The Influence of Interactive Digital Environments on Cognitive Performance and Learning Outcomes among Students in Educational Settings

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Abstract

This study investigates the impact of interactive digital environments on cognitive performance and learning outcomes among 200 students in educational settings. The independent variable, interactive digital environments, is measured by the level of interactivity, incorporating virtual spaces and video games. Two dependent variables are examined: engagement, assessed through self-report surveys, and recall of information within the digital space, evaluated through assessments. The study focuses on students in educational settings as the target population. By exploring these relationships, this research aims to contribute to a deeper understanding of how interactive digital environments influence learning processes and outcomes.

Introduction

In today's educational landscape, the incorporation of technology has received attention for its potential to enhance learning experiences. Interactive digital environments, a key aspect of this technological integration, have the potential to provide immersive and engaging educational interactions. Despite this promise, the extent to which these environments truly facilitate meaningful learning remains unclear. This study seeks to address this gap by investigating the impact of interactive digital environments, including video games, on cognitive performance and learning outcomes among students in educational settings. By delving into these factors, we aim to shed light on the efficacy of such technologies in the realm of education.

A study by Barko and Sadler (2013) explores the conceptual distinctions between video game learning and traditional classroom and laboratory learning. The authors' focus on the notion of virtual experience by comparing a conventional high school laboratory protocol on DNA extraction with a biotechnology-themed video game. Notably, the paper challenges the conventional view that virtual experiences are exclusively generated by computer-aided technology, asserting that the concept of virtuality extends to real-world experiences. The authors propose that the medium of the learning experience, whether a video game or a traditional classroom, should not be a crucial distinction. Instead, the emphasis should be on identifying meaningful experiences applicable to both environments. This study provides insights into the broader ideas surrounding video game learning and its relationship with traditional educational settings.

In a study by Squire (2013), the author explores the potential of interactive digital media, particularly video games, as a powerful medium for learning. Showing the importance of the immersive nature of video games, Squire argues that they provide more than just factual

knowledge. Video game learning allows players to develop problem-solving skills and gain different perspectives. The concept of "serious games" is introduced, encompassing various applications such as business strategy, advergaming, and entertainment gaming, which embody immersive learning experiences. Drawing on interviews with leading designers, the article presents case studies of organizations developing serious games, demonstrating diverse perspectives that have similar conclusions. Squire (2013) states that serious games challenge traditional notions of information dissemination, tools, and aesthetics, bringing in new tools for eLearning in the digital age. This study contributes to our understanding of the evolving role of video games in instructional practices and underscores their potential to reshape educational paradigms.

In a study by Madden et al. (2020), the authors look into the potential of another type of video game by studying immersive virtual reality (VR) in education. By investigating the predictors of student learning in VR, the study aims to find out if VR offers distinct advantages over traditional learning. Through a between-subjects experiment comparing three teaching methods for Moon phases (hands-on activity, VR, and desktop simulation), the researchers assess student improvement on existing learning and attitudinal measures. Despite a notable preference for the VR experience among students, the study reveals no significant differences in learning outcomes across conditions. However, noteworthy disparities based on gender emerge, with a strong correlation observed between gender and experience with video games. These findings suggest that certain demographic groups may benefit more from immersive VR settings, highlighting the need for further exploration into the differential effects of digital environments on student learning.

Transitioning to another study related to the impact of digital environments on education, in their study, Nin et al. (2023) shed light on the significance of executive functions, including working memory, inhibitory control, and cognitive flexibility, in facilitating goal-oriented behaviors and educational success, particularly from an early age. While prior research has demonstrated the potential for computerized activities to enhance executive functions, much of the evidence originates from controlled laboratory studies, leaving gaps in understanding the efficacy of interventions in real-world settings. Moreover, the influence of school socioeconomic status on the effectiveness of such interventions remains underexplored. Addressing these gaps, Nin et al. (2023) investigated the efficiency of a short training program aimed at stimulating executive functions in kindergarten classes from diverse socioeconomic backgrounds. Through a randomized, pre/post, controlled design involving 136 children, the researchers observed improvements in working memory span and performance in a fluid intelligence task among all participants in the training group. Notably, gains in inhibitory control and cognitive flexibility were predominantly observed in children from low socioeconomic background schools. Despite these improvements, the study found no evidence of enhanced performance in planning tasks or classroom behaviors associated with executive functions, highlighting the complexity of these effects.

Sáez-López, et al. (2015) conducted a study aimed at evaluating the utilization of MinecraftEdu in classroom settings, with a focus on analyzing outcomes and attitudes among various stakeholders in the educational community. Employing a quasi-experimental approach, the research assessed the application of MinecraftEdu in a unit on 'History and Architecture,' comparing it to a control group utilizing traditional teaching methods. Additionally, the research evaluated the attitudes of teachers, students, and parents towards the integration of video games

in formal education. These analyses facilitated the comparison of attitudes across different groups. Furthermore, the study explored interactions in the virtual learning environment associated with MinecraftEdu implementation. Despite the absence of significant improvements in academic outcomes and some parental concerns, the majority of participants perceived MinecraftEdu as an enjoyable tool that fosters creativity, exploration, and immersion in historical contexts. This study provides valuable insights into the application and integration of video games, particularly MinecraftEdu, in middle school education.

The purpose of this study is to investigate the impact of interactive digital environments, specifically video games, on cognitive performance and learning outcomes among students in educational settings. The independent variable, interactive digital environments, will be assessed based on the level of interactivity, which includes virtual spaces and video games. Two dependent variables will be measured: engagement, gauged through self-report surveys, and recall of information within the digital space, evaluated through assessments. It is hypothesized that higher levels of interactivity in interactive digital environments will be positively associated with increased engagement among students. Additionally, students exposed to interactive digital environments are expected to demonstrate higher levels of recall of information within the digital space compared to those in traditional learning environments. The study will adopt a quasi-experimental approach, collecting data through self-report surveys and assessments.

Method

Participants

The study will recruit a sample of students from various educational institutions, aiming for a total of over 100 participants. This sample will comprise individuals across diverse demographics, including gender, ethnicity, income level, student status, and computer

proficiency. Incentive would be provided through school credit. Detailed information that could potentially identify participants will be avoided to maintain confidentiality. Informed consent will be provided before involvement in the study. Ethical considerations will be prioritized, to ensure confidentiality and anonymity throughout the process. Convenience sampling will be used to recruit participants from various educational institutions. This method allows for the selection of participants based on their accessibility and availability within these settings. While convenience sampling may limit the generalizability of the findings, efforts will be made to ensure diversity in the participant pool.

The study will utilize interactive digital environments as the primary materials. The independent variable (IV) is the level of interactivity within these digital environments, encompassing features such as virtual spaces and video games. The dependent variables (DVs) include engagement and recall of information within the digital space. Engagement will be measured using self-report surveys, while recall of information will be assessed through performance on assessments.

To ensure reliability, the self-report surveys will be designed with established psychometric properties and validated scales where appropriate. Additionally, the assessments for recall of information will be carefully constructed to provide consistent and accurate measurements of participants' performance.

The task for participants will involve engaging with the interactive digital environments for a specified period. During this time, participants will explore various activities within the digital space, such as completing educational tasks or interacting with virtual scenarios. Following the exposure period, participants will complete self-report surveys to gauge their level of engagement. Subsequently, participants will undergo assessments to evaluate their recall of

information presented within the digital environment. This approach helps develop insight on the impact of interactive digital environments on cognitive performance and learning outcomes among students in educational settings.

Procedure

Participants will be recruited from educational institutions using convenience sampling methods to select individuals based on their accessibility and availability within these settings. Before participation, all recruited participants will be provided with detailed information about the study objectives, procedures, and potential risks and benefits. Informed consent will be obtained from each participant or their legal guardians if they are minors. Prior to exposure to the interactive digital environments, participants will go through pre-testing to establish baseline measures of cognitive performance and learning outcomes. This may involve assessments or surveys to gauge initial levels of engagement and recall of information.

Participants will engage with the interactive digital environments for a specified duration, during which they will interact with various features such as virtual spaces and educational tasks.

Following the exposure period, data will be collected through self-report surveys to measure engagement and assessments to evaluate recall of information within the digital space. Participants' responses will be recorded.

Upon completion of data collection, participants will be provided with a debriefing session where they will receive more information about the study's objectives and have the opportunity to ask any questions or express concerns.

Data Analytic Plan

Data collected from surveys and assessments will be analyzed using appropriate statistical techniques to examine the relationships between interactive digital environments, cognitive performance, and learning outcomes among students in educational settings.

The study will be conducted in controlled environments within educational institutions. These settings will provide an atmosphere for participants to engage with the interactive digital environments without external distractions. Dedicated spaces equipped with the necessary technology, such as computers or VR headsets, will be allocated for the study. These settings will ensure consistency and standardization across participant experiences, minimizing potential confounding variables.

Efforts will be made to standardize the testing environment and procedures across all participants to maintain consistency and reliability of the results. These design controls will enhance the internal validity of the study, allowing for more accurate conclusions regarding the impact of interactive digital environments on cognitive performance and learning outcomes.

Proposed Analyzes

It is hypothesized that a positive relationship between the level of interactivity in interactive digital environments and students' engagement. Pearson correlation analysis will be utilized, treating the level of interactivity as the independent variable and students' self-reported engagement as the dependent variable. Assumptions of normality and linearity will be evaluated for the correlation analysis, with normality assessed using measures such as skewness and linearity examined through visual inspection of scatter plots. The consistency of residuals' spread will be evaluated using scatter plots of standardized residuals. Engagement will be assessed through Likert-type scale responses in self-report surveys, with scores calculated by totaling the responses to individual items. Descriptive statistics, including means and standard deviations,

will be calculated for engagement scores. If significant relationships emerge initially, further exploration may involve conducting post-hoc tests like pairwise comparisons or simple effects analyses. These analyses will provide valuable insights into the relationships between interactive digital environments, cognitive performance, and learning outcomes among students in educational settings.

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