The Historic Mac Series of Medical, Educational Computer Simulations, and their Digital Legacy

These pages recall the pioneering collaboration between a Canadian (McMaster[1]), and a UK (St. Bartholomew's[2]) medical school in developing computer simulation models for medical education, long before personal computers existed. Here, we not only document the models in detail, we also provide viewers with the opportunity to use the models first hand within the browser.

Undergraduate medical education started at McMaster in the fall of 1969. The core of the new academic clinical faculty consisted to a large extent of young, frustrated runaways from established medical faculties in the British National Health Service. The gradually evolving McMaster curriculum emphasized "self-directed, problem-based learning", and frowned on traditional lectures and rote memorization. Moran Campbell, the McMaster chairman of internal medicine invited an extremely creative British colleague – John Dickinson - for a sabbatical year (1970/1), to help design challenging stimuli for problem based learning.

For John Dickinson, understanding applied patho-biology was a key competence for future physicians. Practising on dynamic models of circulation, respiration, acid-base regulation, and so on should prepare students better for dealing with the physical problems of sick patients.

MACMAN became the first of the mac-series of educational computer simulations. It models the behaviour of the human vascular system under various conditions, providing users with different symptoms and other clinical data, requiring interpretation, and therapeutic options. MACMAN was programmed in FORTRAN, and ran on the IBM 1130 computer of the epidemiology department. John was joined by colleagues and a student in the subsequent development of MACPUF, MACPEE, and MACDOPE.

As John Dickinson was appointed chairman of medicine at St Bartholomew's Hospital in London, the centre of further development and professionalization of the mac-series moved with him. The advent of personal computers facilitated the dissemination of the mac-series, though their prevailing archaic user-interface proved to be a barrier for wider acceptance by students.

Except for training in endoscopy and minimally invasive surgery, computer models today play a very small role in medical education. The mac-series of 'medical, educational computer simulations" fell into oblivion – a missed opportunity.

From the dawn of civilization on, complex competencies were transmitted by a coordinated combination of direct instruction, and supervised practice followed by corrective feedback. Both 'in-vivo', and 'in-vitro' practice tasks were employed. The former are more authentic, but raise ethical issues, while the latter tend to be more readily available, and carry lower risks.

Video games, based on realistic computer models, can provide unlimited opportunities for 'in-vitro' practice. Similarly, social games can be developed to practice interpersonal competencies.

The cost-effectivess of computer simulators to train pilots is attested by by the fact that:

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1 McMaster University Medical School, Hamilton, Ontario, Canada
2 The Medical College of St Bartholomew's Hospital, London, UK

> Flight simulator market size reached USD 6.90 Billion in 2021 and is expected to register a Compound Annual Growth Rate (CAGR) of 6.7% during the forecast period, according to latest analysis by Emergen Research. (Bloomberg, 3 January 2023)

In a similar vein, user acceptance of the video game paradigm by young adults is supported by:

> The global gaming market size is anticipated to reach USD 504.29 billion by 2030, exhibiting a CAGR of 10.2% during the forecast period, according to a new report published by Grand View Research, (Bloomberg, 8 Aug. 2023)

These data suggest that catching up with the so far missed opportunities by systematically developing and introducing practice simulators for medical education could result in achieving significant gains of both effectiveness, and cost-effectiveness of medical education.

To be effective, the scope of practice simulators would have to cover the whole gamut of undergraduate-, postgraduate-, and continuing medical education. Their content would have to be both scientifically solid, and didactically sound. Developing such a library would require a herculean effort exceeding the capacity of any one individual medical school. Only a large national, or even better international collaboration could fill the bill.

McMaster has taken some steps into this direction with its Centre for Simulation-Based Learning (CSBL).