The U.S. military continues to develop and expand its use of simulation-based aviation training. While traditional simulation-based training continues to be a proven training method, game-based simulation has become more sophisticated and may provide viable training options in some applications. The use of game-based simulation with traditional simulation-based training can potentially reduce costs, enhance return on investment, advance training objectives, and inform future training environment designs. Current fiscal limitations are driving the need for more efficient training methods, while operational requirements are dictating training protocols that produce optimum levels of readiness. The gap between fiscal constraints and desired training outcomes can be addressed by investigating whether lower-cost, game-based simulations may potentially augment higher-cost, traditional simulation-based training approaches for specific training tasks. Performing a valid investigation of the value of these simulation environments depends on a thorough evaluation of their training effectiveness. However, current approaches to Training Effectiveness Evaluation (TEE) do not adequately address the complete range of factors required to effectively investigate this gap. The present effort leverages research from human performance assessment, neurophenomenology, and instructional science to identify and integrate a set of empirically validated measures that contribute to training effectiveness. From this foundation, an interdisciplinary approach to performing TEEs for simulation training is presented that addresses the shortcomings of current practices. This approach is validated in a use case involving the evaluation of Army Aviation collective training.