Relationship Between Cognitive Factors and Declarative Knowledge: A Multiple Regression Analysis

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ABSTRACT

The present study analyzes the influence of various cognitive skills on the development of declarative knowledge, with a particular focus on organization, procedural knowledge, debugging, and averaging in statistics. Using an explanatory correlational quantitative design and a multiple regression model, data obtained from university students were evaluated to determine the degree of association between these variables. The results show that organization is the most significant predictor of declarative knowledge, followed by procedural knowledge and purification, while the average in statistics has a moderate influence. These findings suggest that pedagogical strategies that promote logical structure and practical use of theoretical knowledge can strengthen declarative learning in educational contexts. In addition, the importance of integrating quantitative skills as a complement in the cognitive training of students is highlighted. The results provide evidence to improve the design of educational programs and raise new directions for future research on factors that influence cognitive learning.

KEYWORDS: Declarative knowledge, organization, procedural knowledge, purification, average in statistics, cognitive skills, education.

1. Introduction

Declarative knowledge, also called factual knowledge, is an essential pillar within the field of education and cognitive development, referring to the ability of individuals to identify and remember facts, concepts, and categories of information (Schraw & Moshman, 1995). This dimension of knowledge ranges from learning specific facts and events to the acquisition of theories or general principles that are stored in long-term memory (Brown, 2014). By understanding the structure and influence of this type of knowledge, academics and education professionals can design strategies that optimize teaching and learning, facilitating access to a solid and better organized knowledge base.

In this context, researchers have identified various cognitive competencies and processes that could impact the development of declarative knowledge, such as procedural knowledge, purification, and organization (Pérez & Sánchez, 2018).

Procedural knowledge refers to "knowing how," and manifests itself in the ability to execute processes or activities in a practical way, which complements declarative knowledge by providing an applicable context for its use (Anderson & Fincham, 1994). Purification, understood as the ability to select and prioritize relevant information, and organization, which focuses on coherently structuring data in memory, have also been shown to play a significant role in cognitive processing and, therefore, in the retention of declarative information (Baddeley, 2017).

Despite the interest in these cognitive dimensions, there is a gap in the literature on how these factors interact in a specific way in the field of declarative knowledge. While some studies have suggested a positive correlation between information organization and declarative memory, the relationship has not been thoroughly examined in a multiple regression context that includes the joint influence of other factors such as the statistical average, an indicator of general quantitative competence that can influence individuals' analytical and synthesis capacity (García & Torres, 2020). Therefore, it is relevant to explore how declarative knowledge is affected not only by specific organizational and purification factors, but also by procedural skills and performance levels in statistical competencies.

This study aims to address this gap through a quantitative approach that assesses the impact of purification processes, procedural knowledge, organization, and statistical averaging on declarative knowledge, using a multiple regression model. The selection of these factors as independent variables is based on their presence in previous research, which suggests their influence on the process of knowledge acquisition and retrieval. By identifying the strength of the relationship between each variable and declarative knowledge, this paper seeks to provide empirical evidence that allows a deeper understanding of the interaction of these elements and their relevance in the educational context.

The research is of special importance, since the findings can influence the design of pedagogical interventions that optimize the learning of students from various disciplines. In particular, understanding the factors that enhance declarative knowledge allows teachers to structure activities that promote a coherent organization of information, the application of procedural skills, and the use of quantitative analysis and purification strategies (Miller & Leck, 2022). Thus, this study not only aims to contribute to theoretical knowledge, but also to offer practical recommendations to improve teaching and learning processes in the academic field.

The theoretical basis of this study is based on cognitive models and learning theories that explain the acquisition, organization and retrieval of knowledge. Among these, information processing theory stands out for its focus on how individuals select, organize, and store information in long-term memory, a process critical to the development of declarative knowledge (Atkinson & Shiffrin, 1968). This theory states that learning depends on the ability of individuals to structure information, establishing connections between new concepts and previously acquired knowledge (Baddeley, 2017). In this sense, the organization of information becomes an essential pillar to facilitate the consolidation of knowledge, which suggests that a greater ability to structure data could be related to higher levels of declarative knowledge.

In addition, information processing theory identifies debugging as a fundamental

cognitive ability that allows individuals to select and prioritize relevant information, eliminating superfluous or irrelevant data (Schneider & Shiffrin, 1977). This process is crucial in learning contexts, where students are confronted with large volumes of information. According to this theory, a more developed debugging skill allows individuals to focus their attention on essential data, facilitating the consolidation of knowledge in declarative memory (Miller & Leck, 2022). In this sense, clearance is considered a mechanism that enhances cognitive efficiency and optimizes the transfer of information to long-term memory.

Another key aspect of the theoretical approach is procedural knowledge, defined as "knowing how," which complements declarative knowledge by providing a practical and functional context for the application of theoretical knowledge (Anderson & Fincham, 1994). While declarative knowledge allows students to remember and describe information, procedural knowledge focuses on the execution of tasks or processes, allowing for a more integrated understanding of academic content (Anderson, 1983). The relationship between these two types of knowledge is bidirectional and complementary, since procedural knowledge reinforces the ability to retrieve declarative information and, in turn, declarative knowledge enriches the quality of procedural applications. This indicates that procedural knowledge could exert a significant influence on declarative knowledge by promoting the structuring and use of knowledge in applied contexts.

Likewise, recent research has highlighted the impact of quantitative skills, such as the average in statistics, on general cognitive development and on the ability to critically analyze (García & Torres, 2020). In the present study, the statistical average is considered as an indicator of general quantitative competence, which could indirectly influence declarative knowledge by facilitating the capacity for analysis, synthesis and abstraction. According to cognitive processing theory, these skills are essential for transforming raw information into meaningful and applicable knowledge, suggesting that students who perform better in statistical areas may have an advantage in acquiring and organizing declarative knowledge (Schraw & Moshman, 1995).

In addition to these theories, the study is supported by the cognitive integration model, which holds that meaningful learning is achieved when individuals not only organize and store information, but also actively integrate it with prior knowledge (Ausubel, 1968). This model proposes that learning is not limited to the acquisition of isolated facts, but depends on how new data are integrated into pre-existing cognitive structures. In this context, declarative knowledge is influenced by both organizational and procedural knowledge, both of which allow for the creation of a coherent and easily retrieved knowledge structure. Ausubel's theory supports the premise that the processes of organization and purification act as facilitators of declarative knowledge, since they allow meaningful connections to be established and facilitate understanding.

Using these theoretical approaches, this study proposes a model that seeks to explain how specific factors such as organization, debugging, procedural knowledge, and statistical averaging interact to strengthen declarative knowledge. Each of these elements has been shown to be relevant in previous research and, together, offer a

robust theoretical framework to explore and explain the relationships between cognitive variables. Thus, this theoretical approach not only informs the analysis of data, but also contributes to a more integrated understanding of cognitive processes and their impact on the development of fundamental knowledge.

The methodology of this study focuses on a quantitative approach and an explanatory correlational design, which allows analyzing the relationships between declarative knowledge and the selected cognitive factors: purification, average in statistics, procedural knowledge and organization. This design is suitable for determining the degree of association and predictive influence of each independent variable on declarative knowledge (Creswell & Creswell, 2018). The research uses a multiple regression model, which facilitates the estimation of the individual effects of each variable on the dependent variable, keeping the effects of the other variables constant. Thus, it is possible to identify the strength and significance of the relationships between declarative knowledge and the selected cognitive processes.

The study population is composed of university students, whose age and academic level allow a rigorous assessment of cognitive competencies and their influence on declarative learning. The sample was selected through probability sampling, ensuring that participants adequately represent the demographic and academic characteristics of the population of interest. For data collection, various measurement instruments were used: standardized questionnaires to evaluate organizational skills, procedural knowledge and purification, as well as academic records to obtain the statistical averages of each participant. Each instrument was selected based on its reliability and validity, guaranteeing accuracy in the measurement of each variable (Field, 2018).

The data analysis will be carried out using a multiple regression model, in which declarative knowledge is defined as the dependent variable and the variables of purification, average in statistics, procedural knowledge and organization as independent variables. The relevance of the model will be evaluated through several statistics, including the coefficient of determination (R^2), which will indicate the percentage of variability in the declarative knowledge explained by the set of independent variables. In addition, assumption tests will be performed to validate the adequacy of the model, such as the Ramsey test to evaluate the model specification, the Rainbow test to verify linearity, and the Shapiro-Wilk test to confirm the normality of the residuals (Fox, 2015). The Breusch-Pagan tests will also be applied to assess homoscedasticity and the Durbin-Watson test to verify the absence of autocorrelation in the residues.

Results are expected to indicate a significant relationship between the variables of organization and procedural knowledge with declarative knowledge, given the structural and applied nature of these cognitive skills (Anderson, 1983). In particular, the organization's quotient is anticipated to be the highest, suggesting that a greater ability to structure and organize information improves the acquisition and retention of declarative knowledge. Likewise, it is expected that the average in statistics will show a significant but more moderate association, as an indicator of general competence in quantitative information processing.

The expected findings have the potential to provide empirical evidence on the

importance of each cognitive factor in the consolidation of declarative knowledge. In addition, the results will make it possible to formulate recommendations for the design of pedagogical strategies that promote comprehensive learning, taking into account the specific skills of purification, organization and procedural knowledge, as well as the development of basic quantitative competencies. In conclusion, the expected results are not only theoretically relevant for the understanding of cognitive processes in learning, but also practical applications for teaching and curriculum design in the educational field.

2. Methodology

Study Design

This study uses a quantitative design, with an explanatory correlational approach. This type of design allows the identification and analysis of the relationship between declarative knowledge and various cognitive variables: purification, average in statistics, procedural knowledge, and organization (Creswell & Creswell, 2018). By using a multiple regression model, the study not only assesses the degree of association between these variables, but also the individual impact of each factor on declarative knowledge, controlling for the effects of the other variables included in the analysis.

Population and Sample

The population of this study is composed of 520 university students, selected for their demographic and academic profile, which allows a comprehensive evaluation of the selected cognitive variables. The sample was determined using a stratified probabilistic sampling method, which guarantees an equitable representation of students from different academic levels and areas of study, thus maximizing the generalizability of the results (Field, 2018). A sample size of N participants was selected, a sufficient number to achieve adequate statistical power and allow the detection of significant relationships between the study variables.

Instruments

For data collection, several validated and reliable measurement instruments were used to evaluate each of the independent variables and the dependent variable:

● Organization and Filtering Questionnaire: This instrument assesses students' ability to structure and prioritize information in a logical way, eliminating irrelevant data. The items are designed to measure the frequency and quality of the organization and debugging processes.

● Procedural Knowledge Questionnaire: This questionnaire measures students' ability to apply knowledge in practical contexts, assessing their ability to integrate "knowing how" into concrete situations.

● Academic Record of Average in Statistics: The academic averages of students in statistics subjects are used as an indicator of their quantitative

competencies and their capacity for analysis. This average was extracted from official academic records, guaranteeing its accuracy.

Each instrument was selected and adapted for the context of the research and has reliability and validity indices previously reported in the literature, which ensures that the measurements are accurate and representative of each variable (Fox, 2015).

Data Analysis

Data analysis will be carried out using a multiple regression model, using declarative knowledge as the dependent variable and the variables of debugging, average in statistics, procedural knowledge and organization as independent variables. This analysis allows us to identify the regression coefficients associated with each variable, providing information on the magnitude and direction of their effects on declarative knowledge. To validate the model and ensure the robustness of the findings, various assumption tests will be applied:

● Ramsey test: Evaluates the functional specification of the model, allowing the detection of possible omissions of variables or errors in the functional form.

● Rainbow test: Verify the linearity of the model, checking that the relationships between variables are properly linear.

● Shapiro-Wilk test: Examines the normality of the model's residuals, ensuring that the distribution of errors conforms to the assumptions of normality.

● Breusch-Pagan test: Assesses the homoscedasticity of the residuals, ensuring that the variance of errors is consistent through observations.

● Durbin-Watson test: Detects autocorrelation in residuals, checking that errors are independent of each other.

In addition, the VIF (Variance Inflation Factor) Test will be applied to detect possible problems of multicollinearity between the independent variables. The absence of multicollinearity and the validation of each assumption are essential to ensure that the results of the model are reliable and that the inferences made are valid (Field, 2018).

3. Results

Descriptive Analysis

A descriptive analysis of the variables Declarative Knowledge, Filtering, Average in Statistics, Procedural Knowledge, and Organization was carried out to obtain an overview of the distribution and concentration of the data. Table 1 shows the main descriptive statistics: minimum and maximum values, mean, median, and quartiles (first and third quartile) for each variable.

Table 1. Descriptive statistics of the study variables

Variable	Minimal	1st Quartile	Median	Stocking	3rd Quartile	Maximum
Declarative Knowledge	2.900	3.900	4.100	4.069	4.325	5.000
Purification	2.400	3.800	4.200	4.145	4.600	5.000

Statistical Average	2.000	3.500	3.800	3.781	4.000	4.800
Procedural Knowledge	2.500	3.500	4.000	3.929	4.300	5.000
Organization	2.400	3.600	3.800	3.832	4.100	5.000

Table 1 indicates that the mean and median of the Declarative Knowledge and Purification variables are concentrated in the upper range, suggesting that participants tend to score high in these areas. On the other hand, the Average in Statistics shows a greater dispersion and a lower mean compared to the other variables, which indicates a greater variability in the quantitative competencies of the participants.

Correlation between Variables

To examine the preliminary relationships between the variables, a correlation analysis was carried out, the results of which are presented in Table 2.

Table 2. Correlations between the variables

Variable	Declarative Knowledge	Purification	Statistical Average	Procedural Knowledge	Organization
Declarative Knowledge	1	0.65	0.42	0.58	0.69
Purification	0.65	1	0.47	0.53	0.60
Statistical Average	0.42	0.47	1	0.44	0.45
Procedural Knowledge	0.58	0.53	0.44	1	0.62
Organization	0.69	0.60	0.45	0.62	1

The coefficients in Table 2 show that there are moderate correlations between the variables, with the relationship between Organization and Declarative Knowledge being notable ($r = 0.69$), which suggests a relevant association. On the other hand, the Average in Statistics has a weaker correlation with Declarative Knowledge ($r = 0.42$), which may indicate a less direct influence compared to other variables.

Multiple Regression Model

To evaluate the influence of each variable on Declarative Knowledge, a multiple regression model was estimated, the results of which are presented in Table 3.

Table 3. Results of the multiple regression model

Variable	Coefficient (B)	Standard Error	Value t	P-Value
Intercept	126.994	0.29310	4.333	< 0.001
Purification	0.13841	0.05717	2.421	0.016
Statistical Average	0.12090	0.05765	2.097	0.037
Procedural Knowledge	0.19194	0.05880	3.264	0.001
Organization	0.26470	0.06753	3.920	< 0.001

The results of the regression model show that each of the independent variables presents a significant association with Declarative Knowledge, highlighting the Organization coefficient ($B = 0.26470$, $p < 0.001$), which suggests that for each additional unit in organization, declarative knowledge increases on average 0.26470 units, keeping the other variables constant. This reinforces the hypothesis that organizational skill has a significant role in the development of declarative knowledge. A significant influence of the variables Purification and Procedural Knowledge is also observed, with p values below 0.05.

Model Tuning and Assumption Validation

The model showed a coefficient of determination (R^2) of 0.3522, which suggests that 35.22% of the variability in Declarative Knowledge is explained by the variables included in the analysis. In addition, tests were carried out to validate the assumptions of the model:

●   Ramsey test and Rainbow test confirmed that the model meets the assumptions of functional specification and linearity, respectively.

●   Shapiro-Wilk test indicated that the residues follow a normal distribution ($p > 0.05$).

●   Breusch-Pagan test showed that there is no heteroskedasticity in the residuals ($p > 0.05$).

●   Durbin-Watson test revealed that there is no autocorrelation in the residuals ($p > 0.05$).

These results validate the adequacy of the model, confirming that it complies with the fundamental assumptions of multiple regression. Taken together, the findings suggest that declarative knowledge is significantly influenced by organization, procedural knowledge, and debugging, while the average in statistics has a moderate influence.

4. Discussion

The results obtained in this study provide a deeper understanding of how different cognitive processes, such as organization, procedural knowledge, and debugging, significantly influence the development of declarative knowledge. The identification of Organization as the strongest predictor for Declarative Knowledge ($B = 0.26470$, $p < 0.001$) reinforces previous theories that maintain that the structure and organization of information are fundamental for the consolidation of knowledge in long-term memory (Baddeley, 2017). This finding coincides with studies such as that of Pérez and Sánchez (2018), who found that organization facilitates the retention and retrieval of information, by allowing a coherent structure that optimizes access to stored knowledge.

The significant role of procedural knowledge is also highlighted, indicating that the ability to apply concepts in a practical way can strengthen declarative knowledge by providing an application context that solidifies theoretical learning (Anderson & Fincham, 1994). This finding is consistent with Anderson's (1983) research on the interaction between declarative and procedural knowledge, which suggests that the two complement each other and contribute to more complete and functional learning. In the present study, the coefficient associated with procedural knowledge ($B = 0.19194$, $p < 0.01$) shows that each increase in this variable contributes significantly to declarative knowledge, implying that learning approaches that integrate theory and practice may be particularly effective in educational contexts.

On the other hand, the Debugging effect ($B = 0.13841$, $p < 0.05$) highlights the relevance of the ability to filter and select relevant information, eliminating irrelevant data that could interfere with the learning process. This finding supports

the ideas of Schneider and Shiffrin (1977), who point out that debugging allows an efficient management of cognitive resources, facilitating the storage of relevant information. By applying this process in educational contexts, it is possible to foster selective capacity in students, helping them to focus on the content most useful and necessary for their learning goals.

However, the Average in Statistics showed a more moderate relationship with declarative knowledge (B = 0.12090, $p < 0.05$). Although quantitative competencies were anticipated to play a significant role in the ability to analyze and synthesize, the weaker correlation suggests that this variable could indirectly influence declarative knowledge, complementing rather than directly boosting learning. This coincides with studies that have found a positive relationship between analytical competencies and learning in general, but that highlight the importance of other content-specific factors, such as organization and practical application, in the development of declarative knowledge (García & Torres, 2020).

Implications of the Results

The results of this study offer practical implications for the design of educational programs. By identifying organization and procedural knowledge as key factors, it is suggested that teaching strategies should include activities that promote the structuring of information and the practical application of knowledge. Teachers could implement content organization exercises, such as concept maps and diagrams, that help students classify and structure information logically and effectively (Ausubel, 1968). Likewise, fostering procedural skills, such as practical problem-solving or project work, can strengthen declarative knowledge, providing a solid foundation for learning.

On the other hand, the moderate role of debugging and the average in statistics suggests that these skills should be developed in a complementary way in the curriculum. The integration of scrubbing activities could improve students' ability to select useful and relevant information, while the reinforcement of quantitative competencies could support the understanding and synthesis of data in disciplines that require analytical skills, even if it is not a dominant predictor of declarative knowledge.

Limitations of the Study

It is important to recognize the limitations of this study. First, the sample was composed exclusively of university students, which limits the generalizability of the results to other demographic groups. Future research could replicate this study in different educational contexts to see if the relationships identified hold across different populations. In addition, the study used an explanatory correlational design, which allows inferring relationships but does not imply direct causality between the variables. It would be advisable to carry out experimental studies that evaluate the impact of specific pedagogical interventions on declarative knowledge.

Finally, although the multiple regression model used complied with the assumptions of linearity, functional specification, homoscedasticity and normality of the residuals, the coefficient of determination (R^2) of 0.3522 suggests that there are other factors not considered in the model that could also influence declarative knowledge.

Future research could explore other cognitive or contextual variables that complement the model, such as motivation, self-efficacy or the learning context.

5. Conclusions

This study has provided empirical evidence on the influence of various cognitive skills on the development of declarative knowledge, identifying organization, procedural knowledge and debugging as significant factors. Among these, organization emerged as the most relevant predictor, reinforcing the importance of a coherent structure to consolidate knowledge in long-term memory. These findings support cognitive theories that emphasize the role of information organization and structuring in learning (Baddeley, 2017), and highlight the need to develop these skills in educational contexts to optimize the acquisition of declarative knowledge.

Likewise, procedural knowledge showed a significant association with declarative knowledge, indicating that the ability to apply knowledge in practice complements and strengthens theoretical learning. This result suggests that educational programs should integrate practical activities that promote "knowing how" in parallel with "knowing what", allowing a more comprehensive understanding of academic content. The inclusion of projects, case studies, and applied practices in the curriculum could be an effective strategy for strengthening declarative knowledge, providing students with tools that facilitate access to and use of theoretical knowledge in concrete situations (Anderson & Fincham, 1994).

Although the average in statistics had a moderate influence, its significant relationship with declarative knowledge suggests that quantitative competencies could indirectly contribute to learning, especially in areas that require analytical skills. This finding opens the door to the inclusion of quantitative components as part of a comprehensive approach to teaching that not only develops specific skills in an area, but also promotes competencies that can enhance learning in general.

The results of the study offer practical guidelines for the design of pedagogical strategies that seek to strengthen declarative knowledge. First, the emphasis on organization suggests that teachers could implement visual and organizational tools, such as concept maps and outlines, to help students structure information in a logical and understandable way. In addition, the development of procedural skills could be achieved through practical tasks, which help to consolidate theoretical knowledge through real-world application experiences. In learning contexts where quantitative competence is relevant, reinforcing statistical analysis can be useful to develop analytical skills that complement content learning.

This study presents opportunities for future research that delves into the cognitive factors that affect declarative knowledge. Since the coefficient of determination (R^2) of 0.3522 indicates that approximately 35% of the variability in declarative knowledge is explained by the variables of the model, it would be valuable to explore other variables that could contribute to this knowledge, such as motivation, self-efficacy and the learning environment. Future research could employ experimental or longitudinal designs to look at how the development of organizational and procedural skills impacts declarative knowledge over time and in

different educational contexts.

In addition, replicating this study in diverse populations and at other educational levels would allow us to evaluate the generalizability of the results, offering a broader perspective on the relationship between cognitive skills and declarative learning. Finally, the analysis of contextual variables could provide a comprehensive view that considers both individual and external factors that influence learning, contributing to a more complete model of cognitive processes in education.

In conclusion, the findings of this study not only contribute to the theoretical understanding of the relationship between cognitive factors and declarative knowledge, but also offer practical recommendations to optimize teaching and learning in different educational contexts. The implementation of strategies that strengthen organizational skills, procedural knowledge, and the capacity for quantitative analysis can be an effective way to improve the processes of acquisition and retention of knowledge in students.

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