The ICT-assisted Classroom: From Teacher-dependence to Independence and Interdependence in Learning

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The Asian Conference on Education & International Development 2019
Official Conference Proceedings

Abstract

The paper narrates the experiences of Senior High School students and teachers in two *ICT-assisted* classrooms, one in Mathematics and another in Science. It traces the transition of students from teacher-dependent learning to more autonomous and cooperative learning when instruction was transformed from traditional to ICT-assisted. Two Grade 11 classes in a private secondary school in Quezon City, the Philippines, were randomly assigned as experimental groups in which ICT-assisted instruction was introduced after one month in one of their subjects. In Experimental Group 1, ICT-assisted instruction was implemented in their Math subject, *Statistics and Probability*, while in Experimental Group 2, it was applied in their Science subject, *Disaster Preparedness and Risk Reduction in Philippine Setting*. Two other Grade 11 classes served as their controls. Experimental and Control participants were taken from academic strands of Senior High School in which the two subjects (Mathematics and Science) were required in their curricular programs. These strands were ICT strand (for the Math subject), and General Academic strand (for the Science subject). For each strand, students were randomly assigned to Experimental and Control groups; stratified random assignment was utilized to ensure that class sizes were equal, and so was gender distribution. ICT-assisted instruction came in the form of *digital* copies of textbooks and an *Internet-based* teaching-learning *platform* in which teachers uploaded class materials, and students submitted their class work and assignments. *Tests*, which had undergone validation and reliability analyses, were administered three times: prior to the introduction of ICT-assisted instruction (as diagnostic), at mid-semester and at the end of the semester (as posttest). *Classroom observations* were also conducted *every* month during instruction, to capture classroom *interaction* between teachers and students and between/among students, particularly after *transition* from teacher-dependent to ICT-assisted was implemented. Separate *Focus Group Discussions* (FGDs) with *students* from all four classes (two experimental and two control) were held at the end of the four-month semester to obtain students' descriptions and perceptions of their classroom experiences. *Teachers* were likewise interviewed individually to find out their assessment of the ICT-assisted instructional method. *Problem* areas that hindered independent and interdependent learning were pointed out, and suggestions for addressing these problems were also offered by students and teachers.

Keywords: ICT, Computer-aided instruction, Digital classroom

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Introduction

One of the commitments that the Philippines has signed up to is the so-called Sustainable Development Goals (SDGs, which are actually a continuation of the Millennium Development Goals or MDGs). Of particular interest to us the Goal 4, Quality Education, and more specifically, the third outcome target, *equal access to technical/vocational and higher education* achieved through effective learning environments which include upgraded education facilities.

Eclaro Academy, a relatively young educational institution providing basic education (Kindergarten to Grade 12), was established primarily to provide an ICT-based instructional program. In 2016, the Academy was fortunate to obtain partnership with a local book distributor and development company (C&E Publishing, Inc.) to undertake an experiment on the use of tablets among students in Grade 11 of Senior High School. We wanted to compare the advantage of having an ICT-assisted classroom relative to the traditional teacher-centered classroom. For this reason, we chose to apply ICT in a mathematics classroom and a science classroom, and to compare the students' and teachers' experiences with those in "regular" classrooms. Our question was, "*How do technology-assisted instructional methods enhance both instruction and learning in Grade 11 Mathematics and Science*?"

Method

Two Grade 11 classes (with an average of 40 students in each) were randomly assigned to ICT-assisted classrooms, one to be taught Mathematics, specifically, *Statistics and Probability*, and one Science, specifically *Disaster Preparedness and Risk Reduction in Philippine Setting*. The experiment was conducted during the Second Term of School Year 2016-2017, spanning five months, from November 2016 to March, 2017, with the Math classes taught by one teacher and the Science, by another teacher. Analysis of data was completed in 2018. ICT-assisted classes utilized digital copies of the textbooks as well as an online teaching-learning platform in which teachers uploaded supplementary materials, assignments, class activity guides, quizzes, and feedback on student work which students could download and study on tablets, laptops or android-based cellphones.

Both teachers received briefing on e-learning, the use of digital copies of the textbooks, and basic troubleshooting, and an intensive training on the use of the online platform from e-learning specialists. Students were likewise given a briefing on how to use the digital textbooks and the online platform on their preferred devices. A survey on ICT use was conducted among students in the ICT-assisted classroom a week before the start of implementation to determine whether students needed additional instruction on how to use gadgets and how to navigate the Internet. Results showed that students were familiar with the use of gadgets and the Internet, spending anywhere from 30 minutes to 11 hours on them for word processing, computing, emailing, searching for information, and social networking.

Classroom observations were conducted monthly in the course of the five-month experiment. Following each observation session, teachers were given feedback on how to improve ICT-assisted instruction during the first two months. Formative and summative tests were administered to monitor students' progress. At the end of the semester, separate focus group discussions (FGDs) were conducted among students in the ICT-assisted classrooms, and brief interviews with teachers. Students were also asked to evaluate their experiences.

The ICT-assisted Classrooms: Students' and Teachers' Descriptions of their Experiences

Students' experiences. When technology was introduced in the classrooms, the students' reaction was one of *excitement* ("*We felt very excited*") and *energy* ("*…and explored the internet–based teaching-learning platform right away*"). They felt it was "*cool*" (modern, great) to be able to learn using technology. In fact it made them feel good as it meant it would make studying easier ("*mas madali mag-aral*"). The excitement elicited by the novelty of the technology applied in the ICT-assisted classroom seemed to have served as an impetus for students to get into the lessons with eagerness and vigor.

In the Mathematics classroom, students navigated digital copies of the textbook on their gadgets, and were able to read lessons in advance, reading from approximately 6 to 8 hours each meeting day. They used their gadgets to access the digital textbook and the platform whenever they needed to study their lessons ("*ginamit pag kailangan aralin ang topics*"), not only in school but also at home ("*hanggang sa bahay*"). When the class was engaged in using their gadgets for learning activities, students worked quietly ("*tahimik sa room*", the room was quiet). However, during group activities, there was more dynamic student participation ("*mas active*").

They had swift access to solutions and examples for exercises which made learning the concepts and formulas a lot less difficult than it would have usually been in a traditional classroom. One student said it was easier for them to solve exercises ("*mas madali mag-solve ng problem*") and they easily finished their tasks ("*mabilis matapos ang schoolwork dahil sa apps*"). They downloaded instructions and activities, quizzes and assignments. The online Internet-based teaching-learning platform was useful in viewing the teacher's and their classmates' feedback posts regarding class work. They took screenshots of their own progress. Their gadgets also enabled them to browse the Internet for more information about topics discussed in class. They looked up for meanings and definitions of difficult terms in Google and verified formulas when it was discovered that there were typographical errors in the textbook and that formulas were not accurate.

In the Science classroom, students were likewise eager about the technology because of the help it could give them in their studies ("*excited kami, kasi malaking tulong ang technology*"). They used the gadgets in class, during free time, and at home ("*sa school, sa bahay*") for class requirements ("*pag gumagawa ng homework*") and for other purposes ("*personal na bagay*"). They were able to view audiovisual materials

uploaded by the teacher ("*may live video*"), which helped them comprehend lessons ("*mas naiintindihan*", "natuto") such as the video on volcanoes ("*maganda gaya ng volcanic eruption*"). They also used their gadgets for *note-taking* and taking *screen shots* of *definitions*, *key words*, *important details*, and teacher's *lectures*. Through their gadgets, they were able to *consult* other resources such as *Oxford Dictionary*, *Merriam-Webster Dictionary*, *Google*, *Wikipedia*, and *YouTube* (video about volcanic eruptions). All these helped them grasp concepts better ("*mas naiintindihan ang lesson*"). The class activities and assignments enhanced their performance ("*mas maganda grades dahil sa activities*").

Aside from applications used in their Science class, students used their gadgets for other purposes. They used it for word processing ("*pag-type ng report*"), sending messages ("*Instagram*", "*Twitter*", *email*", "*messenger*", and "*texting, nilagyan ng SIM*"). They also used search engines for information, documents, and useful video clips ("*Google*" and "*YouTube*"). For "techy-savvy" learners, they thought that technology was an important component of instruction ("*mahalaga talaga, especially dahil techy-savvy na lahat*"). With all these advantages, students assessed the use of technology as better ("*mas maganda ang tablet*") and easier than the print copy and traditional teaching approach ("*mas madali kaysa book*"). The technology helped them to realize "(it) *became more interesting to learn from the tablet than from the book*". Students agreed that technology was an effective delivery technique for instruction if crucial components are provided ("*kung maganda ang connection at ang applications*"). One student suggested that continuing with this approach should be carefully studied ("*Minsan mabagal ang connection, application, sana pag-aralan muna*").

Using technology-assisted instruction also had some *setbacks*. The major difficulty encountered during the semester was connectivity, possibly due to the location of the classrooms and the service provider itself. There was an occasion when much of the class time was used downloading lecture materials or instructions for activities. "*Naubos ang oras (namin) sa pagda-download kasi laging nag-a-update ang gadget*" (We used up our time downloading the material which was interrupted by constant updating of software on our gadgets). A few students who were not used to using the Internet for class work expressed discomfort about submitting assignments on the platform. One student commented that he could not turn in requirements because his Internet access at home was not very good ("*Mahirap mag-work sa Internet sa bahay; minsan di nakaka-submit assignments*").

Like their counterparts in the Mathematics class, students in the ICT-assisted Science classroom were met with problems with connection. They could not access the platform ("*di nabubuksan ang applications*"), and even if they were able to, downloading was rather slow ("*matagal mag-open*"; "*nagko-connect kami pero mabagal*"), and sometimes it would be interrupted ("*nag-hang*"). Sometimes logging on to the platform was difficult ("*erratic ang access*"), which made occasionally hindered early submission of assignments ("*hindi nakakapasok*, *mabagal ang connection*"). When faced with such difficulties, students helped each other by

"*sharing gadgets*". In such situations, teachers understood students' problems and gave extensions in deadlines for submission of assignments.

Students praised their Science teacher for making herself available for consultation through the chat feature of social media and for putting up her advice on the platform ("*nakipag-chat sa assignment*", "*nag-upload ng mga advice*"). As for the activities provided by the teacher, students appraised them positively but also thought that there ways to make them work better in the future ("*maganda, pwede pang i-perfect*").

Despite these setbacks, generally both Mathematics and Science students supported continued use of technology because it facilitated learning ("*Tablets are ok, especially in accessing lessons*") and gadgets, unlike print copies, were not heavy to carry around ("*Di mabigat dalhin sa bag*"). As for the digital copies of textbooks in their gadgets, they liked the pictures and graphs, and found the explanations complete ("*kumpleto ang explanations*") and the exercises made the lessons easy to understand ("*madali kasi may mga exercises*"). They appreciated that they were able to enrich their learning with the video clips that the teacher had uploaded on the platform ("*na-clarify ng mga video and lessons*"). One student disclosed that assignments could be altered to the point of excellence ("*pwedeng ma-perfect*"). Those who wanted to monitor their own progress could simply take screen shots of their submissions ("*kailangang i-screenshot para may copy*"). Notwithstanding these concerns, students endorsed the use of technology for the entire school.

Teachers' experiences. With regard to the platform, the Mathematics teacher had this to say: "*It was very useful and could easily be navigated. But content could be improved, that's why (I) had to make preparations for class presentations, even if meant additional work for (me). It functioned as interactive tool and was useful when there were additional lessons and topics on the platform*." With regard to the digital textbook, she revealed, "*It enabled us to spot some typographical errors on one formula and set of data presented, and some topics that needed to be modified. I was able to give the corrected formula and discuss these in time for students' class activities and assignments. In addition, I uploaded more exercises and activities to develop mastery.*" A statistical calculator software application was also provided by the teacher for the Experimental group, particularly in solving correlation and regression exercises. Once, when Internet service was erratic, the teacher "*provide(d) a portable broadband connection*". She also requested the school technician to extend time allotted for Internet use when necessary. These were ways by which the teacher performed "trouble-shooting tasks.

No matter what difficulties were encountered in implementing ICT-assisted instruction, the Mathematics teacher enumerated a number of advantages. She said, "*When (the students in the Experimental group) needed more explanation to understand lessons, I didn't need to reteach them because there were available tutorial videos I had uploaded on the platform about the lessons so it was very convenient. The quizzes were automatically checked, and I could see the students' progress. When we had activities that needed computations, we often used the statistical calculator software application to make solving the problems faster*." The

students lauded the technology-based instruction, with descriptions such as "*maganda, natuto kami dahil nag-a-upload (ang) teacher ng lesson* (good, we learned because the teacher uploaded the lesson)", "*may live video* (there was live video)", "*mas naiintindihan* (we could understand the lesson better)", "*mas maganda ang tablet* (using the tablet was better)", "*mas madali kaysa book* (easier than the book)", and "*mas maganda grades dahil sa activities* (grades were better because of the activities)" while acknowledging the important role of the teacher ("*kailangan pa rin ang guidance ng teacher sa exercises*"). Many preferred using the digital copy of the textbook to the print copy, although when the connection failed, they thought the book was more advantageous. One student suggested, "*Sana pwede pang i-perfect* (I hope they can perfect the system)".

Using technology-assisted instruction was a *challenge* that became also *profitable* to the teacher, because she felt she had to be "*knowledgeable in front of (the) students in terms of the use of the platform and the gadget; it took some time for me to get used to incorporating it in the classroom; and in situations where internet connection was interrupted, I needed to think of another way to teach the lesson*." If asked about using the technology for the entire school, her response was, "*Yes of course, provided the appropriate technology would be ready for used*."

Traditional Classrooms

In the traditional Mathematics and Science classrooms, students used print copies of the textbooks, and relied on the teacher to give them instructions on class activities. Sometimes, finding the pages for the day's topic took some minutes as students flipped through pages of the textbooks. Group activities were often conducted in almost muted tones, and hushed voices. Group leaders seemed to have difficulty coaxing members to give contributions to activities, some of whom sat on desk chairs reading their textbooks so that only a few group members contributed to group work. There was also less attentiveness among students, with a few choosing to simply watch what others were doing. The teacher herself had to go around the room to ensure that group members were taking part in discussions and preparation of outputs. Moreover, completing the activity took the entire class time, with only a few groups getting the opportunity to explain their outputs. Using hand-held calculators, Mathematics students checked each others' computations, as some lacked certainty in their answers to class exercises. recomputed their answers. In the Science classroom, the teacher showed slides of natural disasters, describing the sequence of events in words as students followed using their textbooks.

Summary

Students in both ICT-assisted and traditional classrooms complimented the formats of their textbooks (digital vs. print) as "*suitable*" and "*helpful*". Both digital and print copies of the textbooks enabled users to understand the lesson ("*mas madaling maintindihan ang lessons*"). They used these textbooks, no matter which format, during class, and at home when they did homework ("*pag may assignment*") and prepared for class ("*advanced reading*"). In terms of content and language, textbooks

were "*user-friendly*" and comprehensive ("*kumpleto bawa't topic, detailed*", "*kumpleto ang images, diagrams, tables, at explanations, madaling maintindihan ang lessons*") and provided "*optional activities*". Textbooks in both formats, digital and print, made it easier for students to learn ("*mas napapadali*") and comprehend lessons ("*mas madaling maintindihan ang tinuturo*"). They enabled students to follow the lectures and discussions ("*mas madali makasunod sa lecture*", "*nakakasabay sa teacher*"). They were most useful in doing homework ("*pwede makatulong sa mga assignments*") and class activities ("*naghahanda sa role-playing*"), and when one missed a class ("*lalo na kung absent, may reference*"). Digital copies loaded in gadgets such as tablets were handy and easy to open anywhere, anytime. Print copies were likewise convenient for students, allowing them to use these materials anywhere, anytime also, without relying on Wi-Fi connectivity. They could also scribble notes on print copies and mark important sections ("highlight"), but so could students who had digital textbooks. However, the equivalence of the two classrooms probably ends here.

Unlike print textbooks, digital textbooks were *interactive*. Some parts of the digital textbooks were linked to supplementary texts and/or sites which provided additional information in one touch of a button. Thus, using digital textbooks increased students' knowledge about their lessons, thus enriching their learning for a give topic. Moreover, the online platform on which students and teachers uploaded and downloaded additional materials, instructions and outputs for class activities and quizzes, and feedback on lessons and student products facilitated both instruction and learning. Providing other materials, class activities and feedback are also possible in traditional classrooms, however, the process is not as fast, immediate and timely as that on an Internet-based platform.

The most noticeable effect of ICT in the classroom was the level of *student engagement* and *teacher-student interaction*. As soon as the teacher gave instructions for the day's activities, students immediately worked in groups, each with his/her own gadget. Although there was a designated "leader" or "facilitator" for group activities, group members gave their own inputs without being asked, sometimes speaking simultaneously. In one Mathematics class session, groups were asked to work on different problems, and had to show their solutions on the board for group discussion. The classroom atmosphere became electric to the point of possibly being considered "*chaotic*" by any passerby, since almost everyone was standing in excitement about arriving at the correct answer, with chairs in disarray and the "noise" to an almost intolerable intensity. Students did *not* have to be prodded to participate in class discussions and activities, but took the *initiative* to do so. The energy level in the ICT-assisted classroom was so high that discussions were kept at a lively pace and student participation was sustained through the entire class period. As one teacher said, "*Learning was made more fun and students developed to be independent learners*." Moreover, while student developed skills in managing their own learning, they nonetheless became inter-dependent one each other as they worked on class requirements in groups and individually. Information acquired on one's own was shared among them, and peer-teaching became an almost natural effect of learning.

Conclusion

ICT in the classrooms assisted teachers in their *delivery* of *instruction*, *monitoring* of student *progress*, and *assessment* of student *performance*. First, teachers provided *supplementary* materials on the teaching-learning platform such as video clips on volcanic eruptions which made the topic more easily comprehensible to the Science students, and software *applications* for online computations which facilitated problem solving in class activities and assignments for Mathematics students. Second, teacher-student interaction was expedited by online channels such that teachers kept students *informed* of how they were doing through the platform, and *other* messaging portals. Finally, teachers uploaded assignments, activities and quizzes online, and rated student submissions promptly, thereby encouraging students to *improve* their performance.

In view of these, students in ICT-assisted classrooms benefited from technology in three ways also. First, they acquired *knowledge*, navigating the digital textbooks and the Internet-based platform according to their own needs and interests, and in their own individual paces. Student *engagement* in academic work increases when learners are provided easy *access* to learning materials and class activities anywhere, anytime, most especially at *the* time their interest and desire to gain knowledge are stimulated. The availability of *other* resources on the Internet facilitates understanding of otherwise confusing or nebulous topics and lessons. Learning is achieved at a much deeper and faster way when students have all the possible help at their *fingertips* whenever wherever they need them. With the ubiquitous android handheld information and communication devices readily available, one's learning is no longer limited to physical materials and places; technically the universal body of knowledge is before the learners at the touch of a button. Thus, technology *favorably* alters classroom *environment*, instructional *quality*, and learning *outcomes.*

Second, students complied with school *requirements* as soon as they could and submitted these online, not having to wait for the class period to do so. Technology enabled teachers and students to carry out tasks with *facility* and *efficiency*. Teachers were able to impart valuable instructional aids in the form of supplementary materials that were readily available in the Internet. Class activities that bolstered understanding of lessons were accessible to students even outside the classroom.

Finally, students received timely *feedback* about errors in assignments, activities and quizzes, thereby enabling them to improve their performance in an auspicious way. Student progress was closely monitored and feedback was promptly delivered through technology. When Internet services were adequately provided and strongly supported by schools, tablets and software programs did increase student class participation and enhanced teaching effectiveness. When delivery of instruction using technology was implemented with adequate technical support and services, it became an effective, and better, alternative to the traditional method

Providing learning materials, guide for activities and homework, and feedback on a student's class standing, all of which supplement classroom instruction, do encourage

student initiative with regard to his/her academic work, a trait on which independent learning is grounded. Moreover, online portals that expedite communication between teachers and students generate the kind of support that independent learners need in order for them to take charge of their own learning. Independent learners who know their own limitations realize their need for *other* fellow-learners, thereby enabling them to accept inter-dependence in school work, and any endeavor for that matter.

Recommendations

We recommend the following if we are to develop independent learners and interdependent students. First, we must see the *value* or importance of independent learning. Second, we must believe in students' *capability* to be independent learners. And third, we must put such a belief into action by affording them opportunities to learn on their own.

In this day and age of the 21st century, when economies have made it possible to provide many learning opportunities, such as free basic education, and population growth remains to be steadily increasing, ICT-assisted, (and even-ICT-based) instruction should be a viable option toward management of large class sizes in view of limited school space, which is a burden for many urban areas. When students are trained to be independent learners, the teacher's role will become that of a facilitator and assessor of learning, no longer the age-old or usual function as "delivery", even "source" of learning. When textbooks are carefully and clearly written they can become "substitutes" for teacher lectures, in the same way that modules have become in many online courses. Independent learning is good not only for schools and teachers, but for individual students themselves. Schools can be physically decongested, and teachers are liberated from large class sizes. Students who have the ability to manage their own learning do not have to be forced to sit up on a chair for hours, physically present but mentally absent.

Belief in students' ability to engage in independent learning can be generated and developed by imparting the necessary skills that are required for them to do so. We need to explore and study the traits of independent learners and develop a strategy for enhancing or drawing out these traits among young learners. More specifically, we need to examine how ICT skills can be "scaffolded" into zones of proximal development (ZPDs) as theorized by Vygotsky. Perhaps some of the ineffectiveness of ICT-assisted and ICT-based instruction may be traced back to the fact that there is little we know, as of now, about the "hierarchy", if any, of ICT-related skills. Teachers assume that all students know how to use a desktop or laptop, that they are familiar with the Internet and how to extract knowledge from its vast store of information, and that minus any sort of briefing, they are able to use technology for learning. Our belief in students' capacity to learn on their own through ICT is shown by our equipping them with skills that will enable them to learn independently.

Finally, valuation ad belief produce nothing unless they are worked out. This we can do by furnishing students with *opportunities* to learn on their own, in their own time, according to their own needs, and in their own pace. By creating ICT-assisted and

ICT-based educational programs we can, in a manner of speaking, “throw students into the water and force them to learn to swim, or else sink”. Courses that integrate ICT in class discussions, activities, and assessment are ways by which we can test just how far ICT can go insofar as instruction and learning are concerned. Teachers should be encouraged to explore how to take advantage of ICT as an aid in managing classes. Internet-based platforms where teachers and students can meet online, even in so-called “virtual classrooms”, push students to develop independence, and inter-dependence, in charting their own academic voyages. When properly guided, students can learn even faster through ICT-assisted and ICT-based programs, compared to traditional classrooms. Administrators must also be prodded to support the use of ICT products and services as complimentary and supplementary, if not critical, to 21st Century education and the attainment of the fourth Sustainable Development Goal: Quality Education for all.

Without a doubt, technology will continue to become an essential component in twenty-first century educational programs, thereby revolutionizing both instruction and learning. The benefits of technology are almost innumerable, but possibly the most important might yet be this: with technology, students discover how they can manage their own learning, and thereby develop independence, and inter-dependence in their academic work. This is one of the key traits if we are to pursue life-long learning

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