A Report on the History and Current State of Computer Assistance in Education

Introduction (by Alan Phillips 19262922)

The dawn of the digital age has brought with it tremendous change across all sectors of society over the past 50 years. No field has felt this shift quite like education. Teachers and students alike have had to adapt to massive change in distribution of content, means of assessment and more at every level of education. Primary school children play educational video games. Secondary school students access exam material and research information online. Universities deliver entire programs over the internet.

The landscape of the teaching environment has been shaken to its very core by the technological revolution. It was a gradual process of change over time, but the high-tech learning of today is a far cry from the classrooms and textbooks of the past. The advantages of this transformation are many and strong, but so too are the downsides.

Computer assisted education or computer assisted learning (CAL) is a rapidly evolving field in the application of computer science that is currently showing no signs of slowing its development. However, this study will begin by looking back at where it grew from.

History of CAL (by Alan Phillips 19262922)

Computer assisted education, “as the name implies, is the use of electronic devices/computers to provide educational instruction and to learn. Computer assisted learning can be used in virtually all fields of education, ranging from TV/DVD play-learn programs for kindergarten kids to teaching quadruple bypass surgery techniques in medicine. CAL is developed by combining knowledge from all fields of education/learning, human computer interaction (HCI) and cognition.” (Olorunosebi, n.d.)

Computer assisted education has been prevalent for a number of decades. According to Jessica Scott “It might shock you to learn that some form or another of Computer Assisted Learning has been taking place in classrooms since the 1960s”. (Scott, n.d.) The scope of CAL is not only limited to computers, but also by definition includes other forms of technology like CDs, MP3 players, interactive whiteboards, and any other form of electronic present in the classroom. It is unsurprising that it was adopted at such an early stage to help and assist in the classroom environment. It enabled better engagement from the students, as well as aided teachers of a broad variety of subjects. Music teachers could playback tapes. Engineering teachers could have their students model their projects with computer software. Other subjects benefited greatly from the ability to give real visual representations of topics that may not be possible to demonstrate in a classroom, like a geography teacher showing footage of the eruption of a volcano. The opportunities CAL gave in enriching the quality of learning achieved in the classroom was only limited by the technology itself.

Another area which has long made use of computer assisted learning is that of language, which has been making use of technology as early as the 1960’s. Known as Computer Assisted Language Learning or CALL, a massive variety of benefits were soon found in the application of technology in language teaching. As Al-Masri states “the basic idea revolves around computers being able to provide a language-learning environment to the learner without the presence of the teacher.” (Al-Masri, 2019) The wealth of foreign language resources available on the internet steadily grew over time, and in more recent history the development of instant messaging technology allowed for communication with native speakers of one’s target language with a never before seen ease. Additionally, this particular field of language has long been of particular interest to those working in artificial intelligence and machine learning, as evidenced by the advancement of Automated Speech Recognition (ASR) and other such attempts at automatic translation.

“In the early 90's education started being affected by the introduction of word processors in schools, colleges and universities. This mainly had to do with written assignments. The development of the Internet brought about a revolution in the teachers' perspective, as the teaching tools offered through the Internet were gradually becoming more reliable. Nowadays,

the Internet is gaining immense popularity in foreign language teaching and more and more educators and learners are embracing it." (Scott, n.d.)

As stated by Scott, the widespread adoption of word processors and word processing software in the 1990's brought massive change, and was another large leap for CAL. This introduction of computing into the school environment soon brought about dedicated computing classes, teaching the fundamentals of software packages such as Microsoft Office. This, coinciding with the growing popularity of home computing, became hugely beneficial, as the rapid shift to computing in the working world necessitated the introduction of employees who had prior experience with a computer.

Recent history has seen the further evolution of online learning. Universities have their own sites with which they may organise their modules, delivering content and accepting the submission of assignments, cutting out much of the need for the use of paper in many disciplines. The advancement of video and streaming technology have made it possible for whole courses to be delivered entirely online. This extends beyond just traditional universities, whereby any institution may deliver content and certification via online means.

Availability of CAL (by Wiktoria Ziaja 19260334)

During the early 90's the cost of computers fell which made it more affordable for schools, universities and even for personal purchase to use at home and therefore increased the availability of Computer Assisted Education. This began with the ability to use programs such as Word to write assignments for classes. Over time it increased to using educational games in primary schools as well as using the internet when writing essays for homework about specific topics or doing research on the internet for an in-class presentation. Specific websites were created for teachers to use to take attendance and store grades which was previously done on paper. Other websites such as Sulis, that we ourselves use in University of Limerick, allowed the ease of uploading assignments from home as well as receiving lecture notes, grades and having direct contact with the lecturer. Unfortunately, even in the 21st century problems with availability occur. Some students might not be able to afford the new technology that is coming out due to it

slowly becoming more and more expensive because of its increased performance and capabilities. Adding to this, there is no surprise that not every area in the country has high-speed internet access which means not every student can access the websites such as Sulis or can't do so without any difficulty of loading times and crashes.

One of the main problems of availability with Computer Assisted education is price as I've stated above. Even though the price of computers began to decrease in the early 2000's, computers were only mainly used to write assignments and do research for those assignments. This then would be stored on a floppy disc or a USB meaning that a powerful computer was not necessary. In today's times we use computers for much more than that, whether it is to have online real time classes, watch video lectures or to send and receive assignments as well as store them on the computer and to have the latest of each apps like Word, Excel, BlueJ we need something more powerful or rather more up to date. As computers become powerful by having larger memory or a stronger CPU to run programs like BlueJ, they also start becoming expensive.

This raises a question of can students or parents afford laptops, iPads or other devices that would be used in at home CAL. If not, is there funding or sponsorship available through schools or the government, seeing as most secondary schools already provide an iPad, laptop or surface Pro (depending on the school and needs)to students with dyslexia or similar learning disabilities, that is owned by the school, but the student can use it for the duration of the academic year both in school and at home. As well as this most schools already have at least one room known as the computer room while universities have several labs which have computers in them. If CAL should be fully integrated into a classroom environment, it would be beneficial for the students to own a device where they can access the online material at home but unfortunately this would be extremely costly. As Scott says in her article, "Cost is perhaps the biggest barrier to using CAL in the classroom. Computers, electronic devices and software are expensive. As such, having a computer for each student is just not a realistic goal for some classrooms." (Scott, n.d.)

Another problem which occurs with the availability of CAL is not only having a device but also having the internet access for the material. Even though statistics from the Central Statistics Office show that "In 2019, 91% of households have an internet connection, an increase of two percentage points since 2018. Data for 2019 indicates that fixed broadband is the most common

type of internet access in the household", (CSO Ireland, 2019). Unfortunately, there are still students who live in rural areas that don't have a high internet speed or others might only have a limited broadband which wouldn't allow for watching lectures daily or maybe even weekly. The other problem with limited broadband is other family members might use it for work which would limit the speed even more or only allow the student to access the internet at certain times which may not be ideal. These problems can impact the availability of online lectures or even the uploading of assignments. The current pandemic, Covid-19, is a good example of this as most students are currently at home and a few are facing some of these issues.

Availability doesn't just cover the hardware side of things or the expenses; it also covers the materials available for students to use on the internet. This allows for students to do research on topics they struggle with by having the option to find more examples and books about the subject. There is also material on the internet that can't always be accessed in person such as videos on medical procedures for medical students and applications mimicking the tsunamis or earthquakes in cities for engineers. Having such applications and hardware to be able to do and redo these things at home and not just in a maximum 2-hour lecture or lab allows for greater and more detailed understanding of the topic.

In recent years, large medical and technological advances have been made. Those technological advances make medical studies much easier as the availability of devices or rather robots which for example simulate birth. "Nursing students at the MGH Institute of Health Professions use Victoria to practice, as realistically as possible, how to guide mother and child through birth. Just like human mothers, Victoria's deliveries don't always go as planned. Sometimes she has complications. Sometimes she hemorrhages fake blood, via a tank on her hips. Sometimes her baby isn't breathing. And just like practicing nurses, students must confront those problems head-on." (Ducharme, 2016). This allows for an easier learning experience for the students as they can go through different scenarios to be fully educated about each, as well as creating a less stressful environment to study since there are no real-life threats if something goes wrong. It also allows more students to practice such procedures as they are not always available to students to even do in real-life.

Benefits of CAL (by Sean Gothard 19265107)

Computer Assisted Education offers many benefits to both students and teachers. The benefits range from small things like keeping an online record track of attendance and assignment submissions or test scores rather than just documenting it on paper, to larger more important ones like helping students with learning disabilities, and disabilities or illnesses that perhaps cause them to miss multiple days of school. It also allows for a more interactive learning environment with the use of educational games and videos, which is a benefit to teaching a younger audience, mainly primary school students who are not so interested in hearing a PowerPoint lecture. As Scott says in her article "Let's be real: A bored student isn't a good one. While some students adore lectures, many others require more stimulation to stay involved and actively learn. CAL is perfect for this, because it offers many ways for each individual student to engage and stay interested in the topic at hand." (Scott, n.d.). Another point that Scott makes is how the interactive games cater towards the individual "With CAL, each student can go at their own pace and make progress in their own time. Computer lessons or games normally adapt to the individual based on their own progress, not on a set standard, so each student is able to have a more personalized experience." (Scott, n.d.)

As I've stated above, one of the most important benefits of CAL is help with learning disabilities. The most common learning disability is dyslexia. "Dyslexia is a learning disorder that involves difficulty reading due to problems identifying speech sounds and learning how they relate to letters and words (decoding). Also called reading disability, dyslexia affects areas of the brain that process language." (Staff, 2017)

Many schools across Ireland provide laptops or similar devices for students with dyslexia to use both at home and in school during the academic year or allow the student to bring their own if they have one. Universities might not necessarily provide laptops but offer students software that will assist them in reading and writing, for example Grammarly, as well as having notes and lecture slides in a more readable format, one that perhaps allows an easy use of text to speech. CAL also benefits students with illnesses or disabilities that cause the student to miss multiple days and unfortunately be behind on class material. Websites such as Sulis where the lecturer can

upload lectures, tutorials, videos and other materials are a huge benefit to those students. If more secondary schools used such websites even just for the disadvantaged students who they don't always have a chance to meet one on one or whose progress they can't fully see in class, it would be to great benefit as those students wouldn't have to worry about being behind or having to catch up on a unreasonably large amount of material. They could also have access to other resources that could help them study at home like direct contact with the teacher for any help or extra material given by the teacher that would normally be explained in class and not necessarily in textbooks or notes.

Speaking of one on one and student progress, schools and especially universities often have more than thirty students per one class and have multiple classes which doesn't allow for much time with each individual student. CAL doesn't just mean showing videos or interactive games it also helps the teacher in assessing each student as an individual or the whole class as a collective group. This benefits the teacher as they can see the progress of those students who are not always in class or might be embarrassed to ask for help. The teacher can see if the student is struggling with anything and give extra help with those topics. The information about the class as a collective helps the teacher to structure lessons accordingly as they clearly know what topics need to be revised, especially with exams like the Leaving Cert and Junior Cert.

Other benefits of CAL are being able to have accurate and up to date information especially for courses or subjects where information is always being updated like in medical school. In medical studies research is constantly being done and published to allow for the most accurate and up to date information as well as the study and discovery of rare or new diseases, ones such as Covid-19. New procedures or methods are also being researched and it is important that medical staff is always aware of them. Having the internet helps these studies to be seen around the world. New technology is also created to allow for the simulation of procedures such as surgeries and childbirth etc. though it can still be quite expensive for hospitals or universities to purchase these machines. Julie J. McGowan and Eta S. Berner have published a writing about the concept of computers in medical education, "Today, the uses of computers in medical education encompass the ideas of the past, but also extend the domain to incorporate the teaching of medical informatics; use of computers in problem-based learning and/or evidence-based medicine; distance learning technologies; and the use of computers to facilitate patient education and

shared medical decision-making. Also included is the use of computers in support of the medical education enterprise, for example, curriculum management support systems and computerized assessment tools." (Julie J. McGowan, 2002)

It is not only a benefit in medical school but also in courses like engineering and history or geography. In today's day we have programs that can simulate volcano eruptions, tsunamis or earthquakes. This can help to teach students the effects they have on our buildings and environment. Computers also help in the engineering aspect of teaching as they can take in values for building bridges and building and see if they can withstand heavy traffic, winds or the mentioned above environmental catastrophes.

Disadvantages of CAL (by Conor McNelis 19277849)

Computer assistance in education has many benefits, however it also creates several issues that can be detrimental to the overall intake of information by students. Whether it be the abundance of false information available on the internet, or the decrease in personal support and individual customisability of lessons for younger students, or perhaps the flawed correction systems of automated marking, it's clear that computer assisted education has quite a few problems that should be resolved before total integration.

Automation of Testing and Learning:

As Computer Assisted Education becomes more commonplace across the world, it becomes easier to notice the continuous increase in automation of testing and learning. While this method of assigning work is quite fitting for colleges and large schools where automating the process of learning is important to the overall efficiency of the facilities, it's with younger students that this

process of automated testing and education with little to no differences between the ways each student is taught, that causes some issues.

Younger impressionable students do not have the required maturity to properly succeed while being self-sufficient. Generally, a teacher with younger students will have to isolate students that seem to be struggling and work with them to help them find a way to learn that is unique to them.

“schools should help students learn about themselves, encouraging self awareness as a way of promoting cognitive development” (Schmeck, 1988)

Younger students require a more personalised approach than is possible to achieve with automated testing and learning. In the paper “Information and communication technology (ICT) in higher education: advantages, disadvantages, conveniences and limitations of applying e-learning to agricultural students in Iran”, which details the history of e-learning and it’s implementation in Iran had this to say regarding the importance of face to face learning.

“Compared with traditional methods, face-to-face and lively communication does not exist in e-learning. This can cause negative effects on academic progression and characteristic development of students.” (Talebian, Hamid Movahead, & Rezvanfar, 2014)

Automated Correction Software:

Another issue with the automation of testing is the fundamentally flawed auto-correction systems that are often implemented with online testing. More educators are turning to automated correcting as the average number of students in a class causes manual correction to be tedious and time-wasting.

Automated testing can work quite well when using multiple choice exams, however that is extremely limiting in the types of questions that educators can ask. Subjects such as Maths, Accounting, and English focus much more heavily on the process that students take to achieve their answer than the answer itself, making automated correction an ill fit for their question style.

This can be seen in grade deflation. This puts a strain on educators to fit their topics in a question style that allows automated correction, which often doesn't work. For example, when staff at the University of Liverpool began using TRIADS, an assessment-based software, it introduced issues as the correction method of the software was difficult to work with using their already established syllabus.

"they were unfamiliar with the new question styles and lacked confidence in writing suitable questions" (McLaughlin et al., 2004)

The limitations of the system itself can cause several issues also. If the educator chose to go with typed in answers rather than multiple choice questions, the automated correction software might not be capable of the same comprehension of answers as humans are. Grammatical errors or misspellings could cost the student marks as their answer might be rejected by the software. Even answers that are fully grammatically correct could be rejected for pedantic reasons. For example, if the answer is "Six electrons", the following answers would be rejected by an unrefined correction system, "six electrons", "6 electrons", "Six Electrons" etc. This risk is minimised as the correction software becomes more advanced, but the possibility of an unfair marking is still possible.

These problems are slowly being circumvented as the software becomes more sophisticated. And online marking is becoming more prevalent in subjects that it is suited to. However, the initial implementation can be quite difficult, and it requires the full cooperation of staff and the full staff need to be educated on how to work the systems. When talking about the issues they encountered when integrating computer assisted education in Turkey, the journal documenting their process stated:

"Successfully involving teachers in CAE did not occur. Selected teachers were not trained in an adequate fashion" (Usun, S., 2006)

The Internet:

The internet has undoubtedly had a large impact on education. This can be proven by simply taking into account the amount of colleges that employ online testing. In a recent research conducted in the US covering a sample of 990 educational institutions,

“it is only 18.7% of all educational institutions in the USA that do not offer some of their study programs via e-learning” (Radović-Marković, M., 2010)

The internet has connected students and professors with their colleges and schools in many helpful ways, but the presence of the internet itself is not always beneficial to education. The internet is a collection of information easily accessible by the majority of students. Therefore, two major problems can stem from it that affect education in particular. The ease of cheating it provides, and the enormous wealth of false information it possesses.

The ease of the internet allows students to cheat much easier than before. Plagiarism runs rampant in the modern era because of the availability of information and the ease of copying it. Of course, plagiarism was present before the internet, but this ease of use has caused it to become much more common. One author describes student use of the Internet as

"a big study group and an endless archive of cut-and-paste essay components [where] the ability to easily scoop a little flotsam from the vast oceans of the Internet doesn't seem nearly as nefarious as pilfering a passage from a library book" (Fritz, pars. 67)

Software such as “Turnitin” is helping to deter this, but this shows how computer assisted education must be employed in certain situations to fix issues that the internet has caused. Aside from essay plagiarism, websites such as Chegg.com and quickmath.com are designed specifically for students to cheat on their assignments.

Another issue that affects education is the abundance of false information on the internet. The lack of prerequisites or proof of information needed for someone to post articles on the internet leads the vast majority of information on the internet to be biased, prejudiced, or just plainly false. The false information becomes hard to distinguish from the truth and thus has often caused intelligent students to be fooled by structured points and good referencing, manipulated into serving a false conclusion.

“Both trained and casual readers get fooled into believing false information when it is well written, long, and is well-referenced” (Kumar S. and Shah N., 2018).

Conclusion (by Alan Phillips 19262922)

The impact of technology on our society has been and continues to be immense, and the educational sector is evidently no different. In an ever-changing world there arises many new advancements and improvements in teaching and learning, as well as numerous amounts of unforeseen challenges. The limits of what it can achieve are as boundless as technology itself but exercising caution and restraint in the speed of its implementation is of vital importance.

The coexistence of education and computers will no doubt continue to be a topic of inquiry for researchers of learning and developers of technological solutions alike for many years to come.

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