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Evolution of technology in teaching: Blackboard and beyond in Medical Education

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Abstract:

Teaching and learning - the passing of knowledge from one generation to another - has been in existence from the earliest times of human civilization. It began in 1801, with a large piece of slate hung on the wall in a school in Scotland to provide information to a large audience at one time. In the US by mid-19th century, every class room had a blackboard to teach students. The modern version of the blackboard is either green or brown board. This was introduced in late 1960s. The whiteboards came into use during the late 1980s. Projected aids have been used since 1420. The various devices used are the epidiascope, slide projector, overhead projector for transparencies and the micro projector. An instrument to project images from a horizontal surface onto a vertical screen was invented in the 1870s. By the 1960s, transparencies were in use in classrooms.

The 'Hyalotype', a transparent image of a photograph using actual black and white photographs on a glass slide that could be projected was invented in 1851. By 1916, the German company Agfa started producing colored lantern slides. The first version of PowerPoint was released by Microsoft in the year 1990.

Cell phones, palmtops, and handheld computers; tablets, laptops, and media players are included under mobile learning devices. With the evolution of technology, students achieved competence and interested in interactive learning. The education industry has moved from distance learning to e-learning and finally to m-learning as knowledge expanded exponentially and the demand escalated.

While using teaching aids with advanced technology, we must not forget the lessons from the past, striking a balance between embracing new methods of teaching and learning while upholding the timeless principles of education. The newer educational technology can be part of a comprehensive system for lifelong education.

Keyword: Teaching; Blackboard; Medical Education.

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Introduction

Teaching and learning, which is the passing of knowledge from one generation to another has been in existence from the earliest times of human civilization. Teaching in primitive societies occurred through the oral tradition and memory retention. The first primordial step in developing a teaching tool was the advent of writing. Hence, the development of a script and writing can be considered the first 'teaching tool'. Earliest writing may have been on soft surfaces such as the ground surface or sand, and the equipment originally, fingers and then sticks. What is preserved, as the earliest writings are those that were carved on stone tablets. It is of ironic significance that today, another kind of tablet is one of the latest technologies that is used in teaching/learning.

The Sumerians emerged as one of the earliest urban societies in the world in Southern Mesopotamia more than 5000 years ago. They developed a writing system whose wedge-shaped strokes would influence the style of scripts in the same geographical area for the next 3000 years [1]. Eventually, all of these diverse writing systems became known as cuneiform.

By about 3500 BC, various writing systems developed in ancient civilizations around the world. In Egypt, fully developed hieroglyphs were in use as early as 3400 B.C. One hieroglyphic script was used on stone while other scripts were written in ink on papyrus [2].

The documented development and use of 'teaching machines' as against 'teaching aids' dates back to the Greek period. Teaching machines are devices manufactured to demonstrate certain conditions not easily observable. It is the earliest known use of 'teaching technology'. Archimedes (287-212 BC) is attributed to have produced the first documented teaching machines to teach astronomy. Cicero (106-43 BC) had described them and suggested that Thales of Miletus (ca 550 BC) had allegedly constructed a globe which was the precursor to it [3].

The earliest known 'technology' that was used in teaching has to be the stone carver or chisel; if you ignore the sharpened stick used in writing on the sand. The first known 'erasable' tablet used as a teaching aid was when Quintilian got students to write on hard wax tablets using a blunt stylus made of wood or metal. The wax tablet could be scraped to get a new surface to write on it again [4]. This was perhaps the first time reusable writing material was used; a new technological innovation. The use of the stone slate and stylus - an ancient teaching/learning tool before paper and graphite pencils came into common use, was used in rural schools in the developing world as late as the mid-20th century [5].

From this beginning, the teaching machines today have become the computer, the laptop, the modern tablet and the smart phone.

The story of technology in teaching and learning is a long one extending from the misty past of the early ages of human civilization to the present times.

The teaching boards

The need to provide information to a large audience at one time led to the evolution of teaching boards. The whole class or group of students can visualize the information provided on the board. Globally, the classrooms of universities, colleges and schools use blackboard, green board, white board (dry-erase board) or the smart boards.

Blackboard: In Europe and United States (US) during the 18th century, teachers and students used clay tablets. The teacher went to each student and wrote the lesson on each student's slate/tablet. In 1801, in Scotland, James Pillans, Head of the school and geography teacher, hung a large piece of slate on the wall to teach the students [6]. George Baron, a mathematics teacher from the US used the first wall-mounted blackboard of connected slates. In the US by mid-19th century, every class room had a blackboard to teach students. These were made of dark grey or black slate stone [7-10]. Calcium carbonate or calcium sulphate sticks were used to write on the blackboard. The use of the blackboard by a teacher depended on his/her ability to draw and write on the board. It provided variety of opportunities for modifying the presentation of the subject content. The introduction of blackboard was a new innovation that was well accepted by the teachers and it gained popularity across the globe.

Greenboard and Brownboard: The modern version of the blackboard is either green or brown board. This was introduced in late 1960s. These boards were steel plate coated with porcelain-based enamel, which could be used for a long time.

Whiteboards: The whiteboards or dry-erase boards came into use during the late 1980s. They have a glossy-white surface for writing. Instead of chalk pencils, whiteboard pens were used to write on whiteboards. Considering the health reasons and cost-effectiveness, by 1990s most of the class rooms were replaced with whiteboards instead of blackboards [8].

Interactive Boards: Interactive boards are connected to a projector which connects with a computer or laptop. The interactive whiteboards can be mounted on to walls and used in any setting. Towards the end of 2000, the Smart Board came into existence. It is like a dry-erase board that does not use pens to mark on it. It has a projector that puts the image on the board [11].

The teacher could however never reproduce on the boards by either chalk or markers the intricate diagrams in a book. Hence a teaching aid had to be created to do just that. The epidiascope and the overhead projectors were the results of that need.

Projected Teaching Aids:

Projected aids have been used since antiquity. One of the first ones to depict this idea was a drawing by Johannes de Fontana in 1420 which showed a monk with a lantern and the side of the lantern had a translucent window with an image of the devil on it and the image could be projected on the wall. Several people took inspiration from this and created their own versions. Thomas Rasmusser Walgenstein was the first to call the device a "Lanterna Magica" or the Magic Lanterna [12]. A projected aid is used to enlarge the image of a slide or a filmstrip and project it on a screen kept at a distance. The room is either totally or partially darkened. Since a darkened room reduces distraction it tends to be an effective teaching aid. Color on the slides makes it more attractive, motion will make it more dynamic and motion with sound will make it more enticing. Projected aids are useful for small and large group learning [13]. The various devices used are the epidiascope, slide projector, overhead projector for transparencies and the micro projector. The epidiascope is an optical device for projecting a magnified image of both transparent and opaque objects onto a screen. The epidiascope is comprised of an episcope and a diascope. In the epi-position, it can project opaque and flat objects such as textbooks, journal pages and drawings. In the dia-position, with the use of a suitable slide carrier slides can be projected.

Transparencies for overhead projection: French optician Jules Duboscq invented a well-designed instrument to project images from a horizontal surface onto a vertical screen during the 1870s. When the projector was illuminated the audience could see images placed on the horizontal surface on a vertical surface. The United States Army was the first to use it in training in World War II. By the early 1960s, Minnesota Mining and Manufacturing Company (3M) sold transparencies for classroom use [14].

Slides: In 1850, William and Frederick Langenheim, from Philadelphia invented the 'Hyalotype' a transparent image of a photograph using actual black and white photographs on a glass slide that could be projected using a Magic Lantern. Later, transparent colors were added to the pictures to enrich the visual experience. By 1873, a German art historian Bruno Meyer, manufactured and used projected lantern slides called Glasphotogramme in art history lectures. In 1892, the new electric Magic Lantern projectors were introduced. This technology was embraced with enthusiasm by Hermann Grimm, an art history professor at the University of Berlin. In 1916, the German company Agfa started producing colored lantern slides but it was only after the1920s that it was available outside Germany [15].

Software package

The wide availability of computers, laptops, the low cost of convenient storage media and the ease with which teaching materials can be distributed through local area networks (LANs) and the internet have contributed to a great extent to the abandonment of the cumbersome audio-visual aids of the past.

MS PowerPoint: Bob Gaskins and Dennis Austin developed the first version of PowerPoint called presenter in 1984 and Microsoft released the first version of the software in the year 1990. Before the introduction of PowerPoint a lot of time was spent drawing and writing on the board/transparencies/slides. The introduction of PowerPoint thus saved millions of man-hours every year [16]. The prominent place that the chalkboard, whiteboard, and the overhead projector occupied in the classroom was replaced almost completely by the ubiquitous PowerPoint presentation. PowerPoint software package has found wide acceptance among the teaching, scientific as well as the business community for making presentations.

Computer assisted instruction

Computer assisted instruction consists of a range of computer based packages which focuses on providing interactive instruction in a specific subject area. In the field of education, computers were used initially in mathematics, science and engineering as a tool for mathematical problem-solving [17].

Around 1900 the use of computers and e-learning were increasingly incorporated in the teaching/ learning resources in medical schools. In the 1960's the use of computer-based materials were used to demonstrate management of acute abdominal pain in emergency care settings [18]. A large number of high quality computer simulations and computer programs developed by several medical schools are available for instruction. The rapid changes in health care delivery systems and methods of instruction in medical education have also been the driving force for including computers as a teaching tool [19]. Currently, in most part of the world, there is an emphasis on the computer-based instruction in medical curricula starts right from the beginning of the medical school training. During the preclinical years, simulations of experiments, interactive atlas of dissections and anatomical cross sections and simulation programs for learning clinical skills have been incorporated. Case libraries, computer based case simulations, computer modeled patients and clinical reasoning programs are being used in the clinical years [20].

Mobile learning (m–learning):

"A mobile learning educational process can be considered as any learning and teaching activity that is possible through mobile tools or in settings where mobile equipment is available" [21]. Cell phones, palmtops, and handheld computers; tablets, laptops, and media players can all be included under mobile learning devices [22].

With the evolution of technology, also evolving is a generation which has a preference for multimedia to written texts; who have grown up with increasing attachment to technological innovations and are interested in interactive learning [23-25].

The education industry has also been affected by these changes resulting in a transformation in knowledge delivery using information technology and digital media; from distance learning to e-learning and finally to m-learning as is seen today. It was only around 2005 that the term m-learning became known. It was first used to channel e-learning which was being imparted on desktop computers. However, the lack of functionality, processing speed and battery life served as limitations of this approach [26]. In the latter part of 2000s with the introduction of tablets and iPhones the trend shifted to greater mobility adding a boost to m-learning.

Discussion

As stated by [27], a teaching aid assists the teacher in teaching a topic, does only a part of the job and is controlled and administered by the teacher. These aids encompass many kinds of tools starting from the basic Blackboard to the most modern mobile teaching aids. The clarity of the lesson depends on the type of teaching aids. The choice of teaching aid used depends fundamentally on the task to be accomplished.

Black, green brown & white boards

As an old method of teaching aid, the blackboard has advantages of being inexpensive reusable, allow students to keep pace with the teacher and not dependent on electricity. The chalk used for writing requires no special care, is cheaper, without any smell, good impact on presenting written and visual ideas. The disadvantages include time consumption to write, not being very effective for a large audience, content cannot be retrieved once erased and chalk dust may cause respiratory problems [28]. The green board is more pleasing to the eye than black, lighter in weight, more durable and cost-effective. Dust formed while cleaning the board was the only disadvantage which led to the development of chalk-free white boards. Washable or permanent ink markers of multiple colors can be used on such boards as the background is white. There boards are convenient for drawing diagrams and highlighting. The pens used for writing and the solvents used for cleaning have pungent smell and are expensive. Sometimes solvents are required for cleaning the whiteboard when permanent ink markers are used. Added to this is the fundamental limitation that reproducibility of figures was limited by the drawing skills of the teachers.

Epidiascope, Transparencies for overhead projection, Slides:

The epidiascope was used to project any non-transparent pictures, photographs, charts, sketches, 3-dimensional objects and hand written materials. The reason for its popularity was the ease of use by busy practitioners [29] and the fact that it obviates the need for making slides and transparencies. The disadvantages of using an epidiascope is that in spite of having inbuilt powerful fans the pages of the books exposed to the intense heat can become dehydrated and get damaged. The light scattered from the book source is less than 20% and the image formed on the screen may not be bright. Therefore, the room needs to be totally darkened [13, 29].

Transparencies however can be projected in normal lighting to large audiences and the presenter can face the audience. It is easy to prepare with materials that are readily available. The presenter can use strips of opaque paper or cardboard to cover sections to progressively disclose information [29, 30]. The disadvantage is that it cannot be used without electricity and storage is difficult as the transparencies can stick to each other. The projector head can get in the way of audience's view and some presenters feel confined to the machine because they have to manually change each transparency by hand. Another drawback is that it is not suitable for photographic material. Slides overcame this drawback with its ability to show full-resolution photographs. The disadvantages are that it requires a screen, a slide carousel, projection equipment, and power and at least partial darkness for viewing. The order of the slides is fixed in the frame strip making any last-minute additions or changes difficult. Duplication of color slides is difficult or often impossible in resource limited settings [29, 31].

MS PowerPoint, Computer assisted instruction, Mobile learning (m–learning):

The subject content, the learning objectives and learner types are the primary factors that determine the effectiveness of the software package in the learning setting [32]. Although the software package has many features that can be used to promote learning and teaching, it is rarely that one sees teachers incorporating these aspects into their presentations [33]. Among the facilities underutilized is the opportunity for "builds" that may be used to show, for example, variations from the normal in a progressive manner [34]. The choice of font types and sizes that facilitates reading and the factors related to the design that promote or hinder the recall of information have been described. The judicious use of the features available would help the instructor to produce slides that play an important role in conveying the key messages effectively [35, 36]. The slides can be used by both by the teachers as well as the learners. Few presenters use the interactive features available in PowerPoint; instead of relying on text, sound and animation, thus leading to the categorization of the common use of the package as a "weak" form of multimedia [37]. Text-heavy slides with inappropriate and incorrectly used images and symbols abound in many classroom settings [38]. The practice of many teachers providing slides that are loaded with text to their students may be attributed to the fondness of some students for slides of this format, which obviates them from the need of having to take notes. Some critics refer to the emphasis of the use of

unnecessary animations as that which interferes with the presentation of clear ideas.

Apart from PowerPoint, other Computer based materials can enhance or supplement lectures and other tradition methods of instruction. Computer aided instruction is readily accessible in electronic format. It is reproducible, can create an interactive environment and can mimic clinical situations in medical practice. Computers have the advantage of presenting a large number of images, images with sounds, animations and video clips. The information can be easily accessed by students at home and enables individualized learning at their own pace and time [20]. It assists in the understanding of the theoretical concepts when it is applied in a simulated setting. The effectiveness of this method of instruction has been documented in terms of knowledge acquisition and meeting learning objectives [39]. A well-structured computer-assisted session is enjoyable and appealing and maintains the interest of the student [39]. Computer aided instruction reduces the expenses in terms of laboratory costs and consumables. It is a useful aid to demonstrate difficult and time consuming experiments; it can extend the learning experience to a large number of students [20]. The case scenarios in the computer program are effective in imparting knowledge in terms of short-term knowledge gain and problem-solving abilities, but cannot replace patients in the clinical settings [20]. Technical difficulties are often encountered during sessions which could be resolved with appropriate IT assistance [40]. Integration of computer-based resources into modules and learning strategies in the curriculum have been often ignored due to the high cost involved in acquiring appropriate computing materials [41]. Another challenge faced by institutions is the resistance of faculty to adopt computer-based material or to operate these programs in the context of their teaching [20].

When compared to computers the small size of the mobile devices make them portable, helping the doctors or students to enter patient details, transfer them immediately and be able to retrieve the information online without being restrained by location [42]. Desktop or laptop computers are relatively more expensive than mobile devices in spite of the fact that these devices have to be replaced frequently as they could become outdated just like any other technology [42]. The short message system (SMS) available in mobile phones can help in alerting all the students about changes in schedules or alerts on any issues. This is of importance especially owing to the fact that medical students are highly mobile, balancing schedules on campus and off campus [43]. Personal Digital Assistants (PDAs) and smartphones have a variety of productivity tools such as memos, address lists and calendars that provide greater support to the teacher for class management [43-45]. Hand held devices like PDA are ideal for playing podcasts as they can play audio and video files. Videos of simulated patients or sometimes even real patients can be used to design Problem Based Learning case videos which once copied into the device are easily available for the students to revise as and when they desire [42]. PDAs can also serve as knowledge data bases as they are a resource for various activities like accessing electronic texts, patient tracking and obtaining drug information [43-46]. The small screens of the handy mobile devices however pose a difficulty in viewing a large amount of text or vivid graphical representations. Compared with the larger screens offered by desktop or laptop computers this is especially limiting [42]. While portability is an important advantage it also increases the threat of damage or loss and can put the security and confidentiality of information at risk; hence the necessity of password protection and file encryption. The ease of connectivity helps in easy information transfer among students, nevertheless it is essential to inculcate the value of confidentiality, responsibility and other aspects of professional practice. This is especially so in medical practice where confidentiality of patient or cadaver images is at stake [42]. Other activities in a professional environment could be disrupted if basic etiquette of mobile use is not followed during work time [9, 47]. In view of ongoing compatibility issues of these devices, newer generations are being produced to combine greater ranges of functions, fidelity and usability. This ensures that use of mobile devices will most likely become an integral part of education in years to come.

Conclusion

Use of technology in education has come a long way since the earliest times of human civilization. While embarking on aids with advanced technology, we need to take full cognizance of the lessons from the past, striking a balance between embracing new methods of teaching and learning while holding on to the timeless principles of education. Thus, the newer educational technology can be effective tools of teaching and learning in this rapidly changing technological world and be part of a comprehensive system for lifelong education.

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JM, SM, LJJ, NS, JS, RBS -Concept, retrieving the articles and preparing the review. SM-Editing the manuscript.

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