Summary of "unsupervised Machine Learning Algorithms Examine Healthcare Providers' Perceptions and Longitudinal Performance in a Digital Neonatal Resuscitation Simulator" by Lu et al. (2020)

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Introduction

This paper addressed the problem of the unavailability of simulation-based medical education (SMBE), a simulated clinical environment that corresponds to a real-life experience, in developing skills for supporting neonatal resuscitation. The authors explored the possibility of integrating digital SBME as an alternative educational tool to traditional medical education and studied the effectiveness of the *RETAIN* game as such a tool in the performance of the healthcare professionals (HCPs).

In delivery rooms, HCPs need to make rapid decisions and act precisely in a time-restricted manner. In complex situations, newborns often need assistance in learning to breathe independently at birth. Newborns who require breathing assistance must go through a series of sequential tasks completing the preceding tasks successfully. In studies, researchers observed that HCPs have increased human errors and reduced performance in such restricted tasks due to stress, which results in poor patient health outcomes (McCarthy, 2013; Al-Elq, 2010). In order to improve performance, the recent neonatal resuscitation guidelines recommend using SBME (Perlman, 2015). Studies with mock patients found that the SBME enhanced HCPs' cognitive performance and reduced risks to both patients and learners (Donoghue, 2009; Al-Elq, 2010). Unfortunately, SBME is often not readily available to trainees because of lack of time, personal requirements, and its cost extensiveness. Moreover, the optimal frequency of SBME training to achieve educational goals is still unknown (Cutumisu, 2018).

Existing Approaches

In recent years, computer-based medical programs have been introduced to improve knowledge retention and mitigate human errors as an alternative medium of SBME (Cutumisu, 2018). Alternative computer-based simulators is established to be a potential motivator to HCPs, helping them to understand a difficult task in a simplified way. Although board games, video games, mobile learning platforms, virtual environments, and simulations are developed for the HCPs to train, their performance and attitudes towards these modern tools have yet to be broadly identified. Cutumisu and her colleagues designed a computer-based game called RETAIN to educate HCPs on neonatal resuscitation as a complementary tool to SBME. The RETAIN game was implemented using the Neverwinter Nights game engine, and the characters in the game were designed in such a way that they could provide information about the tasks when the users interacted with them. RETAIN consists of a short tutorial and three simulated neonatal resuscitation training levels using action cards, adjustable respiratory function monitors, and equipment pieces.

Study Objectives

This paper examined HCPs' perception of using the RETAIN game. The authors explored whether the HCPs' growth mindsets or fixed mindsets have any connection to their neonatal resuscitation performance. The authors performed an analysis based on HCPs' survey responses to comprehend the efficacy of the digital simulation-based training programs on user performance using the RETAIN game. This study has four

research objectives: 1) examine the validity of the instruments used in the survey, 2) study the factors that influence user attitudes towards technology, 3) identify different clusters from a cluster analysis based on user attitudes, and 4) explore the long-term pattern of performance of these clusters.

Statistical Analysis and Findings

A total of fifty HCP participants took part in the study on the RETAIN game. Participants' demographic information was collected through a questionnaire, and baseline performance was assessed via RETAIN tutorial simulator. Then, participants' performance was evaluated by two practice tests and a final test with a complex clinical scenario. Finally, participants' performance was measured by scoring in the four game-based tests (a pretest, two posttests using a digital simulator, and a delayed posttest using a tabletop simulator) following the 7th edition of the Neonatal Resuscitation Program (NRP). A binary score of one was given when the performance was 100% in agreement with the NRP guidelines and zero otherwise.

The authors performed several statistical tests to assess the four objectives of the study. They employed an unsupervised machine learning algorithm called agglomerative hierarchical clustering and established three clusters based on participants' attitudes. These three clusters are: 1) the highest endorsement on most items and high motivation in technology, 2) neutral attitudes on all survey items, and 3) the highest level of agreement on growth mindset but the lowest interest in using technology for career improvement.

Two generalized linear mixed models (GLMM) for repeated measurements were used to examine the participants' performance trajectories over time. The first GLMM model tested the effects of time on the three clustered groups fitted over the entire data set. In this analysis, the within and between variables are repeated time measurements (performance from four tests) and the three HCP groups, respectively. The second GLMM model tested the performance trajectories within each cluster fitted on three different groups of data. Again, the within variable was repeated time measurements, and participants' ID was used as a random effect in both models.

Regardless of the participants' different attitudinal views, all participants improved their performance over time and transferred their knowledge to a new medium (a tabletop simulator) after the digital simulator intervention. Surprisingly, cluster three participants who enjoyed the least using the technology or the digital simulator had the lowest score in the two immediate posttests but improved their performance significantly when the medium of training was changed.

Conclusion

The authors argued that negative attitudes toward technology could block learners' progress in the short term, but a positive growth mindset could still help them learn in the long term. Herein, having a growth mindset shows a way to improve performance over time. It would be interesting to study the factors that influence users' performance in the long run, regardless of their negative attitude towards technology as a medium for career improvement. Ultimately, incorporating those factors in digital simulation training and measuring its effectiveness may attract a broader audience of users. The study proposes that traditional medical training must take advantage of technological advancement, and the novel RETAIN simulator may serve as a supportive approach to traditional neonatal resuscitation training.

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