007156	16870	2227	710	1301	0.23	0.06
10007166	16580	2710	743	1476	2.12	0.16
10007150	16550	3362	941	1877	0.23	0.13
10001883	16330	1678	553	1106	2.35	0.05
10007146	15995	1942	617	1231	3.67	0.06
MEAN AVERAGE EXCL OPEN UNIVERSITY	20535	2681	847	1673	1.63	0.13
10007773 The Open University	187,338	**201**		129		0.01
OPEN UNIVERSITY C/F AVERAGE		**7.48%**	**No Data**	**7.70%**	**No Data**	**6.67%**

Table 7
Environmental costs of largest UK HEI 2014/2015

UKPRN	Teaching student headcount	Total Energy Consumption/Total Teaching headcount	Total Scope 1 &2 carbon emisions/ Total Teaching headcount	Total Scope 1&2 emmissions from fuel/Total Teaching Headcount	Total Scope 3 emissions other than commuting/ Total Teaching Headcount	Total waste mass (tonnes)/Total Teaching Headcount
10007784	29865	7454	2236	2	3.11	0.19
10004180	29485	1780	535	0	0.58	0.24
10005790	27105	1393	435	5	0.01	0.03
10001726	26905	1785	471	0	0.01	0.07
10004797	24600	1894	570	0	0.62	0.07
10003645	23600	5423	1653	0	2.28	0.12
10007164	23425	2082	622	0	0.56	0.06
10003861	22985	1623	503	0	0.33	0.14
10001282	22765	2585	741	0	0.51	0.06
10007140	21275	1941	536	0	0.60	1.65
10007799	20375	6059	1739	1	1.89	0.16
10007807	19920	2482	651	0	0.01	0.03
10007147	19790	2207	988	3	1.27	0.17
10007155	18950	2174	675	0	0.02	0.06
10007793	18875	2122	613	0	10.02	0.08
10000886	18860	1849	519	0	0.59	0.62
10007165	18750	2155	603	0	1.39	0.06
10007805	18075	5569	1566	1	2.10	0.03
10007156	17845	1704	513	0	0.21	0.37
10003678	17675	2004	582	1	0.72	0.06
10001883	17535	1678	507	0	0.88	0.04
10007166	17270	2606	688	0	0.92	0.12
10007150	16825	3390	887	0	0.03	0.14
10004351	16360	1134	362	0	0.49	0.03
10007148	15955	1643	511	0	0.00	0.03
MEAN AVERAGE EXCL OPEN UNIVERSITY	21003	2669	788	1	1.17	0.19
10007773 The Open University	173,889	206	62	0	0.00	0.01
OPEN UNIVERSITY C/F AVERAGE		**7.73%**	**7.81%**	**0.00%**	**0.04%**	**7.02%**

Table 8

Environmental costs of largest UK HEI 2015/2016
(data missing for Open University emissions other than commuting.)

When compared to similar institutions, in all categories, in all years, the Open University environmental costs are significantly lower than that of campus-based institutions.

Third Iteration of Data. Environmental costs per student.

To further refine the analysis of the data, it was decided to divide the environmental data by the student headcount in order to arrive at environmental costs per student.

2013/14 Academic Year.

UKPRN	Teaching student headcount	Total Energy Consumption/ Total Teaching headcount	Total Scope 1 &2 carbon emissions/Total Teaching headcount	Total Scope 1&2 emissions from fuel/Total Teaching Headcount	Total Scope 3 emissions other than commuting/Total Teaching Headcount	Total waste mass (tonnes)/Total Teaching Headcount
10004180	29485	1,756	595	1,190	1.35	0.24
10005790	27275	1,235	461	920	0.01	0.03
10001282	23885	2,444	812	1,622	2.73	0.06
10007793	23405	2,054	642	1,281	0.01	0.05
10001726	23315	1,678	534	1,067	0.01	0.06
10007784	23180	8,092	2,733	5,465	59.86	0.20
10004797	22930	2,236	739	1,474	1.53	0.25
10007164	22905	2,311	761	1,520	0.02	0.55
10003645	22890	5,431	1,861	3,722	8.64	0.16
10003861	22240	1,867	648	1,289	0.90	0.14
10007140	20090	1,938	619	1,236	1.50	0.16
10007146	19725	2,094	1,111	1,877	1.53	0.55
10007799	19085	7,155	2,304	4,585	2.13	0.12
10003678	19060	2,149	712	1,422	3.95	0.05
10007155	18725	2,136	772	1,536	0.02	0.08
10007165	18425	2,240	713	1,401	1.75	0.26
10000886	18185	2,018	628	1,251	1.58	0.07
10007807	18155	2,761	805	1,609	1.81	0.05
10007805	17255	5,338	1,699	3,395	3.06	
10007166	16690	2,437	727	1,443	1.56	0.15
10004351	16655	996	362	744	1.46	0.03
10007150	16555	3,275	956	1,850	0.03	0.13
10001883	16450	1,707	587	1,209	1.05	0.05
10002718	16425	1,640	532	1,061	3.69	0.06
10004078	16415	1,614	544	1,087	3.61	0.04
MEAN AVERAGE EXCL OPEN UNIVERSITY		2,744	914	1,810	4	0.15
10007773 The Open University	206,300	**182**	**63**	**126**	**0.033%**	**0.01**
OPEN UNIVERSITY C/F AVERAGE		**6.64%**	**6.89%**	**6.94%**	**0.01%**	**5.31%**

Table 9
Environmental costs per student of largest UK HEI 2015/2016

UKPRN	Teaching student headcount	Total Energy Consumption/ Total Teaching headcount	Total Scope 1 &2 carbon emisions/Total Teaching headcount	Total Scope 1&2 emmissions from fuel/Total Teaching Headcount	Total Scope 3 emissions other than commuting/Total Teaching Headcount	Total waste mass (tonnes)/Total Teaching Headcount
10007784	29050	7494	2365	4482	8.08	0.19
10004180	28735	1874	614	1227	0.51	0.08
10005790	26585	1354	471	941	0.11	0.04
10001726	24955	1674	514	1025	0.01	0.07
10003645	23960	5015	1645	3290	5.72	0.05
10004797	23505	1963	634	1264	2.10	0.06
10001282	23165	2726	854	1706	0.23	0.05
10003861	23045	1718	571	1139	1.13	0.12
10007164	23010	2349	728	1454	1.73	1.04
10007793	21060	2345	756	1509	0.01	0.06
10007140	20825	1921	576	1151	2.27	0.21
10007807	20430	2509	689	1377	0.01	0.04
10007147	19945	2839	1220	2148	4.28	0.30
10007799	19615	6755	2092	4153	3.21	0.14
10007805	19035	5170	1565	3128	3.77	0.03
10007165	18845	2138	638	1275	2.20	0.06
10000886	18705	1918	574	1146	1.32	0.07
10007155	18585	2225	751	1497	0.02	0.07
10003678	18535	2070	657	1312	3.03	0.05
10007792	17980	3867	1211	2411	0.02	0.05
10007156	16870	2227	710	1301	0.23	0.06
10007166	16580	2710	743	1476	2.12	0.16
10007150	16550	3362	941	1877	0.23	0.13
10001883	16330	1678	553	1106	2.35	0.05
10007146	15995	1942	617	1231	3.67	0.06
MEAN AVERAGE EXCL OPEN UNIVERSITY	20535	2681	847	1673	1.63	0.13
10007773 The Open University	187,338	**201**		129		0.01
OPEN UNIVERSITY C/F AVERAGE		**7.48%**	**No Data**	**7.70%**	**No Data**	**6.67%**

2015/16 Academic Year.

UKPRN	Teaching student headcount	Total Energy Consumption/Total Teaching headcount	Total Scope 1 &2 carbon emisions/ Total Teaching headcount	Total Scope 1&2 emmissions from fuel/Total Teaching Headcount	Total Scope 3 emissions other than commuting/ Total Teaching Headcount	Total waste mass (tonnes)/Total Teaching Headcount
10007784	29865	7454	2236	2	3.11	0.19
10004180	29485	1780	535	0	0.58	0.24
10005790	27105	1393	435	5	0.01	0.03
10001726	26905	1785	471	0	0.01	0.07
10004797	24600	1894	570	0	0.62	0.07
10003645	23600	5423	1653	0	2.28	0.12
10007164	23425	2082	622	0	0.56	0.06
10003861	22985	1623	503	0	0.33	0.14
10001282	22765	2585	741	0	0.51	0.06
10007140	21275	1941	536	0	0.60	1.65
10007799	20375	6059	1739	1	1.89	0.16
10007807	19920	2482	651	0	0.01	0.03
10007147	19790	2207	988	3	1.27	0.17
10007155	18950	2174	675	0	0.02	0.06
10007793	18875	2122	613	0	10.02	0.08
10000886	18860	1849	519	0	0.59	0.62
10007165	18750	2155	603	0	1.39	0.06
10007805	18075	5569	1566	1	2.10	0.03
10007156	17845	1704	513	0	0.21	0.37
10003678	17675	2004	582	1	0.72	0.06
10001883	17535	1678	507	0	0.88	0.04
10007166	17270	2606	688	0	0.92	0.12
10007150	16825	3390	887	0	0.03	0.14
10004351	16360	1134	362	0	0.49	0.03
10007148	15955	1643	511	0	0.00	0.03
MEAN AVERAGE EXCL OPEN UNIVERSITY	21003	2669	788	1	1.17	0.19
10007773 The Open University	173,889	206	62	0	0.00	0.01
OPEN UNIVERSITY C/F AVERAGE		**7.73%**	**7.81%**	**0.00%**	**0.04%**	**7.02%**

Conclusions

As might be expected intuitively, the qualitative data suggested that the environmental costs of DL programmes are significantly lower than those of face-to-face programmes. The qualitative data, form the UK supports this finding. Furthermore, the data demonstrates that this is repeated over the three years of the study.

Implications

The authors' earlier paper, from an international study, identified that Institutions exclusively providing distance learning programmes have very significant financial cost savings compared the traditional campus-based institutions providing face-to-face programmes. This paper demonstrates that those institutions can also achieve very significant savings in environmental costs.

When Governments worldwide are seeking to reduce the cost of Higher Education; these findings may have profound implications for the funding of Higher Education.

The next paper in this series will examine whether or not these savings are being passed onto students in the form of reduced fees.

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