# PRIOR KNOWLEDGE AND MISCONCEPTIONS ABOUT THE PHYSICAL-GEOGRAPHICAL CHARACTERISTICS OF ASIA AMONG PRIMARY SCHOOL PUPILS

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## ABSTRACT

An important prerequisite for effective learning and conceptual understanding of geography is the early identification of misconceptions among pupils in primary education. This paper aims to examine pupils' prior knowledge and to identify misconceptions related to the physical-geographical characteristics of Asia among Grade VII primary school pupils, prior to the formal instruction of the curricular content. The study is based on the assumption that pupils possess general knowledge about the topic acquired through prior learning, media exposure, personal experiences, and other sources, which may include persistent and incorrect conceptions. The research employs a four-tier diagnostic pre-test that enables an examination of response accuracy, pupils' confidence levels, and the reasoning underlying their choices. The testing was conducted before the instruction of the curricular content related to Asia, with the aim of determining what pupils know and identifying the content areas in which misconceptions are most pronounced. The reliability of the diagnostic test was verified, and the main research was conducted in accordance with statistical standards. The sample included Grade VII pupils from different regions, representing both urban and rural environments. The data analysis revealed the presence of numerous and stable misconceptions. A significant proportion of pupils demonstrated misconceptions related to climatic diversity, the spatial distribution of natural phenomena, and the tectonic activity of Asia. In the second phase of the research, a post-test is planned following the implementation of the curricular content on Asia, to determine whether the identified misconceptions have been resolved or continue to persist among pupils. The results of this study indicate the need for systematic diagnosis of pupils' prior knowledge and its active integration into the planning and implementation of geography instruction, as well as the creation of conditions for more effective remediation of misconceptions and the enhancement of teaching quality.

**Keywords:** diagnostic testing, prior knowledge, misconceptions, primary education, geography of Asia

## INTRODUCTION

A highly significant direction in contemporary geography education is the early identification of misconceptions. For this purpose, it is necessary to distinguish between preconceptions, misconceptions and errors. A preconception is defined as an incomplete or naive representation that a pupil possesses before formal learning of the teaching content, while a misconception is an incorrectly formed mental construction that occurs after exposure to a scientific model or theory. On the other hand, an error refers to an answer that is scientifically considered incorrect [4]. Pupils often come to class with their own prior knowledge and beliefs about scientific phenomena. These understandings, which do not coincide with scientifically accepted explanations, are designated as alternative conceptions or misconceptions and can be integrated into the cognitive structure of the pupil, thereby hindering further learning [23]. According to Guerra-Reyes et al. [12], misconceptions can arise from misinterpretation of everyday experiences, inaccurate information obtained through informal media or cultural traditions. Passive receipt of knowledge from traditional teaching, lack of connection of teaching content with real life, use of inappropriate teaching methods can contribute to the formation of misconceptions among pupils. Before studying the teaching content, pupils already have previously formed concepts related to the topic, but they do not always coincide with scientific understanding. Pupils develop intuitive explanations ("naïve theories") from an early age to understand natural phenomena, but these explanations often lead to the formation of misconceptions [11]. As Treagust and Duit [24] point out, such prior knowledge is deeply rooted in pupils and is often resistant to change. Therefore, the early diagnosis of misconceptions prior to formal instruction is of great importance for teachers, as it enables them to effectively plan their teaching. According to Novak [19], the first and necessary step towards overcoming misconceptions is their identification. Diagnostic tests are particularly useful for detecting misconceptions, but also for pupils' scientific knowledge and ignorance.

In geography education, misconceptions arise among pupils due to the abstract nature of certain geographic concepts and processes, as well as a lack of practical examples that would facilitate their understanding. Numerous authors point out that in geography education, misconceptions occur in several thematic areas – cartography, geomorphology, climatology, and regional geography ([18]; [13]; [1]; [7]; [5]; [15]; [25]; [2]).

Within the framework of the study of the teaching content on the natural- geographic characteristics of Asia, specific and measurable phenomena (relief, mountains, rivers, climate) are covered, where pupils can more easily connect them with physical experiences and previous knowledge. This research is designed in two phases. The first phase includes the identification of misconceptions before the formal study of the teaching content on Asia by applying a diagnostic pre-test with four tiers. The second phase will be conducted after the study of the teaching content by applying a diagnostic post-test with four tiers.

The purpose of this paper is to examine the prior knowledge and identify misconceptions related to the natural-geographic characteristics of Asia among seventh-grade pupils in primary education, before the formal study of the teaching content by applying a diagnostic pre-test with four tiers in order to overcome them.

## METHODS

The research was conducted in primary schools in seven municipalities in the Republic of North Macedonia on seventh-grade pupils. A total of 339 pupils were tested, of which 162 (47.8%) were male and 177 (52.2%) were female. In terms of territorial distribution, the most pupils were tested from the municipality of Prilep – about 21.2%, while the least were tested from the municipality of Chair – about 4.4% (Table 1). The number of pupils by municipality is not the same, but it does not affect the results obtained. According to official data from the State Statistical Office, the total number of enrolled seventh-grade pupils in the 2024/2025 school year is 20,116[17] pupils, with the tested sample falling within the statistical representative sample.

**Table 1.** Sample Structure (N=339)

| Feature | Category | n | % |
|---|---|---|---|
| **Gender** | Male | 162 | 47.8 |
| | Female | 177 | 52.2 |
| | **Total** | **339** | **100** |
| **Municipality** | Gazi Baba | 63 | 18.6 |
| | Chair | 15 | 4.4 |
| | Aerodrom | 48 | 14.2 |
| | Dojran | 32 | 9.4 |
| | Prilep | 72 | 21.2 |
| | Radovish | 50 | 14.7 |
| | Gostivar | 59 | 17.4 |
| | **Total** | **339** | **100** |

For the purposes of this research, a diagnostic pre-test with four tiers was designed. Diagnostic tests for the identification of misconceptions in the natural sciences were established by Treagust [22], who developed the methodology of the two-tiers diagnostic test. The first tier tests the pupil's content knowledge, while the second tier requires an explanation of the answer. Later, these tests are upgraded, where Hasan, Bagayoko and Kelley [14] introduce the index of certainty of the answers, while Caleon & Subramaniam, [3] introduce the four-tier diagnostic test, where both the answer and the reason are followed by a measurement of the degree of certainty. The test contains 10 questions that cover key natural-geographic topics: geographical location, tectonic activity, mountains, rivers, lakes, deserts and climatic diversity. Each question is structured in four tiers: the first tier contains content answers with four offered distractors, the second tier measures the confidence of the answer through three levels - I am not sure, I am somewhat sure and I am very sure. The third tier requires an explanation of the reason with four offered alternatives, while the fourth tier measures the confidence in the given reason. This structure allows for a precise distinction between: scientific understanding (correct answer, correct reason and high certainty), superficial knowledge (correct answer or correct reason with inconsistent certainty), strong misconception (incorrect answer with incorrect reason, but with high certainty), weak misconception (incorrect answer and incorrect reason, but the certainty is high only at one tier) and ignorance (incorrect answer and incorrect reason, followed by a low level of certainty).

[17] State Statistical Office (2025). Primary and secondary schools in the Republic of Macedonia, 2024/2025. Available at: https://www.stat.gov.mk/pdf/2025/2.1.25.07_mk.pdf [20]

The testing was conducted before the formal study of the teaching content of Asia. The test questions are based on the content of the geography textbook for seventh-grade by prof. dr. Blagoja Markoski [17], which is in official use in primary schools in the Republic of North Macedonia.

Before the main testing, a pilot study was conducted on a smaller number of pupils, in order to check the functionality and understandability of the test. The analysis was performed only on the first tier of all 10 questions, i.e. on the content accuracy of the answers. The results showed that the coefficient of internal consistency, Cronbach's Alpha (α) is 0.600, which indicates an acceptable level of reliability of the test. The test was also checked by experts in the field of geography teaching methodology. Cronbach's alpha was used to assess the internal consistency reliability of the test. Cronbach's alpha measures the extent to which items in a test measure the same construct and its values range from 0 to 1 [21]. According to George and Mallery [9], they propose the following interpretation rule: $\alpha \geq .9$ – Excellent, $\alpha \geq .8$ – Good, $\alpha \geq .7$ – Acceptable, $\alpha \geq .6$ – Minimally acceptable, $\alpha \geq .5$ – Poor, $\alpha < .5$ – Unacceptable.

The testing was conducted in December, before studying the curriculum content for Asia. Pupils solved the test in writing during geography class for 15 minutes. The testing was anonymous. Before conducting the main statistical analysis, the internal consistency of the test was checked, which was good (Cronbach's $\alpha = 0.735$; $N = 339$; 10 items).

The test responses were entered into an Excel database and then statistically processed in the statistical package SPSS (Statistical Package for the Social Science). The responses were categorized into five groups: scientific understanding, superficial knowledge, strong misconception, weak misconception and ignorance. Scientific understanding, misconception and ignorance indices were determined, as well as the mean value (M) and standard deviation (SD) for each question separately. The normality of the data distribution was checked with the Shapiro–Wilk test. The Shapiro–Wilk test indicated a statistically significant deviation from normality ($p < .001$). However, for large sample sizes, even small deviations from normality may lead to significant results without substantially affecting parametric statistical tests [10]. Homogeneity of variances across groups was examined using Levene's test, a classical procedure for testing the equality of variances [8]. The results indicated that the assumption of equal variances was not violated ($p = .326$). An independent samples t-test and Chi-square test were used to analyze gender differences. One-Way ANOVA with Tukey HSD post-hoc test was used for analysis by municipality.

## RESULTS

This section presents the results obtained from the diagnostic pre-test for determining misconceptions among seventh-grade pupils.

Table 2 shows the percentage representation of the three categories: scientific understanding, misconceptions and ignorance separately for each question**.**

**Table 2.** Distribution of categories by question

| Question | Topic | Scientific understanding % | Misconceptions % | Ignorance% |
|---|---|---|---|---|
| **Q1** | Climatic diversity of Asia | 25.4 | 40.1 | 29.2 |
| **Q2** | Position of the con. Asia | 32.7 | 42.4 | 21.2 |
| **Q3** | Europe-Asia border (Ural) | **55.2** | 23.9 | 16.2 |
| **Q4** | Highest mountain | 20.6 | **58.7** | 13.0 |
| **Q5** | Causes of climate diversity | **47.8** | 22.7 | 21.5 |
| **Q6** | Gobi Desert | 4.1 | **53.1** | **41.3** |
| **Q7** | The longest river | 20.9 | **53.7** | 14.7 |
| **Q8** | Tectonic activity | 38.1 | 31.6 | 23.9 |
| **Q9** | Lake Baikal | 4.4 | **49.0** | **43.7** |
| **Q10** | Natural features of Asia | 30.1 | 30.4 | 33.0 |

According to the results shown in Table 2, it can be concluded that the highest percentage of scientific understanding was registered in the question about the natural border of Europe and Asia (55.2%), which indicates understanding of this geographical concept. The highest percentage of misconceptions was recorded in the questions about the highest mountain (58.7%), the longest river Yangtze River (53.7%) and the Gobi Desert (53.1%), which indicates that pupils have significant misconceptions about certain teaching contents. Meanwhile, the highest percentage of ignorance was recorded in the question about the deepest freshwater lake - Lake Baikal (43.7%).

For a more detailed view of the results for the different categories of responses among pupils, figure 1 shows the mean value (M) and standard deviation (SD) for the indices of scientific understanding, misconceptions and ignorance.

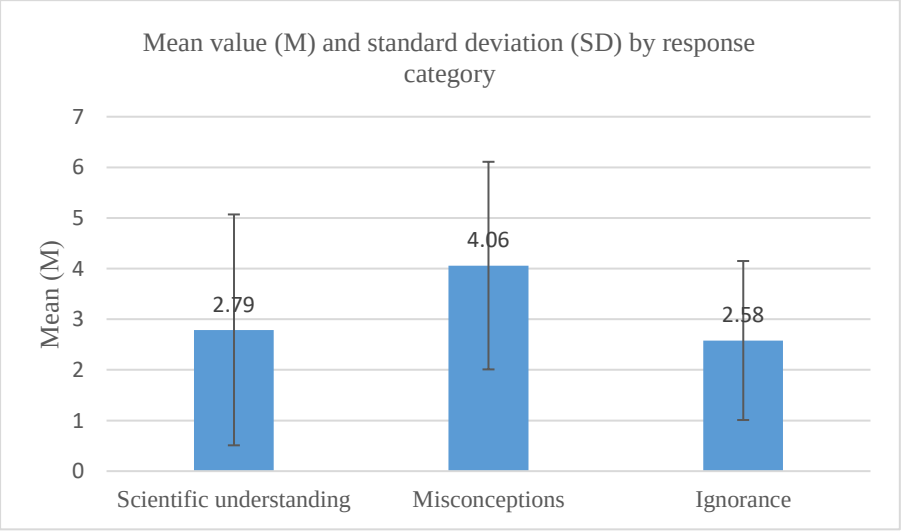


**Figure 1.** Mean value (M) and standard deviation (SD) for the indices of scientific understanding, misconceptions, and ignorance.

From the presented results, it can be noted that the highest average value was registered for the misconception index (M=4.06), which indicates that conceptual misconceptions are present and expressed among pupils. Meanwhile, the average value for the scientific understanding index is (M=2.79), and for the ignorance index (M=2.58). These results show that conceptual misconceptions among pupils are more often present than scientifically correct answers. The greatest variability of pupils' answers was observed for the scientific understanding index (SD=2.28), then for the misconception index (SD=2.05), and the smallest for the ignorance index (SD= 1.57).
In order to determine possible differences by gender, an analysis of the mean value (M) and standard deviation (SD) of the scientific understanding, misconceptions, and ignorance indices was performed.

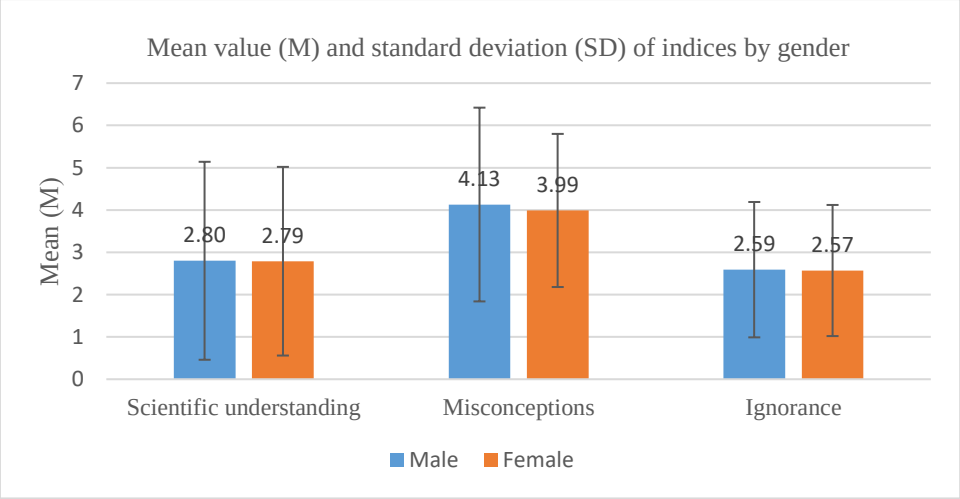


**Figure 2.** Mean value (M) and standard deviation (SD) of the indices of scientific understanding, misconceptions and ignorance by gender

From the figure, it can be observed that the differences according to gender are minimal. In the indices of scientific understanding and ignorance, the average values for male and female pupils are almost identical. While in the index of misconceptions, a slightly higher value is observed for male pupils (M=4.13; SD= 2.29) compared to female pupils (M=3.99; SD= 1.81), but the difference is very small. The results of the t-test showed that there are no statistically significant differences between male and female students in the indices of scientific understanding, misconceptions and ignorance ($p > 0.05$).
Table 3 shows the results of the $\chi^2$-test for examining gender differences in the occurrence of misconceptions in individual questions related to the natural-geographic characteristics of Asia.

**Table 3.** Gender differences in misconceptions by questions (Chi-square)

| Question | $X^2$ | df | p | Male % | Female % |
|---|---|---|---|---|---|
| **Q1** | 0.00 | 1 | .998 | 40.1 | 40.1 |
| **Q2** | 0.38 | 1 | .536 | 40.7 | 44.1 |
| **Q3** | 0.03 | 1 | .857 | 23.5 | 24.3 |
| ***Q4*** | **7.14** | **1** | **.008** | **51.2** | **65.5** |
| **Q5** | 2.59 | 1 | .107 | 26.5 | 19.2 |
| **Q6** | 0.19 | 1 | .666 | 54.3 | 52.0 |
| **Q7** | 2.31 | 1 | .128 | 49.4 | 57.6 |
| ***Q8*** | **4.30** | **1** | **.038** | **37.0** | **26.6** |
| ***Q9*** | **5.39** | **1** | **.020** | **55.6** | **42.9** |
| **Q10** | 1.87 | 1 | .172 | 34.0 | 27.1 |

**Note:** $\chi^2$ – value of the $\chi^2$ test; df – degrees of freedom; p – level of statistical significance.

The results show that for most questions, no statistically significant differences are observed between male and female pupils ($p > 0.05$). However, statistically significant differences were registered for three questions (questions 4 ($\chi^2 = 7.14$, $p = .008$), 8 ($\chi^2 = 4.30$, $p = .038$) and 9 ($\chi^2 = 5.39$, $p = .020$) which indicate that in these teaching contents there are certain differences in the occurrence of misconceptions according to gender. In question Q4, women showed a significantly higher tendency to misconceptions (65.5%), while in questions Q8 and Q9, men had statistically higher percentages of misconceptions. According to conventional statistical criteria, results with p-values higher than .05 indicate that there is no statistically significant association between the examined categorical variables [6].

In addition to the analysis of gender differences, the research also examined whether there are statistically significant differences in the prevalence of misconceptions depending on the regional affiliation of the pupils. The results of the One-Way ANOVA analysis are shown in Table 4.

**Table 4.** Average number of misconceptions by municipality with results of One-Way ANOVA analysis

| Municipality | M | SD | Homogeneous Subset |
|---|---|---|---|
| **Aerodrom** | **2.50** | **1.76** | **1** |
| **Prilep** | 3.93 | 1.85 | 2 |
| **Gostivar** | 4.20 | 2.00 | 2 |
| **Radovish** | 4.32 | 1.97 | 2 |
| **Gazi Baba** | 4.40 | 2.21 | 2 |
| **Dojran** | 4.88 | 1.86 | 2 |
| **Chair** | **5.00** | **1.51** | **2** |

From the results shown in Table 4, it can be noted that the lowest average number of misconceptions was registered in the municipality of Aerodrom (M=2.50), while the highest was observed among pupils in the municipality of Chair (M=5.00). The results of the post hoc analysis show that the municipality of Aerodrom forms a separate homogeneous subgroup, while the remaining municipalities belong to another subgroup, which statistically indicates a lower number of misconceptions among pupils in this municipality.

## DISCUSSION AND CONCLUSION

This method of research is used to "catch" the misconceptions that pupils have that they create throughout the process of their education. An interesting fact is that by using diagnostic tests before studying the teaching content, teachers can analyze and strategize which teaching methods to apply in order to eradicate misconceptions among pupils. According to Novak [19], some pupils learn mechanically, whereby knowledge is retained in the short term and they can answer the questions asked correctly at the moment. Such knowledge is not retained in long-term memory and therefore often leads to misinterpretation of concepts or loss of knowledge.

According to the results obtained, it can be concluded that seventh-grade pupils have misconceptions about the teaching content related to the natural-geographic characteristics of Asia. The average value of the misconception index is higher compared to the scientific understanding index, confirming the fact that conceptual misconceptions are a common occurrence among pupils. The occurrence of misconceptions among pupils about this content can be linked to the fact that natural-geographic concepts are more specific and related to pupils' everyday experiences, and therefore lead to the more frequent formation of erroneous, but stable representations, as emphasized in their research by Francek [7] and Dove [5]. Particularly worrying are the results for the questions about the Gobi Desert (4.1%) and the deepest freshwater lake - Lake Baikal (4.4%), where scientific understanding of these concepts is worryingly low, while the combined prevalence of misconceptions and ignorance exceeds 90%. These results indicate significant gaps in pupils' prior knowledge. The analysis of gender differences showed that gender is generally not a significant factor in the formation of misconceptions. Statistically significant differences were determined for certain questions by gender, which indicates that there may be different levels of understanding for certain teaching contents. Regional analysis through One-Way ANOVA reveals statistically significant differences between municipalities, where pupils from the municipality of Aerodrom stand out with a lower number of occurrences of misconceptions compared to pupils from other municipalities. While the municipality of Chair records the highest level of occurrence of misconceptions. Such regional differences can be associated with several factors, such as: teaching practices, quality of teaching, availability of teaching materials, as well as social and cultural influences. Within the framework of this research, pupils were surveyed in order to determine from which sources they acquired their prior knowledge about the natural-geographic characteristics of Asia.

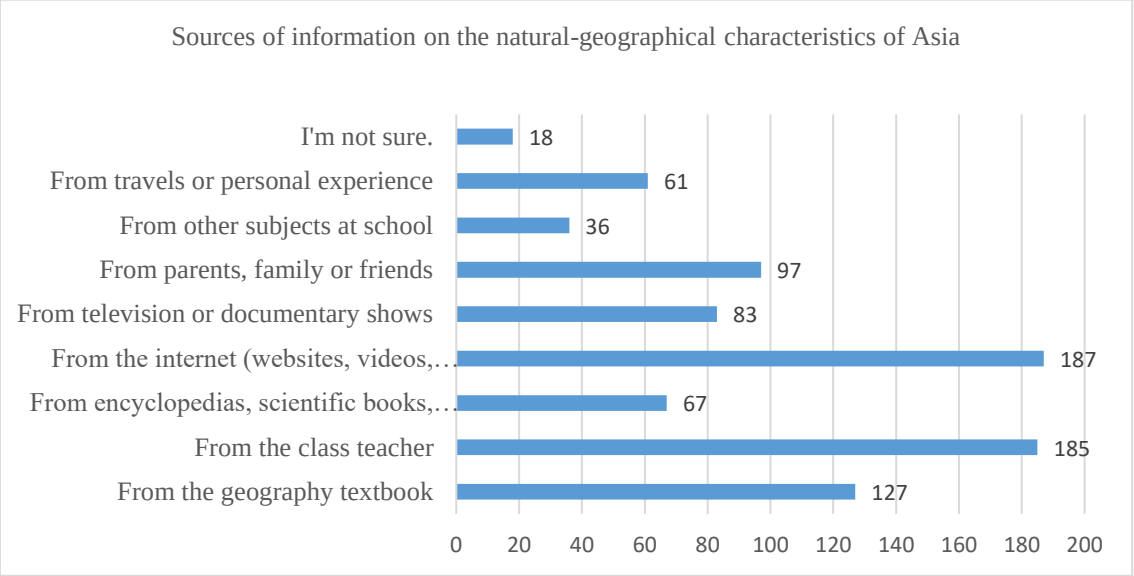


**Figure 3.** Sources of information regarding the natural-geographic characteristics of Asia among pupils before studying the instructional content

According to the results shown in figure 3, it can be seen that pupils get most of their information about the given topic from the Internet (187 pupils), i.e. using certain websites, videos, social media, etc., as well as from the teacher (185 pupils). A significant number of pupils indicate that they also get information from geography textbooks (127), as well as from parents or friends (97).

The dominance of the Internet and informal media as primary sources of prior knowledge can be a significant factor in the formation of misconceptions, since online content does not always provide scientifically accurate and pedagogically appropriate information. Textbooks also represent an important source of information for teachers and pupils and can directly influence the formation or maintenance of misconceptions [16]. These results indicate that in addition to formal education, pupils also rely heavily on informal sources of information. According to Guerra-Reyes et al. [12], informal media represent one of the main sources of misconceptions among pupils.

The results indicate the need for a systematic diagnosis of the pupils' prior knowledge of the curriculum content before teaching geography and the application of strategies aimed at discovering and overcoming misconceptions, such as discussions, using visual and cartographic materials, and activating critical thinking among pupils. In the second phase of this research, a post-test is planned after studying the curriculum content about Asia, in order to determine whether the identified misconceptions have been overcome or are still present. By analyzing the results of the pre-test and post-test, a comparison will be made as to whether the conceptual misconceptions among pupils were just a preconception or are already permanent misconceptions.

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