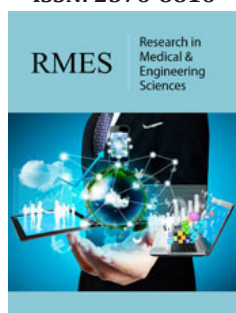


Learning Optimization Strategies

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Abstract

In this paper, we present a comprehensive review of learning strategies based on a meta-analysis of existing literature. The study aimed to identify effective methods for long-term information retention. Results indicate that practice testing and distributed practice are the most effective strategies, with moderate effectiveness for elaborated interrogation, self-explanation, and multimodal training. Other methods, such as creating outlines, underlining, and rereading, demonstrated lower effectiveness. We also highlight the importance of teacher involvement in promoting effective learning styles.

Keywords: Artificial intelligence systems; Mnemonic formulas; Human species

Introduction

Learning is the process through which an individual acquires new skills or stores new information in their memory by acquiring it from an external source. While not unique to humans, as both animals and artificial intelligence systems are capable of learning, for the human species, learning is a complex process involving higher cognitive functions such as language and abstraction. This paper aims to provide a concise description of various learning methods specifically related to the accumulation of theoretical information.

Possible learning styles

Dunlosky et al. [1] identified at least ten learning styles and, in their narrative review on this topic, qualitatively evaluated their effectiveness. Later, Donoghue [2] conducted a meta-analysis of the studies previously mentioned by Dunlosky et al. [1] in order to prove their conclusions.

Regarding the methodology of the meta-analysis, the authors examined three types of characteristics of each article: the article's scientometric quality, the type and quality of the students, and the format and methodology of the study. The effect size was quantified using Cohen's d (calculated based on the means and standard deviations of the studied groups, or by transforming F scores - Cohen 1988) [3], and extreme values were reduced. The authors also evaluated the heterogeneity of the results of individual studies, which was high in most cases, as expected given the variety of research methods used in the primary literature on which these studies were based.

Practice testing and distributed practice are the most effective methods

The most effective methods (leading to long-term information retention) were practice testing and distributed practice. Practice testing refers to the (self) simulation, by the learner, of the context in which information needs to be reproduced, followed by the correction of the information emitted by the student. This method has the major advantage of providing immediate feedback on both the correctly retained information and that which was not retained. In the meta-analysis that quantified the effectiveness of learning methods, this method obtained an effect size of $d=0.74$. Distributed practice is based on the timing of the repetition of the material, offering the learner multiple opportunities to review the material of interest [4]. In the meta-analysis, this method obtained an effect size of $d=0.85$.

It is worth mentioning the result of Rowland's meta-analysis [5], which concluded that timed testing of memory is more effective than rereading it, but this is more valid for deep understanding and information retrieval activities (such as in the case of essay exams), compared to information recognition activities (valid in the case of multiple-choice exams).

Less effective learning methods

Methods such as elaborated interrogation (asking "why" type questions), self-explanation, and multimodal training (alternating types of materials and domains addressed) had moderate effectiveness. These types of learning are most effective when the student already knows information in the field of study, as these methods are based on the integration of pre-existing information. However, paradoxically, these methods have been considered to encourage a superficial understanding of information, according to the aforementioned authors. In the meta-analysis, these methods had effect sizes of $d=0.56$, $d=0.54$, and $d=0.47$, respectively.

Finally, methods such as creating outlines, underlining or highlighting in books, mnemonic formulas, rereading the material, as well as learning assisted by graphs and images, have proven to be less effective. In particular, creating outlines has the disadvantage of being highly dependent on the student's ability to filter relevant information, this method being more suitable for essay exams, not for multiple-choice exams. Underlining and highlighting are more effective when the emphasized sequences are selected by a teacher. Repeated reading of the material is more effective when it is timed, as in the case of methods based on distributed practice and testing. However, the benefit of repeated reading is insignificant after the second reading, but also at younger ages. Moreover, this method ensures recognition, but not understanding of the information. The use of images had an effect size of $d=0.56$, mnemonic formulas had an effect size of 0.5, rereading had an effect size of $d=0.47$ and creating outlines, as well as underlining and highlighting, had effect sizes of $d=0.44$.

The role of the teacher in effective learning

Another study by Dunlosky et al. [6] highlights the role that the teacher, an expert in the field of study, should have in guiding the student's learning process. The authors found that the teacher, not the student, is responsible for promoting an effective learning style. Teachers should organize tests (with low stakes) at the beginning of each course, emphasizing the important elements. Also, cumulative exams should be designed to promote the repetition of the study material in a timed manner, and the questions should be integrative.

Conclusion

In conclusion, using the correct learning methods can increase the efficiency of the process (by almost doubling it), however, to reach the maximum potential that the student has, the active involvement of the teacher and the adaptation, by the latter, of the material to the student's needs is necessary.

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