# The Effects of Active and Passive Learning Methods

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## Abstract

While active learning is widely recognized as the more instructional approach for improving student engagement and knowledge retention, traditional passive learning methods remain prevalent in modern educational settings. The study examined the effects of active and passive training methods on immediate comprehension and application of new knowledge, evaluating whether study duration influenced learning outcomes. Using a 2-by-2 factorial design, participants were assigned to either active or passive training conditions and to a 10- or 20-minute time constraint prior to completing a post-test. The analysis of the post-test outcomes showed that those in active training conditions achieved significantly higher scores than those in passive training conditions, with a statistically significant effect of the training method (p=0.007). In contrast, study duration showed no significant effect on performance. These findings suggest the importance of learners' active engagement with learning materials for immediate comprehension and application of new material, supporting how active training methods play a critical role in educational environments.

## Keywords

Active vs. Passive Training, Educational Research, Comprehension and Application, Study Duration

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## 1 Introduction

Educational systems have undergone significant changes over the past decades to foster improvement in instructional practices and learning outcomes (Yue, 2024). Despite these past advancements and developments of new training methods, determining the most effective method for immediate comprehension and application of new knowledge remains an important challenge in the field of education. As the learning environment becomes increasingly diverse and complex, and as new learning methods emerge in contemporary educational settings, educators continue to seek instructional approaches that most effectively encourage student engagement and enhance academic performance.

Among the most widely discussed approaches in education, two of the prominent methods include active and passive learning (Bonwell & Eison, 1991). Passive learning, more traditionally characterized by lectures and instructor-led explanation, positions students as recipients of information; in contrast, active learning is often characterized by the learners' direct engagement in the learning process in forms of discussions, questioning, problem-solving, and self-assessments. As such, active learning encourages proactive construction of knowledge and understanding by applying concepts during the learning process (Chi & Wylie, 2014).

Recent educational research has suggested that active training methods may lead to improved student outcomes (Freeman et al., 2014). Despite the benefits, lecture-based passive training methods continue to play a significant role in many educational settings, primarily for their efficiency in delivering masses of information to large numbers of people (Bligh, 2000), as well as their familiarity to both instructors and learners alike (Burgan, 2006). This raises important questions about the comparative effectiveness of such approaches and the settings in which each method can be deemed beneficial.

This study aims to investigate the effects of active and passive training methods on students' immediate comprehension and application of new material. Specifically, participants were either administered an active training method in which they answered comprehension questions throughout the learning process, or a passive training method in which they studied the same material without interruption. Additionally, the study examined whether the amount of study time influenced learning outcomes by comparing participants who were given either 10 or 20 minutes to study the material. The study measured the effectiveness of both training methods with a post-test, measuring the participants' ability to understand and apply the new knowledge.

Understanding the strengths and limitations of active and passive training methods is essential for educators and curriculum designers who aim to enhance the quality of education. As demands of modern education continue to evolve, identifying evidence-based teaching practices will be critical in fostering meaningful and lasting learning experiences.


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## 2 Literature Review

The effectiveness of active training methods compared to traditional passive training methods has been a major focus of educational research over the past several decades. Research has increasingly suggested that active training promotes deeper understanding and stronger retention of knowledge by encouraging students to further construct knowledge proactively rather than simply receiving information (Lovett et al., 2023).

A previous study conducted by Scott Freeman et al. (2014) examined the effectiveness of active learning methods by performing a meta-analysis of 225 studies comparing active learning with traditional lecturing in science, technology, engineering, and mathematics (STEM) education. The study showed that students in active learning environments achieved significantly higher examination scores. It also showed that students in lecture-based courses experienced substantially higher failure rates. These findings provided strong empirical evidence that active learning consistently produces higher academic outcomes in a range of academic contexts.

Michelene T.H. Chi and Ruth Wylie (2014) also proposed the Interactive, Constructive, Active, Passive (ICAP) Framework, which explained how different forms of cognitive engagement produce different levels of learning outcomes. The proposed framework suggests that the effectiveness of learning increases as students move away from passive activities, such as listening to lectures, and move toward active behaviors that contribute to generating new ideas or explanations. Chi and Wylie argued that higher levels of engagement promote deeper cognitive understanding and construction of knowledge, such that the training method results in improved understanding and information retention. The ICAP framework provides a strong theoretical basis for the effectiveness of active training methods by demonstrating the critical role of cognitive engagement in maximizing learning outcomes.

In a study by Douglas B. Markant et al. (2016), active learning was found to enhance retention and memory by increasing engagement with information and encouraging self-directed exploration of the study material. The researchers argued that active participation strengthens the processes by which learners obtain and encode new information into memory and therefore improves long-term retention. Learners who actively interact with the material are more likely to develop meaningful cognitive connections that aid in later recall in comparison to learners who passively receive information.

A study conducted by Louis Deslauriers et al. (2019) found that students in active learning environments demonstrated significantly greater learning gains than students in traditional, passive settings despite reporting lower feelings of learning. Authors of the study suggested that while passive learning may accompany greater self-reported feelings of learning, active learning introduces productive cognitive effort referred to as "desirable difficulties" that make learning feel more challenging while ultimately improving understanding. These findings thereby highlight an important distinction between perceived ease and actual effectiveness in learning.

Thus, existing literature consistently indicates how active training methods outperform passive training approaches in knowledge retention and academic achievement by encouraging meaningful engagement with the material. The present study aims to build upon the existing body of research by examining whether active training continues to provide meaningful advantages over passive training under different study time conditions.

## 3 Method

### 3.1 Participants

Participants were recruited through Prolific, an online research platform. Respondents participating in the experiment were directed to a custom-built survey website that administered the study.

Participants provided informed consent and were compensated through Prolific at the platform's standard rate. All 85 participants who completed the study were included in the research.

### 3.2 Technology

The study materials and the training methods were administered through a web application using the Python Flask framework and a client-server architecture. Participants were able to access the application through any modern web browser and a variety of compatible devices. The implementation enabled features such as automated random assignment, standardized delivery of treatment conditions, and efficient data collection for subsequent analysis.

### 3.3 Research Design

The study employed a 2-by-2 factorial experimental design examining the effects of training method and study duration on knowledge comprehension and application (using the knowledge obtained in challenging exercises). The two independent variables were the administered training methods (active training vs. passive training) and time allocation (10 minutes vs. 20 minutes), resulting in four treatment conditions:

- Condition A: Active training method with a 10 minute time limit
- Condition B: Active training method with a 20 minute time limit
- Condition C: Passive training method with a 10 minute time limit
- Condition D: Passive training method with a 20 minute time limit

Participants were randomly assigned to one of the four conditions upon entering the study. Randomization was handled automatically through the survey platform.

### 3.4 Study Material

The study material consisted of an informational article published by Red Hat discussing the concepts of generative artificial intelligence and agentic artificial intelligence. The article was selected based on its moderate technical complexity. This enabled participants to be presented with unfamiliar material that they may encounter in the media. The topic was considered suitable for evaluating training methods in immediate comprehension and application of knowledge. It required participants to process and understand new conceptual material and apply what they have learned in a practical exercise.

### 3.5 Respondent Demographics

Random assignment resulted in 20, 21, 20, and 24 respondents allocated to conditions A, B, C, and D, respectively. The participants' ages ranged from 18 to 72, with a mean age of 36.7 and a median age of 36. The sample was predominantly male (63.5%), with 34.1% identifying as female and 2.4% as non-binary. Participants also self-reported their level of technology proficiency, with 39 (45.9%) identifying as advanced, 35 (41.2%) identifying as intermediate, and 11 (12.9%) identifying as basic. Daily internet usage was also collected, given its potential relevance to the study material, with 58.8% of participants spending between 5 and 10 hours online per day, while 20.0% reported more than 10 hours online per day.

A pre-test was not conducted to preserve the novelty of the study material. Therefore, baseline equivalence rests on random assignment, and demographic features were similar across the four conditions (mean ages of 38.0, 34.5, 37.2, and 37.2 years for Conditions A–D).

### 3.6 Procedure

After being assigned to their respective conditions, participants were instructed to study the article within their allocated time limits of either 10 or 20 minutes. A visible countdown timer remained on screen throughout the study period.

Participants in the passive training conditions (Conditions C and D) were instructed to read the article without interruption or interaction. In contrast, participants in the active training conditions (Conditions A and B) were instructed to read the article in sections. Following each section, participants completed short multiple-choice comprehension questions designed to reinforce understanding and encourage active engagement with the material.

After the allocated study period expired, participants were directed to a 10-question test administered uniformly across the four treatment conditions. The final questionnaire was designed to assess critical thinking and the application of knowledge acquired from the article. The areas in which the respondents were tested included application in real-life situations, comparison in context, and evaluation to extend upon simple factual recall. Participants' final percentage scores on the post-test were recorded as the primary outcome measure for subsequent analysis.

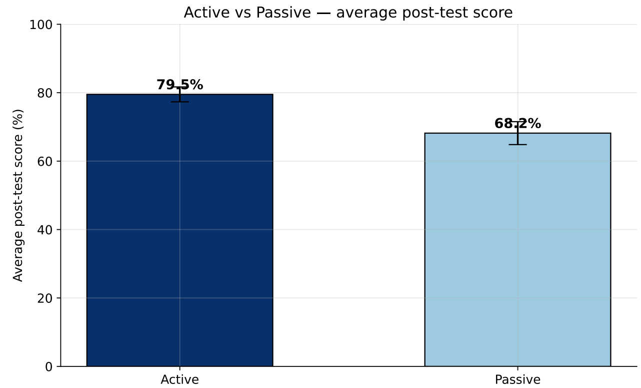


**Figure 1: Average post-test score by training method. Bars show the group mean percentage score for the Active (n = 41) and Passive (n = 44) training conditions, collapsed across study duration; error bars denote ±1 standard error of the mean. The active group averaged 79.5%, versus 68.2% for the passive group, an 11.3 percentage-point difference.**

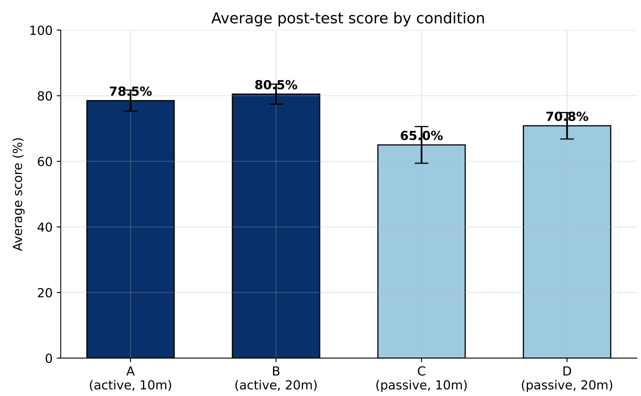


**Figure 2: Average post-test score by treatment condition. Bars show the group mean percentage score for each of the four conditions (A: active, 10 min, n = 20; B: active, 20 min, n = 21; C: passive, 10 min, n = 20; D: passive, 20 min, n = 24); error bars denote ±1 standard error of the mean. Both active conditions outscored their passive, same-duration counterparts: A exceeded C by 13.5 percentage points, and B exceeded D by 9.7 percentage points.**

## 4 Results

Figure 1 shows the average test score by training methods, with the active and passive training method groups scoring an average score of 79.5% and 68.2%, respectively. The difference of 11.3 percentage points suggests better comprehension and application of new knowledge for the active training group.

Figure 2 shows the performance across the four treatment conditions. Active training groups in both 10- and 20-minute

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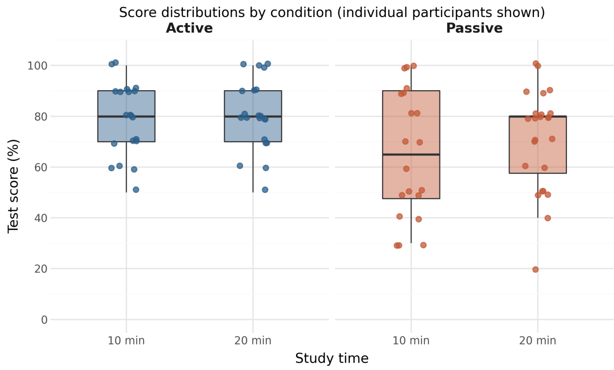


**Figure 3: Score distributions by condition and study duration, with individual participants shown. Box plots give the median and interquartile range (IQR) of post-test scores (%) for the Active and Passive training methods at each study duration (10 min, 20 min); whiskers extend to the most extreme values within 1.5×IQR, and each point is one participant's score. Passive-condition scores show visibly greater spread, including more low-scoring outliers, than active-condition scores at both durations.**

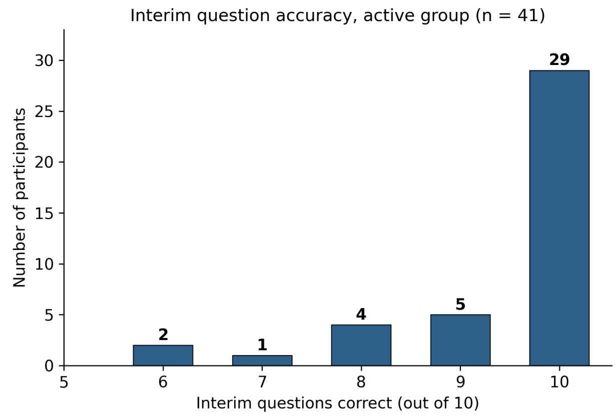


**Figure 4: Distribution of interim comprehension-question accuracy for the active training group (n = 41). Bars show the number of participants who answered each possible count (6 through 10) of the ten embedded interim questions correctly; no participant in this group scored below 6 of 10. Most participants (29 of 41) answered all ten interim questions correctly.**

**Table 1: Analysis of Variance**

| Source of Variation | df | SS | F | p |
|---|---|---|---|---|
| Training Method (Active vs. Passive) | 1 | 27.25 | 7.71 | .007 |
| Training Time (10 min vs. 20 min) | 1 | 3.33 | 0.94 | .335 |
| Training Method × Study Duration | 1 | 0.79 | 0.22 | .639 |
| Residual | 81 | 286.34 | — | — |

Note. ANOVA was conducted on raw test scores (0–10 scale).

time constraints scored consistently higher than their passive counterparts, with a 13.5% difference between group A and C and a 9.7% difference between group B and D.

Box plots in Figure 3 show distributions of participant post-test scores (%) across treatment conditions. Compared to passive training participants, active training participants showed less variability in test performance. This suggests that the use of active training methods not only raised average performance but also produced more consistent results.

Figure 4 shows the performance of the active training group in the interim quiz, with the majority of participants (29 out of 41) answering all 10 questions correctly. Very few participants received a score below 8 out of 10, suggesting that the participants actively interacted with the material and completed the task as intended, thereby indicating a high level of engagement.

A two-way Analysis of Variance (ANOVA) was conducted to examine the effects of training method (active vs. passive) and training time (10 minutes vs. 20 minutes) on participants' performance on the questionnaire. The training method effect corresponded to partial $\eta^2 = .087$ (Cohen's d = 0.61), a medium-sized effect. Effect sizes for duration and the interaction were small (partial $\eta^2 = .011$ and .003, respectively). The analysis revealed a statistically significant main effect of the training method ($F = 7.71$, $p = 0.007$), indicating that participants who engaged in active training achieved significantly higher test scores than those who participated in passive training. This finding is consistent with the descriptive results presented in Figures 1 and 2. In contrast, the main effect of training time was non-significant ($F = 0.94$, $p = 0.335$).

Additionally, the interaction between training method and training time was non-significant ($F = 0.22$, $p = 0.639$). The result indicates that the advantage of active training remained relatively consistent and stable regardless of whether participants were given 10 or 20 minutes to study the material. Considering these results, the experiment suggests that the method of training had a greater influence on post-test outcomes than the amount of study time.

After Levene's test, there was a meaningful difference in variances across conditions, reflecting the greater variability in the passive conditions visible in Figure 3. A Welch's t-test for the method contrast, which does not assume equal variances, confirmed the effect ($t(73.0) = 2.83$, $p = .006$).

## 5 Conclusion

The study examined the effect of active and passive training methods in the acquisition and application of new knowledge and whether these advantages are influenced by the amount of time available for study. Participants in the active training conditions achieved higher average scores (79.5%) than those in passive training conditions (68.2%), with confirmation of a statistically significant effect of training method via ANOVA ($p = 0.007$). In contrast, the study duration was shown not to have a significant effect on performance.

The findings of the study suggest that the methods by which learners engage with the study material can be more effective than the amount of time spent on studying it; as active training strategies require learners to process and apply information, it is able to promote stronger understanding and application than passive exposure alone. The results are also consistent with the findings of previous research that identified active training methods as an effective instructional approach in various educational settings relative to passive training methods.

The study further proposes a practical implication for educators and instructional designers, highlighting the importance of incorporating proactive training methods into learning, especially when instructional time is limited. While increasing the study time is often assumed to improve learning outcomes significantly, the findings of the study suggest that the quality of learner engagement may be a more critical factor than the duration of study. However, since the study compared only two durations using a single article, the absence of a duration effect may also indicate that 10 minutes was already sufficient to process the particular text used in the study; the present data cannot distinguish between these explanations. Hence, incorporating opportunities for learners to reflect on or test their understanding of the material in between may yield greater benefits than simply extending exposure to content.

It is also important to note that the active manipulation displayed in this study is a form of interpolated retrieval practice rather than active learning in general, as interpolated retrieval practice includes answering comprehension questions during reading, whereas active learning in general includes discussions or problem-solving. Although the active participants had less raw reading time due to the interim questions taking up a part of the fixed study window, the active participants still showed outperformance compared to the passive participants.

Within the ICAP framework (Chi & Wylie, 2014), answering interim multiple-choice questions is categorized under the active tier of engagement, rather than the constructive or interactive tier. Since a meaningful advantage was observed at said modest tier, it is suggested that higher tiers of engagement, such as self-explanation or peer discussion, may yield greater benefits.

Several limitations of the study can additionally be acknowledged. The prominent methodological limitations of the study include limitations in the scope of the study material, as well as applicability for longer retention durations. The study was also conducted in an online environment, which may enable more proactive training via person-to-person interaction that affects the effectiveness of the training method. These factors may limit the generalizability of the findings in other educational contexts not explored in the study.

Further research could investigate whether the advantages observed in this study can persist over a longer period of time across different subject areas. As the post-test was conducted immediately after the participants' study, the present results do not represent long-term retention, but rather immediate comprehension. The testing-effect literature predicts the active-learning advantage to grow with delay (Roediger & Butler, 2011). It can also be valuable to compare specific forms of active learning, such as peer discussion, direct question-and-answer sessions, and interactive exercises, to determine which approaches are most effective for different types of content and learners.

Overall, the study provides further evidence that active training methods are an effective approach for promoting understanding and application of knowledge in the learning process. As the educational environment continues to adapt to increasingly complex and dynamic subject matter, modifying strategies to encourage active engagement with the material at hand may play an important role in improving learning outcomes.

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