The Power Law of Practice in adaptive training applications

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Abstract

This research paper was inspired by the difference of findings in empirical learning-curve-data collected by ourselves and those of Newell and Rosenbloom (1981), who analysed empirical data-sets from other investigators to prove the ubiquity of the Power Law of Practice. The aim of this paper is to show some fundamental statistical and numerical flaws associated with Power Law analysis in this research literature. Additionally, we present the results from analysis of empirical data that reveal the low predictive value of the Power Law of Practice, using least-squares non-linear regression technique to find the best fitting estimate for the free parameters of the Power Law. These exercises lead us to the recommendation to take account of these flaws, for example, when considering application of the Power Law of Practice in adaptive training or intelligent tutoring.

Introduction

We have been searching for some time for a psychological model that successfully predicts the learning curve for students acquiring complex skills in the aviation domain. An example of this is the prediction of the learning curve of military pilots who learn to fly a specific mission. The model we were looking for would be able to predict the course of trainees' future task performance on the basis of a series of previous trials performed on the task. With future task performance, we mean the performance level that is reached after a specified number of training trials or a specified amount of training time.

When used in an adaptive training device (e.g. a suitably equipped flight simulator), it would be possible, with the use of such model, to optimally adapt the learning environment. We could, for example, adapt the complexity of the training task or we could adapt the feedback to the trainee. An accurate prediction of future task performance could lead to the optimal adaptation. In fact, a predictive model would actually be indispensable in an adaptive training device (or intelligent tutoring device) for training complex skills. After all, from a didactical point of view, the ultimate aim of a training device is to influence future task performance-- that is, to deliver a skilled operator after a certain (most often restricted) amount of training time. Thus, the output variable that must be controlled by the adaptive logic is future task performance, rather than momentary task performance. For example,