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İşaretler Aracılığıyla Harita Anlama Yeteneğini Artırma: Çocukların Bilişsel Gelişimine Dayalı Tematik Haritalar İçin İşaretler Geliştirme

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ÖZ

Çocuklara yönelik haritalar, işaretler ve atlaslar gibi malzemelerin derlenmesi ve tasarlanması titizlik dikkat ve yüksek düzeyde sorumluluk gerektiren bir süreçtir. Bu çaba içerisinde merkezi vurgu ve birincil endişe çocukların bilişsel gelişimi, eğitim seviyeleri, çeşitli coğrafi olguları algılama şekilleri ve düzeyleri, ikamet ettikleri bölgeleri kapsayan nesneler etrafında şekillenmelidir. Bu araştırma, Kuzey Makedonya Cumhuriyeti'nde ilkokul öğrencileri için özel olarak tasarlanmış olan "İlkokul Öğrencileri için Kuzey Makedonya Atlası" adlı bir atlasın derlenmesi ve tasarlanması amacıyla bir proje kapsamında yürütülmüştür. Bu proje çerçevesinde, 6 ila 10 yaş arasındaki öğrencilerin bilişsel ihtiyaçlarına ve gelişim aşamasına uygun işaretler titizlikle derlenmiş ve tasarlanmıştır. Dört farklı devlet ilkokulundan toplamda 567 öğrenci, tasarlanan işaretlerin algılanmasını ölçen bir teste tabi tutulmuştur. Testten elde edilen genel sonuçlar olumlu bir sonuç göstermektedir. Bununla birlikte, bazı işaretler öğrenciler tarafından yanlış yorumlanmış ve farklı isimlendirme standartları ortaya çıkmıştır. Bu nedenle, öğrenciler arasında düşük performans gösteren ve yetersiz yanıtlar alan işaretler değişikliklere ve geliştirmelere tabi tutulmuştur.

Enhancing Map Comprehension Via Symbols: Developing Symbols For Thematic Maps Based On Children's Cognitive Development

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ABSTRACT

The compilation and design of materials and products targeted towards children, such as maps, symbols, and atlases, necessitate meticulous attention and a high level of responsibility. The central emphasis and primary concern in this endeavor should revolve around the cognitive development of children, their educational level, their mode and level of perception of various geographical phenomena, and the objects that encompass the localities in which they reside. This research was undertaken as part of a project aimed at compiling and designing an atlas specifically tailored for primary school pupils in the Republic of North Macedonia, known as the "Atlas of North Macedonia for Primary School". Within the framework of this project, appropriate symbols have been meticulously compiled and designed to cater to the cognitive needs and developmental stage of pupils ranging from 6 to 10 years of age. A total of 567 pupils, aged between 6 and 10 years old, from four distinct municipal primary schools were included in the administration of the test designed for the symbols. The overall results derived from the test indicate a positive outcome. Nevertheless, certain symbols were erroneously interpreted by the pupils, resulting in varied and divergent naming conventions. For this purpose, the symbols that exhibited lower performance among pupils and those that elicited suboptimal responses have been subjected to modifications and enhancements.

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INTRODUCTION

The field of cartography holds considerable significance in the education of children, as it provides them with a comprehensive understanding of the world and its complex dynamics. Central to the teaching of geography is the use of maps, which play a fundamental role in enabling pupils to comprehend the spatial relationships between different regions, cities, and physical-geographical features. Maps serve as potent visual tools for conveying spatial information, facilitating effective communication between users and geographic data. Within the realm of education, maps assume a prominent role in conveying geographical concepts and fostering spatial awareness among pupils. To facilitate the widespread use of maps throughout individuals' lives, it is imperative to develop and promote their utilization in the realm of education. Therefore, maps and atlases employed in educational settings should be designed in accordance with the educational system, the age of the children, and their level of comprehension. Numerous studies have indicated that changes in the reading and comprehension processes of children during childhood are largely influenced by Jean Piaget's theory of cognitive development [1-5]. Piaget directed his attention towards concepts encompassing graphic representation, the configuration of shapes, and the modeling of the universe, prioritizing these over the examination of children's interaction with maps [1, 2]. In the field of cartography, it is widely acknowledged that maps should adhere to certain criteria, namely being "correct, complete, appropriate, clear and distinct, readable and visually appealing" [5-8]. An authority in the field of children's map design emphasizes the importance of employing highly contrasting colors, pictorial images, and rich illustrations in order to create visually appealing and engaging maps for children. Such elements enhance the attractiveness and amusement value of children's maps [9-11]. The portrayal of cartographic information through color usage has been a subject of thorough exploration within the domain of cartographic scholarship. This area of study, constituting one of the most closely scrutinized facets of map design, has received substantial attention from scholars throughout history. Notable contributions have come from researchers such as Robinson (1952) [12], Jenks & Knos (1961) [13], Crawford (1971) [14], Kimerling (1980) [15], Olson (1981) [16], Imhof (1982) [17], MacEachren (1995) [18], Dent (1999) [19], and Brewer et al. (2003) [20]. Brewer, with an extensive repertoire of scholarly work that spans several publications, has made significant strides in the realm of color research. Brewer's research encompasses a wide array of topics, including the application of spectral color schemes, guidelines for utilizing diverging color schemes, the impact of simultaneous contrast on maps, strategies for color selection to assist individuals with color impairment, and a tool for selecting suitable colors for cartographic purposes. Brewer's noteworthy contributions include Brewer (1989) [21], Brewer (1992) [22], Brewer (1994) [23], Brewer (1996) [24], Brewer (1997a) [25], Brewer et al. (1997) [26], Brewer (1997b) [27], MacEachren et al. (1998) [28], Brewer (2003) [29], and Brewer et al. (2003) [20]. Another salient aspect in this context pertains to the utilization of colors in maps for children or even other materials like symbols, used as part of maps, and known as part of cartographic design for children. These kinds of purported distinctions have prompted numerous publishers and cartographers to produce maps specifically tailored for children, distinct from those intended for adults. The examination of color in maps has been a subject of extensive investigation in cartographic research, constituting one of the most extensively studied facets of map design [12-20]. Brewer's extensive body of work on color [20-29], encompasses a wide range of topics pertaining to color usage. These include the exploration of spectral color schemes, guidance on diverging color schemes, the impact of simultaneous contrast on maps, color selection strategies for aiding individuals with color vision deficiencies, and the development of tools for selecting appropriate colors for mapping purposes. In recent years, there has been significant progress in various atlas projects aimed at improving map resources tailored to different age groups, considering the evolving and revised curriculum [11]. Additionally, several educational atlas projects with diverse content have been conducted [30-33], along with thematic map activities under international initiatives [34]. Noteworthy studies by Gandy [35], Dough and Kay [36], and Kristien et al., [37] have examined high-quality maps and conducted map-related activities, highlighting the importance of designing maps based on pupils' abilities and emphasizing the significance of cartography education in effective map utilization. According to Şenol and Gökgöz, if children are given maps of the region during activities such as nature trips or city trips, it will be easier for them to both understand the maps and recognize the region they are in [38]. Elementary school pupils

readily comprehend the representation of small portions of the Earth on a two-dimensional plane due to their familiarity with such spatial abstraction. However, when confronted with the depiction of the Earth's spherical form onto a flat surface, such as a map displayed in the classroom, their understanding becomes challenged [39]. In their 2018 investigation, Şenol and Gökgöz discovered that children exhibit a nearly equivalent capacity to discern topological relationships both within their immediate living environments and in relation to two-dimensional/three-dimensional models (maps) [40]. Furthermore, concerning scale awareness, it can be inferred that primary school students typically operate at a broader, large-scale level [41]. In the study conducted by Ayuldeş and Akbaş with sixth-grade students, the objective was to cultivate direction-finding skills among students. Nevertheless, during the implementation, certain students encountered challenges when attempting to locate the designated target points. This difficulty may be attributed to the fact that these students were engaging in orienteering activities for the first time [42]. This standpoint is further substantiated by the students' suggestion to provide clues during the orienteering course. In a similar vein, Uzuner (2019) underscores that heightened orienteering experience among students leads to a more accurate identification of target points [43]. Cartography and cartographers bear significant responsibilities in designing maps that are specifically tailored to meet the needs of children, align with educational curricula, and align with children's cognitive development levels [44]. Much remains unexplored, inadequately deliberated, or only partially comprehended in the realm of children's atlases [45]. In a study conducted by Şahin et al., through analysis and testing it was emphasized that in general the development of children is influenced by four distinct factors, including here personal security, sharing of personal information, social media privacy, and parental control [46]. The Republic of North Macedonia encompasses a diverse array of cultural heritage sites spanning various historical epochs. The Republic of North Macedonia is home to a diverse range of cultural heritage sites from different historical periods. These cultural treasures hold significant importance in understanding the historical, cultural, and economic context of the region. The remnants from the Ottoman Empire are particularly valuable, contributing to the region's cultural heritage and serving as indicators of its tourism potential and economic development. Preserving and promoting these historical artifacts play a crucial role in showcasing the region's cultural wealth and attracting visitors. Additionally, there are notable remnants known as waqfs, established during the Ottoman period in various cities of North Macedonia, such as Skopje, Debar or Dibra, Dojran, Kumanovo, Bitola or Manastir, Ohrid, and Prilep [47]. Based on this evidence, North Macedonia is confidently advancing on the trajectory of development and progress, heading towards a promising future [48]. The historical artifacts from various historical periods that now serve as tourist attractions in contemporary times have been instrumental in the development of symbols, particularly those related to tourism and economic aspects.

This study is conducted as an integral component of the compilation and design process of an atlas intended for primary school pupils in North Macedonia. Within this framework, special attention has been given to the creation of specifically designed and curated maps, along with the compilation of representative symbols and population-related tables. This research mainly centers on symbols, including their creation, testing with pupils to evaluate understanding, analyzing test results, refining symbols based on pupils responses, and gathering relevant data and additional information about the symbols.

MATERIALS AND METHODS

Symbols were created and designed for an atlas aimed at primary school pupils in the Republic of North Macedonia. The symbols, along with the overall content of the atlas, were specifically tailored to align with the cognitive abilities, age group, and spatial thinking skills of primary school pupils. Extensive testing of the symbols designed for utilization in maps and atlases was conducted with primary school pupils to ensure their clarity and comprehensibility to the intended users.

Participants

A total of 567 primary school pupils, ranging from 6 to 10 years of age, participated in this test featuring the designed symbols for the Atlas. Among these participants, there were 132 pupils in the second grade, 139 pupils in the third grade, 161 pupils in the fourth grade, and 135 pupils in the fifth grade. In order to mitigate

the influence of socio-economic status and environmental factors on the participants, four comparable schools were chosen within the city of Tetovo, situated in the northwestern region of North Macedonia. Among the participating schools, three are located within the city limits, while one is situated in a village on the outskirts of the city. This selection was made to ensure a balanced representation of different contexts for the conducted testing. The selection of the age group for participation in the conducted testing as part of the atlas project is based on the cognitive development age groups proposed by Jean Piaget (ages 7 to 11 years). However, due to some pupils in North Macedonia being allowed to start school nearly a year earlier than the criteria for registration in the first grade, the lower age criterion has been adjusted, making it possible for second-grade pupils to participate in the test at the age of 6 years. Additionally, at the age of 11 in North Macedonia, some pupils are part of the class of the second cycle of primary schools, although a small number of them are briefly part of the last class of the first cycle of primary school.

Designed Symbols

The symbols featured in the atlas are meticulously crafted to reflect the distinctive identity of each city within the territory of the Republic of North Macedonia. These symbols serve as visual representations and identifiers for the cities and regions, both within the maps and throughout the atlas. Moreover, these symbols are also presented independently as figures. Each symbol is assigned a specific name that corresponds to the municipality, to the city or to the region it represents, thereby providing a clear reference to its intended destination. The purpose behind the design of these symbols for the atlas is to present the cities, municipalities, and regions of North Macedonia in a straightforward and easily recognizable manner. Each symbol incorporates visual elements that highlight the unique characteristics and landmarks associated with the respective locations.

The symbols utilized in the maps possess distinctive and precise characteristics. They have been specifically conceived and crafted for the purpose of the thematic maps and the atlas, serving as identical symbols across all maps and atlases. Prior to their creation, an in-depth analysis was conducted on the cities within the Republic of North Macedonia, considering factors such as cultural heritage, tourism, economy, history, and more. Every symbol in the atlas portrays a unique aspect of North Macedonia. Subsequently, the key features specific to each city were identified in alignment with the aforementioned aspects. This information was then employed to develop, create, and design unique symbols exclusively for the cities. The symbols were crafted utilizing software programs such as CorelDRAW and Illustrator in collaboration with a graphic designer. It is important to note that all symbols are entirely novel and have not been employed in any previous works, including other maps or atlases. Each symbol is designated with a name that corresponds to the city or region it represents or symbolizes. The design of the symbols prioritizes vibrant colors, distinct outlines, and simple shapes to ensure their easy recognition and comprehension among pupils aged 6 to 10. Additionally, a legend accompanies the symbols, providing explanations regarding their name, meaning, and significance. This facilitates young learners' understanding of the symbols depicted in the maps. The creation and design process adhered to specific criteria to preserve the authenticity and identity of the objects presented through the symbols, as well as the cities or regions they represent and identify. Furthermore, the symbols maintain consistency across all thematic maps, fostering a sense of familiarity among pupils. This enables them to establish connections between different aspects of North Macedonia as they acquire knowledge about the country. Overall, the carefully crafted symbols serve as a visual aid that enhances young learners' comprehension and appreciation of North Macedonia's diverse characteristics.

During the assessment and examination of social science textbooks for primary schools encompassing grades two to five, illustrations were identified that were employed to depict economic, tourism, and related activities. These illustrations were duly acknowledged and regarded as templates for the development of symbols intended for utilization in the thematic maps featured in the atlas. As an illustration, in the fourth-grade textbooks [49], there is a depiction of a skiing center. Drawing upon the elements utilized in the illustration presented in the fourth-grade textbook (left), a corresponding symbol for the atlas (right) was fashioned employing similar components (Figure 1).

During the educational sessions focused on acquainting pupils with the environment in which they reside,

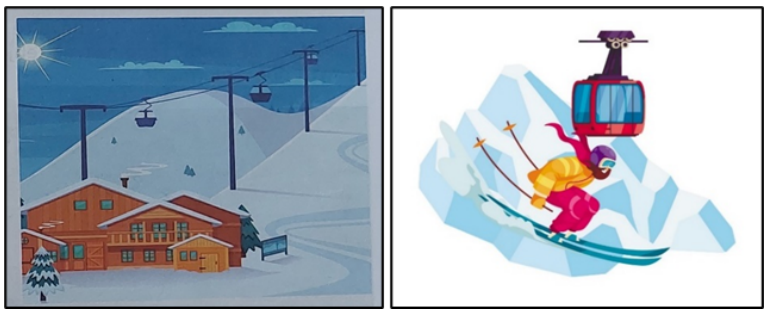

Figure 1. *Presentation of the skiing center in the fourth-grade primary school book* [49] *– left side and the Ski Center symbol designed for the Atlas – right side.*

they encounter images depicting fruits, vegetables, and grains that are predominantly cultivated within the borders of the Republic of North Macedonia. These images are examined in relation to the specific regions or territories within the country where they are cultivated. For instance, in Figure 2, images of Sunflower, Wheat, Sugar Beet or Red Turnip, and Apple are showcased. Utilizing these images as a foundation, representative symbols representing fruits, vegetables, and grains were devised, intended for application in thematic maps and atlases. Through these instructional sessions and visual presentations, it is argued that pupils acquire a deeper understanding of the economic significance associated with the cultivation of authentic products within the territory of North Macedonia.

Figure 2. *Presentation of fruits, vegetables and grains grown and cultivated in the Republic of North Macedonia in the fourth-grade primary school book* [49]*, and the designed symbols of Sunflower, Wheat, Sugar Beet (Red turnip), and Apple used in Atlas.*

The curriculum for fourth-grade books includes lessons on the physical and geographic features of the land, as well as the natural resources it possesses. This curriculum also covers the topic of national parks, emphasizing the importance of their preservation and conservation to enhance awareness and consciousness among pupils. As part of the instructional material, images depicting various national parks in the Republic of North Macedonia are presented. These serve as examples for the creation of a symbol representing National Parks, specifically designed for integration into the atlas (Figure 3).

With this perspective in mind, all symbols utilized in the thematic maps and atlas were conceived and developed, taking into consideration the level of perception and cognitive development of the pupils. The examples provided served as a foundation for the creation and design of these symbols, ensuring their suitability for effective comprehension by the intended audience. A total of 67 symbols were designed for the tourism and economy maps included in the Atlas, with the assistance of a professional graphic designer. Figure 4 depicts a section of the test utilized for the purpose of this evaluation.

Figure 3. *Presentation of the national parks of the Republic of North Macedonia in the book of the fourth-grades* [49] *– left side and the designed Symbol of the National Park for use in the Atlas – right side.*

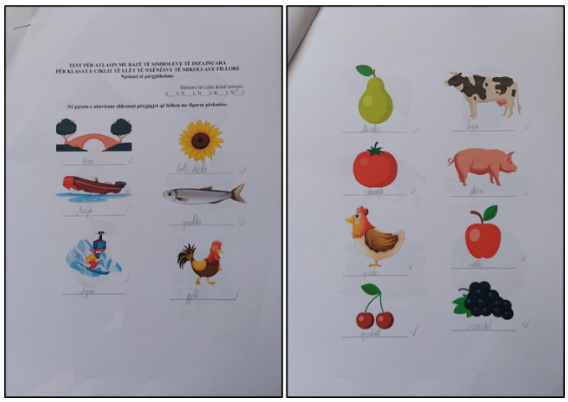

Figure 4. *Test taken by pupils, based on Symbols designed.*

RESULTS

Test based on symbol designed

A comprehensive examination was conducted involving 132 primary school pupils from the 2nd grade, specifically encompassing children aged 6 and 7 years. These pupils participated in a test that assessed their familiarity with the symbols devised for the Atlas. It is important to underscore that the percentages depicted in the table below are derived from the accurate and affirmative responses provided by the pupils. The ensuing table exhibits the outcomes acquired from the test, as follows:

Table 1. *Symbol based test for the 2nd grade primary school pupils, and the success percentages*

Questions	Success Percentages (%)
The Stone Bridge	95.45 %
Boat	94.70 %
Ski Center	91.67 %
Sunflower	86.36 %
Trout Fish of Ohrid	98.48 %
Rooster	91.67 %
National Park	84.09 %
Corn	90.91 %
Plum	81.06 %
Watermelon	94.70 %
Tobacco	18.18 %
Castle	56.06 %
Sharri Dog	90.91 %
Rice	93.18 %
The Clock Tower	77.27 %
Mosque	90.91 %
Church	80.30 %
Ice Cream	93.94 %

Pear	88.64 %
Tomato	93.94 %
Chicken	87.12 %
Cherry	88.64 %
Cow	92.42 %
Pig	85.61 %
Apple	93.18 %
Grape	90.15 %
Sheep	84.85 %
Balkan Lynx	0.76 %
Camping / Picnic	74.24 %
Cable Car / Telepher	69.70 %
Swimming / Summer Holiday	78.79 %
Cabbage	69.70 %
Swan	81.06 %
Potato	81.06 %
Sugar-Beet / Red Turnip	46.97 %
Monastery of Saint Naum – Ohrid	12.88 %
Matka Canyon	20.45 %
Wheat	53.03 %
Monastery of Saing George – Kumanovo	3.03 %
The Ancient City of Stobi	7.58 %
Archaeological Site Heraklea – Manastir / Bitola	5.30 %
Ishak Mosque – Manastir / Bitola	3.03 %
Kratovo Ottoman Tower – Kratovo	0.76 %
Painted Mosques / Pasha Mosque – Tetovo	84.85 %
Wooden Boat	79.55 %
Natural Themal Baths	37.12 %
Wine of Tikvesh	47.73 %
Wooden Bridge – Struga	18.94 %
Stone Bridge – Skopje	18.94 %
The Roman Aqueduct – Skopje	3.79 %
Pepper	78.03 %
Charshi (Baazar) Mosque – Prilep	8.33 %
Church of St. Cyril and Methodius – Prilep	9.85 %
St. Pantelejomon Church – Veles	9.85 %
Church of the Ascension of Jesus – Gevgelia	7.58 %
St. Nikola Church – Shtip	7.58 %
Makedonium Monument – Krushevo	18.94 %
St.George Church – Resen	8.33 %
Monsatery of St. Jovan Bigorski – Debar	9.09 %
The Alphabet Museum of the Albanian Language – Manastir / Bitola	76.52 %
Monastery of Joakim Osogovski – Kriva Palanka	6.82 %
St. George Orthodox Church – Kochan	5.30 %
Statue of Skanderbeg – Debar	78.79 %
Monastery of St. Bogorodica Prechishta – Kichevo	8.33 %
Traditional Albanian Clothes – Kichevo	64.39 %
Mustafa Pasha Mosque – Skopje	58.33 %
New Yugoslavia Square – Kumanovo's Main Square	8.33 %

Based on the results obtained from the second-grade pupils, it can be concluded that the symbols depicting the Balkan Lynx and the Kratovo Ottoman Tower are the least favored, as they received a response rate of only 0.76% each. On the other hand, the symbols that garnered the highest popularity among the pupils are the Trout fish of Ohrid symbol, with an overwhelming percentage of 98.48%, closely followed by the Stone Bridge symbol, which received a response rate of 95.45%.

A comprehensive examination was conducted involving 139 primary school pupils from the 3rd grade, specifically encompassing children aged 7 and 8 years. These pupils participated in a test that assessed their familiarity with the symbols devised for the Atlas. It is important to underscore that the percentages depicted in the table below are derived from the accurate and affirmative responses provided by the pupils. The ensuing table exhibits the outcomes acquired from the test, as follows:

Table 2. *Symbol based test for the 3rd grade primary school pupils, and the success percentages*

Questions	Success Percentages %
The Stone Bridge	97.84 %
Boat	94.24 %
Ski Center	92.81 %
Sunflower	93.53 %
Trout Fish of Ohrid	98.56 %
Rooster	93.53 %
National Park	97.12 %
Corn	97.12 %
Plum	86.33 %
Watermelon	98.56 %
Tobacco	73.38 %
Castle	73.38 %
Sharri Dog	98.56 %
Rice	93.53 %
The Clock Tower	85.61 %
Mosque	85.61 %
Church	73.38 %
Ice Cream	98.56 %
Pear	97.12 %
Tomato	95.32 %
Chicken	93.53 %
Cherry	95.32 %
Cow	94.24 %
Pig	94.24 %
Apple	94.24 %
Grape	93.53 %
Sheep	91.37 %
Balkan Lynx	5.04 %
Camping / Picnic	76.26 %
Cable Car / Telepher	85.61 %
Swimming / Summer Holiday	87.77 %
Cabbage	85.61 %
Swan	89.21 %
Potato	89.21 %
Sugar-Beet / Red Turnip	60.43 %
Monastery of Saint Naum – Ohrid	13.67 %
Matka Canyon	36.69 %
Wheat	93.53 %
Monastery of Saing George – Kumanovo	0.72 %
The Ancient City of Stobi	6.47 %
Archaeological Site Heraklea – Manastir / Bitola	5.04 %
Ishak Mosque – Manastir / Bitola	0.72 %
Kratovo Ottoman Tower – Kratovo	0.72 %
Painted Mosques / Pasha Mosque – Tetovo	88.49 %
Wooden Boat	76.26 %
Natural Themal Baths	35.97 %
Wine of Tikvesh	64.75 %
Wooden Bridge – Struga	26.62 %
Stone Bridge – Skopje	28.06 %
The Roman Aqueduct – Skopje	3.60 %
Pepper	76.26 %
Charshi (Baazar) Mosque – Prilep	13.67 %
Church of St. Cyril and Methodius – Prilep	12.23 %
St. Pantelejomon Church – Veles	13.67 %
Church of the Ascension of Jesus – Gevgelia	11.51 %
St. Nikola Church – Shtip	10.79 %
Makedonium Monument – Krushevo	21.58 %
St.George Church – Resen	12.23 %
Monsatery of St. Jovan Bigorski – Debar	20.86 %
The Alphabet Museum of the Albanian Language – Manastir / Bitola	89.93 %

Monastery of Joakim Osogovski – Kriva Palanka	10.79 %
St. George Orthodox Church – Kochan	10.07 %
Statue of Skanderbeg – Debar	78.42 %
Monastery of St. Bogorodica Prechishta – Kichevo	12.95 %
Traditional Albanian Clothes – Kichevo	79.14 %
Mustafa Pasha Mosque – Skopje	65.47 %
New Yugoslavia Square – Kumanovo's Main Square	12.95 %

Based on the results obtained from the third grade, it can be concluded that the symbols of Saint George's Monastery of Kumanovo, Ishak Mosque of Bitola, and Kratovo Ottoman Tower were the least recognized by the pupils, each receiving a recognition rate of 0.72%. Conversely, the symbols of the Trout Fish of Ohrid, Watermelon, and Ice cream were the most recognized symbols among the pupils, with a recognition rate of 98.56% for each symbol.

A comprehensive examination was conducted involving 161 primary school pupils from the 4th grade, specifically encompassing children aged 8 and 9 years. These pupils participated in a test that assessed their familiarity with the symbols devised for the Atlas. It is important to underscore that the percentages depicted in the table below are derived from the accurate and affirmative responses provided by the pupils. The ensuing table exhibits the outcomes acquired from the test, as follows:

Table 3. *Symbol based test for the 4th grade primary school pupils, and the success percentages*

Questions	**Success Percentages %**
The Stone Bridge	98.76 %
Boat	97.52 %
Ski Center	96.27 %
Sunflower	93.79 %
Trout Fish of Ohrid	98.76 %
Rooster	93.17 %
National Park	98.14 %
Corn	93.17 %
Plum	90.06 %
Watermelon	97.52 %
Tobacco	64.60 %
Castle	68.32 %
Sharri Dog	98.14 %
Rice	98.14 %
The Clock Tower	87.58 %
Mosque	95.65 %
Church	93.17 %
Ice Cream	96.89 %
Pear	95.03 %
Tomato	97.52 %
Chicken	94.41 %
Cherry	95.65 %
Cow	95.65 %
Pig	96.27 %
Apple	97.52 %
Grape	95.65 %
Sheep	92.55 %
Balkan Lynx	5.59 %
Camping / Picnic	91.93 %
Cable Car / Telepher	93.17 %
Swimming / Summer Holiday	95.03 %
Cabbage	88.82 %
Swan	91.30 %
Potato	88.82 %
Sugar-Beet / Red Turnip	86.34 %
Monastery of Saint Naum – Ohrid	41.61 %
Matka Canyon	47.20 %
Wheat	86.96 %

Monastery of Saing George – Kumanovo	1.24 %
The Ancient City of Stobi	9.94 %
Archaeological Site Heraklea – Manastir / Bitola	1.24 %
Ishak Mosque – Manastir / Bitola	1.24 %
Kratovo Ottoman Tower – Kratovo	1.24 %
Painted Mosques / Pasha Mosque – Tetovo	91.93 %
Wooden Boat	83.23 %
Natural Themal Baths	49.07 %
Wine of Tikvesh	88.82 %
Wooden Bridge – Struga	40.99 %
Stone Bridge – Skopje	64.60 %
The Roman Aqueduct – Skopje	4.97 %
Pepper	83.85 %
Charshi (Baazar) Mosque – Prilep	8.70 %
Church of St. Cyril and Methodius – Prilep	10.56 %
St. Pantelejomon Church – Veles	9.94 %
Church of the Ascension of Jesus – Gevgelia	9.94 %
St. Nikola Church – Shtip	9.94 %
Makedonium Monument – Krushevo	37.27 %
St.George Church – Resen	10.56 %
Monsatery of St. Jovan Bigorski – Debar	36.02 %
The Alphabet Museum of the Albanian Language – Manastir / Bitola	94.41 %
Monastery of Joakim Osogovski – Kriva Palanka	8.07 %
St. George Orthodox Church – Kochan	9.32 %
Statue of Skanderbeg – Debar	88.20 %
Monastery of St. Bogorodica Prechishta – Kichevo	8.07 %
Traditional Albanian Clothes – Kichevo	86.96 %
Mustafa Pasha Mosque – Skopje	67.70 %
New Yugoslavia Square – Kumanovo's Main Square	10.56 %

Based on the results obtained from the fourth grade, it can be observed that the symbols of the Monastery of Saint George of Kumanovo, Archaeological site Heraklea, Ishak Mosque of Bitola, and Kratovo Ottoman Tower were the least recognized by the pupils, each receiving a recognition rate of 1.24%. Conversely, the symbols of the Stone Bridge and the Trout Fish of Ohrid were the most recognized symbols among the pupils, with a recognition rate of 98.76% for each symbol.

A comprehensive examination was conducted involving 135 primary school pupils from the 5th grade, specifically encompassing children aged 9 and 10 years. These pupils participated in a test that assessed their familiarity with the symbols devised for the Atlas. It is important to underscore that the percentages depicted in the table below are derived from the accurate and affirmative responses provided by the pupils. The ensuing table exhibits the outcomes acquired from the test, as follows:

Table 4. *Symbol based test for the 5th grade primary school pupils, and the success percentages*

Questions	**Success Percentages %**
The Stone Bridge	98.52 %
Boat	98.52 %
Ski Center	97.78 %
Sunflower	99.26 %
Trout Fish of Ohrid	99.26 %
Rooster	96.30 %
National Park	99.26 %
Corn	97.78 %
Plum	96.30 %
Watermelon	96.77 %
Tobacco	74.81 %
Castle	86.67 %
Sharri Dog	97.04 %
Rice	100 %
The Clock Tower	85.93 %
Mosque	99.26 %
Church	100 %

Ice Cream	99.26 %
Pear	100 %
Tomato	99.26 %
Chicken	98.52 %
Cherry	99.26 %
Cow	100 %
Pig	100 %
Apple	99.26 %
Grape	98.52 %
Sheep	99.26 %
Balkan Lynx	17.04 %
Camping / Picnic	92.59 %
Cable Car / Telepher	96.30 %
Swimming / Summer Holiday	99.26 %
Cabbage	94.07 %
Swan	96.97 %
Potato	94.81 %
Sugar-Beet / Red Turnip	88.89 %
Monastery of Saint Naum – Ohrid	57.78 %
Matka Canyon	60.74 %
Wheat	91.85 %
Monastery of Saing George – Kumanovo	1.48 %
The Ancient City of Stobi	10.37 %
Archaeological Site Heraklea – Manastir / Bitola	9.63 %
Ishak Mosque – Manastir / Bitola	3.70 %
Kratovo Ottoman Tower – Kratovo	3.70 %
Painted Mosques / Pasha Mosque – Tetovo	94.81 %
Wooden Boat	91.85 %
Natural Themal Baths	56.30 %
Wine of Tikvesh	96.30 %
Wooden Bridge – Struga	59.26 %
Stone Bridge – Skopje	57.04 %
The Roman Aqueduct – Skopje	2.96 %
Pepper	98.52 %
Charshi (Baazar) Mosque – Prilep	11.85 %
Church of St. Cyril and Methodius – Prilep	12.59 %
St. Pantelejomon Church – Veles	14.81 %
Church of the Ascension of Jesus – Gevgelia	10.37 %
St. Nikola Church – Shtip	11.11 %
Makedonium Monument – Krushevo	52.59 %
St.George Church – Resen	14.07 %
Monsatery of St. Jovan Bigorski – Debar	42.22 %
The Alphabet Museum of the Albanian Language – Manastir / Bitola	97.78 %
Monastery of Joakim Osogovski – Kriva Palanka	11.85 %
St. George Orthodox Church – Kochan	12.59 %
Statue of Skanderbeg – Debar	95.56 %
Monastery of St. Bogorodica Prechishta – Kichevo	14.81 %
Traditional Albanian Clothes – Kichevo	89.89 %
Mustafa Pasha Mosque – Skopje	74.81 %
New Yugoslavia Square – Kumanovo's Main Square	14.81 %

Based on the results obtained from the fifth grade, it can be observed that the symbols of the St. Monastery George - Kumanovo and the Roman Aqueduct were the least recognized symbols among the pupils, with recognition rates of 1.48% and 2.96% respectively. Conversely, the symbols of Rice, Church, Pear, Cow, and Pig were the most recognized symbols among the pupils, each receiving a recognition rate of 100%.

Subsequently, we will delineate the disparities in responses, ranging from the least to the highest percentage of accuracy, across second to fifth-grade levels. This will be accomplished through a makeshift chart, which will feature the less familiar symbols, denoted by their corresponding percentages, juxtaposed with the more prominently recognized symbols among the pupils.

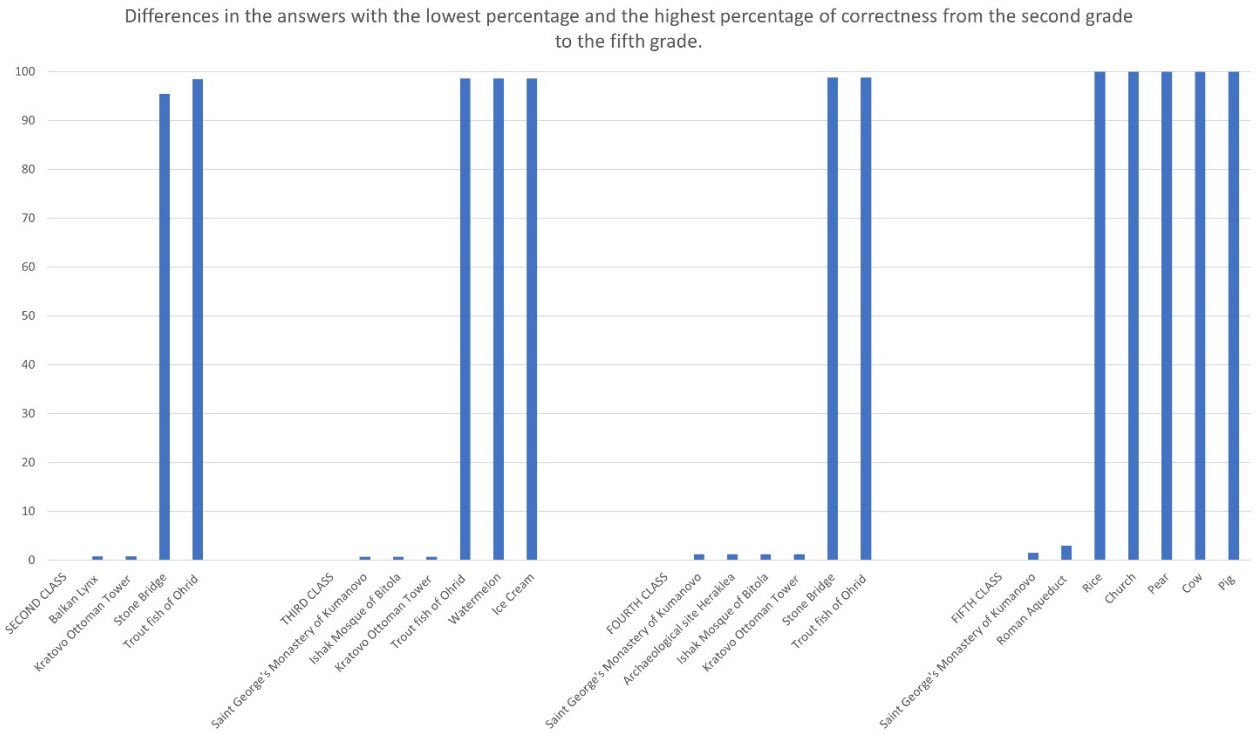

Figure 5. *Differences in the answers with the lowest percentage and the highest percentage of correctness from the second grade to the fifth grade represented with a chart.*

A total of 567 primary school pupils, ranging from 6 to 10 years of age, participated in this test featuring the designed symbols for the Atlas. Among these participants, there were 132 pupils in the second grade, 139 pupils in the third grade, 161 pupils in the fourth grade, and 135 pupils in the fifth grade. Following the completion of the test on symbols designed for primary school pupils, the resulting outcomes are presented in the following table and also in Figure 6:

Table 5. *Symbol based test for all pupils of primary school (from 2nd to 5th grade), and the success percentages*

Questions	Success Percentages %
The Results of the Second Classes	54.90 %
The Results of the Third Classes	61.10 %
The Results of the Fourth Classes	65.15 %
The Results of the Fifth Classes	69.77 %
The Results of all Classes Together / The Average	62.73 %

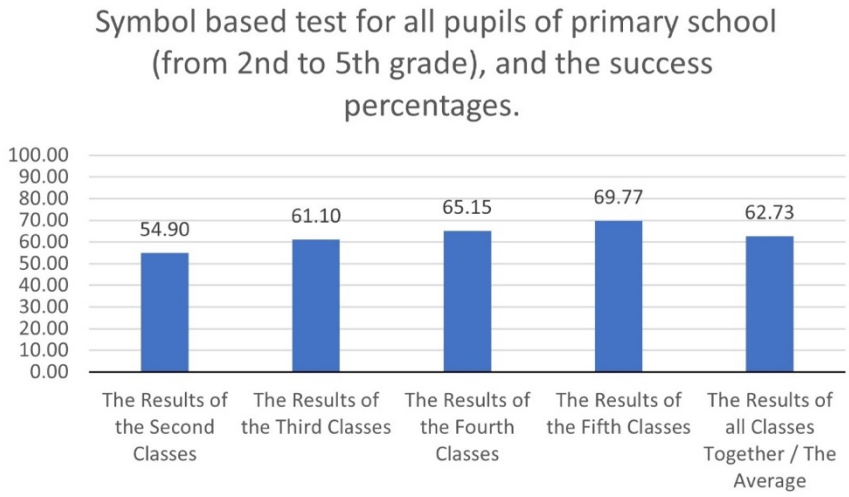

Figure 6. *The Symbol based test for all pupils of primary school (from 2nd to 5th grade), and the success*

percentages represented with a chart.

DISCUSSION

Improvement of symbols based on the results

Based on the analysis of the knowledge pertaining to the symbols designed for use in the atlas, it can be concluded that the pupils possess a general understanding of the symbols, particularly those representing common elements such as fruits, vegetables, and grains. However, there are instances where the symbols are misidentified, indicating a tendency to perceive them as similar symbols or even as something entirely different from their intended representation. For instance, a noteworthy example is the symbol of the Balkan Lynx, which is consistently perceived and described by most pupils across all grade levels as a Hyena.

In light of these findings, it is evident that the symbols specifically designed for the Economic and Touristic map of North Macedonia, which depict significant landmarks or objects representative of various cities, are relatively less familiar to the pupils. The pupils primarily recognize symbols corresponding to the cities or landmarks in their immediate vicinity, followed by symbols associated with cities in close proximity to their residences. Furthermore, they exhibit recognition of symbols or images related to cities they have visited, often through school excursions or family outings. Conversely, the pupils demonstrate a lack of identification when it comes to cities or countries they have not visited, as well as the respective symbols or representative images associated with them. Consequently, they express unfamiliarity with such symbols.

Based on the findings derived from the test assessing the designed symbols for the atlas, it is evident that certain symbols require enhancements to ensure their completeness and facilitate easier identification by the pupils. In the subsequent section, we will present these symbols alongside brief descriptions and images illustrating their initial form during the testing period and the subsequent improvements made. The presentation commences as follows:

The symbol representing Stone Bridge has undergone improvements based on the results of testing. In the initial evaluation, the symbol was frequently identified and labeled as a park or a forest. Furthermore, during the preliminary testing phase, the description and naming of the trees depicted in the symbol were also described. These enhancements have contributed to the refinement and accuracy of the symbol's representation (Figure 7).

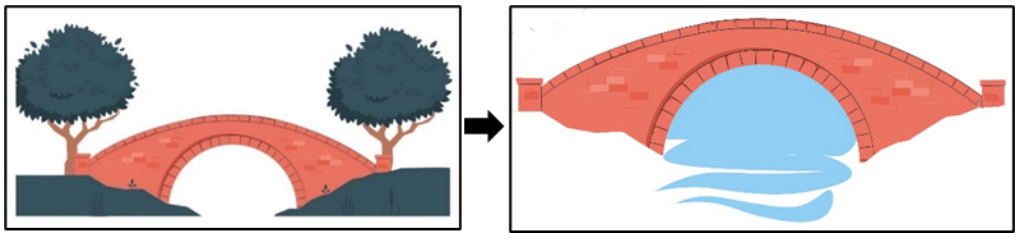

Figure 7. *The Stone Bridge symbol; left side – first version used in the test, and right side - improved version*

The Sunflower symbol has undergone improvements based on feedback received during testing. In the previous iteration, the symbol was described simply as a flower without specifying it as a sunflower. Consequently, adjustments were made to accurately depict and label the symbol as a sunflower, ensuring its proper representation (Figure 8).

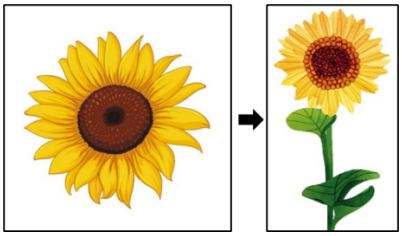

Figure 8. *The symbol of the Sunflower; left side-first version used in the test, and right side-improved version*

Based on the findings from the preliminary testing of the symbols, it was identified that the tobacco symbol required improvement. During the testing process, the symbol was often interpreted as leaves, straw, or other similar representations, indicating a lack of clarity or distinctiveness. Therefore, adjustments and enhancements are necessary to ensure that the tobacco symbol is more accurately recognized and differentiated from other visual elements (Figure 9).

Figure 9. *The Tobacco symbol; left side - first version used in the test, and right side - improved version*

The symbol representing a castle or fortress has undergone significant modifications due to its limited recognition and incorrect interpretations by the pupils. In many instances, the symbol was incorrectly described as a guesthouse or erroneously perceived as an abandoned and vacant structure. To address these issues, substantial changes have been made to enhance the clarity and accuracy of the castle symbol, ensuring that it is properly recognized and understood by the intended audience (Figure 10).

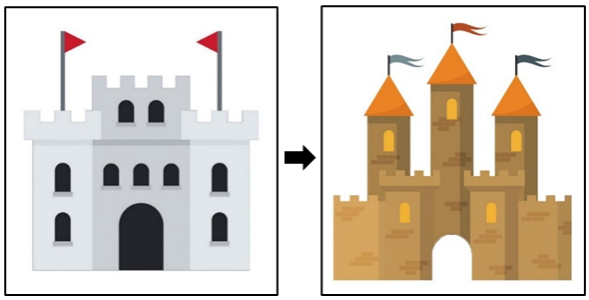

Figure 10. *The symbol of the Castle; left side - first version used in the test, and right side - improved version*

The symbol representing the Sharri Mountain Dog has undergone revisions and improvements. In the previous test, the symbol was simply identified as a dog without proper definition. To enhance its clarity and comprehension, a new design has been introduced. The revised symbol now features a panoramic image of a mountain along with a sheep, aiming to create a more understandable and explicit representation for children. These modifications have been implemented to ensure that the symbol effectively communicates its intended meaning to the target audience (Figure 11).

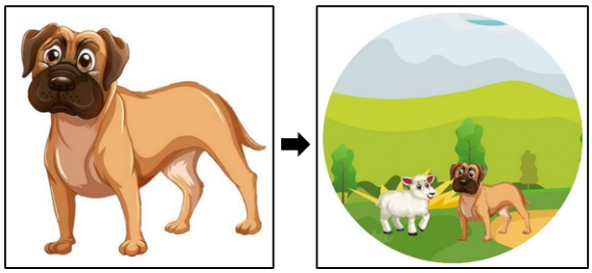

Figure 11. *The Sharr Mountain Dog symbol; left side - first version used in the test, and right side - improved version*

The symbol representing the Clock Tower has undergone a modification by removing the cross that was originally positioned at the top of the tower. This alteration was prompted by the perception of some pupils who

associated the symbol with a church or cathedral. Consequently, a decision has been made to conceal the cross element of the symbol. This adjustment aims to avoid potential confusion or misinterpretation among viewers and ensure a more accurate representation of the Clock Tower (Figure 12).

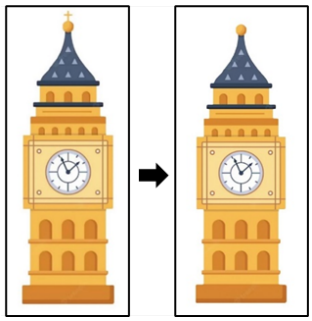

Figure 12. *The Clock Tower symbol; left side - first version used in the test, and right side - improved version.*

Based on the testing conducted, it was observed that the symbol representing the mosque was often mistaken for a mansion or a house, primarily due to the absence of minarets in the depiction. Consequently, a decision was made to enhance and replace the symbol to ensure its accurate representation. The revised symbol will incorporate the necessary elements, including minarets, to more effectively convey the intended depiction of a mosque. This adjustment aims to eliminate any potential confusion or misinterpretation associated with the previous symbol (Figure 13).

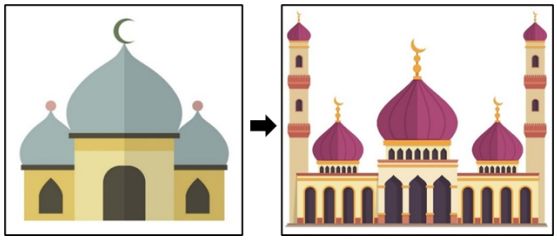

Figure 13. *The symbol of the Mosque; left side - first version used in the test, and right side - improved version.*

Based on the findings of the testing phase, it was observed that the symbol representing the Church was often misinterpreted as a house or even a hut, despite the inclusion of a cross above the depicted structure. The pupils' perception of the symbol did not align with its intended representation. Consequently, a decision was made to enhance and replace the symbol to ensure its accurate portrayal. The revised symbol will incorporate elements that more effectively convey the distinct architectural features and characteristics associated with a Church, aiming to eliminate any potential confusion or misinterpretation (Figure 14).

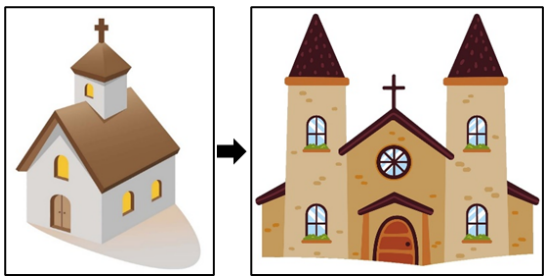

Figure 14. *The symbol of the Church; left side - first version used in the test, and right side - improved version.*

Based on the feedback received, the Chicken symbol is scheduled for improvement. In some instances, pupils have misinterpreted and described the symbol as a Rooster. To address this issue, the symbol will be

enhanced by incorporating small birds within the design. These modifications aim to provide greater clarity and ensure that the symbol is accurately recognized and distinguished as a Chicken by the pupils. Concrete measures have been taken to rectify the misunderstanding and improve the symbol's representation (Figure 15).

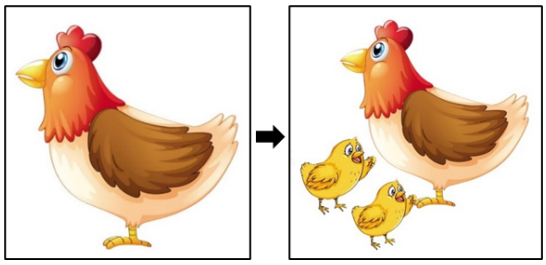

Figure 15. *The symbol of the Chicken; left side - first version used in the test, and right side - improved version.*

Based on the evaluations and descriptions provided by the pupils, it has been determined that the Balkan Lynx symbol requires improvement. In the preliminary test, a significant majority of pupils mistakenly identified and described the symbol as a hyena. To address this issue, the symbol has been completely redesigned and replaced with a new representation. The modifications aim to ensure that the symbol is accurately recognized and associated with the Balkan Lynx by the pupils (Figure 16).

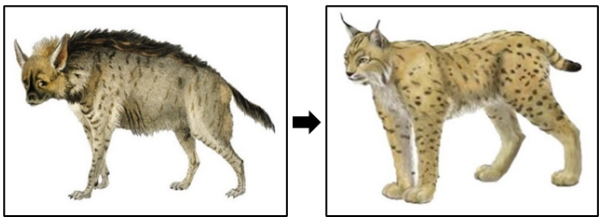

Figure 16. *The symbol of the Balkan Lynx; left side - first version used in the test, and right side - improved version.*

Based on the results of the conducted test, it was observed that the cable car symbol was occasionally identified as a helicopter, while in some cases, respondents left it blank. Consequently, it was determined that the symbol required improvement and modification. In the updated version, the figure now includes a backdrop depicting a cityscape comprising houses, buildings, and elements of the natural environment within the city. These enhancements aim to provide a clearer and more recognizable representation of the cable car symbol to the participants (Figure 17).

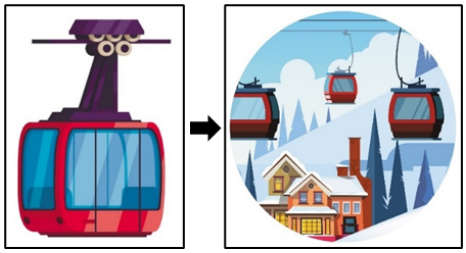

Figure 17. *Cable car (Telpher) symbol; left side - first version used in the test, and right side - improved version.*

Based on the perceptions and descriptions provided by the pupils who participated in the test, it was determined that the Cabbage symbol required improvement and modification. Some pupils identified and described it as a leaf, fir, or tree, indicating a lack of clarity in the symbol's representation. Consequently, a decision was made to create a new symbol that would address these concerns and provide a more accurate depiction of a cabbage (Figure 18).

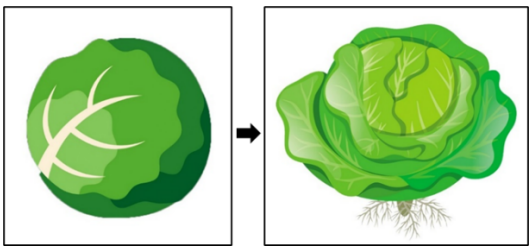

Figure 18. *Cabbage symbol; left side - first version used in the test, and right side - improved version.*

Based on the results obtained from the test conducted with the pupils, it was observed that the Potato symbol was frequently perceived and identified as a broom or sponge. This discrepancy indicated a need for improvement and modification of the symbol. Therefore, it was decided to create a new symbol that accurately represents a potato, addressing the issue of misinterpretation identified during the test (Figure 19).

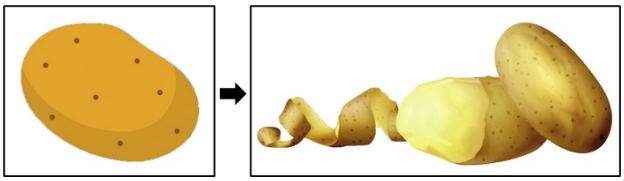

Figure 19. *Potato symbol; left side - first version used in the test, and right side - improved version.*

Based on the responses of the tested pupils, it was observed that the symbol of the red turnip or sugar beet was frequently misidentified as an onion or red onion, while some pupils referred to it as a carrot. These discrepancies in identification prompted the decision to modify and improve the symbol to ensure accurate representation (Figure 20).

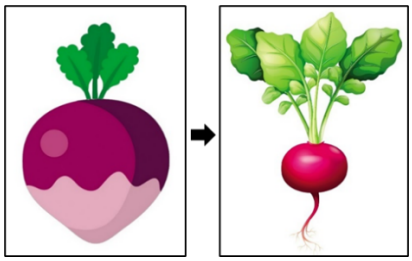

Figure 20. *Sugar Beet symbol (Red Turnip); left side - first version used in the test, and right side - improved version.*

The symbol representing Matka Canyon has undergone improvements and alterations based on the feedback received from pupils. It was observed that some pupils mistakenly identified the symbol as a ship port rather than recognizing it as Matka Canyon or the Canyon of Matka. To address this issue, the new symbol has been redesigned with more vibrant colors and a clearer depiction of the canyon's panorama (Figure 21).

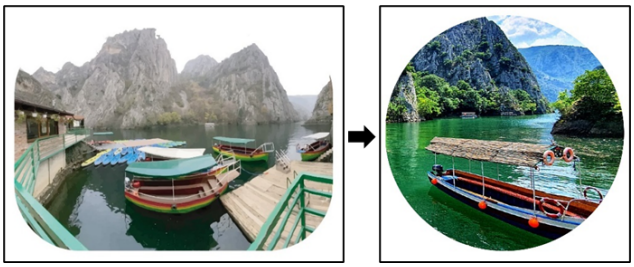

Figure 21. *Matka Canyon symbol; left side - first version used in the test, and right side - improved version.*

The symbol representing Wheat has been subjected to improvements and modifications due to the misinterpretation and lack of clear identification by pupils. A considerable number of pupils mistakenly identified the symbol as straw, while others left it unanswered. In response to these observations, the symbol has been refined and altered to enhance its clarity and distinction (Figure 22).

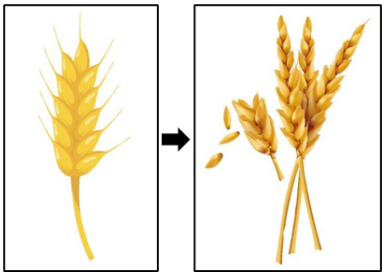

Figure 22. *Wheat symbol; left side - first version used in the test, and right side - improved version.*

The wooden boat symbol has undergone enhancements and rectifications to ensure its improved representation. The symbol now includes the depiction of water, presenting it in its most accurate form. The decision to improve the symbol stemmed from instances where pupils left the symbol blank or unanswered, indicating a need for clarification. Consequently, the improvements were implemented to render the symbol more comprehensive and complete (Figure 23).

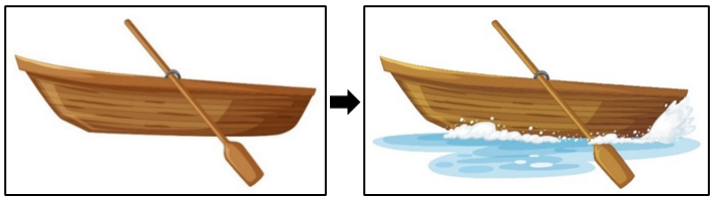

Figure 23. *Wooden Boat symbol; left side - first version used in the test, and right side - improved version.*

Following the alterations and enhancements made to the symbols created for the atlas, the representation of the Natural Thermal Bath symbol has also been modified. This decision was influenced by the findings derived from the symbol tests and the responses provided by the pupils. In the majority of cases, the symbol was interpreted as a swimming pool, a woman in a sauna, or even a jacuzzi. To address these misconceptions, the symbol has been entirely redesigned with a new depiction that is more comprehensible, distinct, and unambiguous (Figure 24).

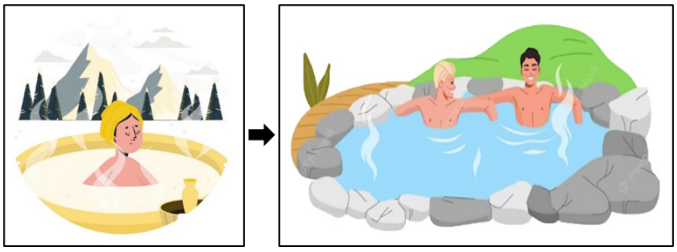

Figure 24. *Symbol of Natural Thermal Bath; left side - first version used in the test, and right side - improved version.*

The symbol representing the Stone Bridge in Skopje is currently undergoing enhancements and revisions. These modifications are based on the findings obtained from the initial symbol testing. During the testing, pupils identified the symbol solely as a "Stone Bridge" without specifically associating it with the Stone Bridge of Skopje. Consequently, it was determined that the existing symbol should be replaced with an entirely new representation that is more comprehensible to pupils (Figure 25).

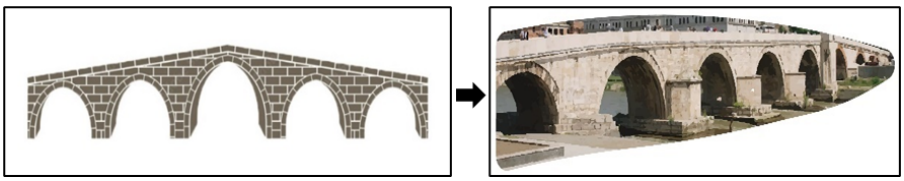

Figure 25. *The symbol of the Stone Bridge in Skopje; left side - first version used in the test, and right side - improved version.*

The Pepper symbol is the final symbol undergoing enhancements and revisions as part of the overall improvement and redesign of the symbols compiled and designed for the atlas. This particular symbol has undergone a complete transformation based on the findings and responses obtained during the testing phase. In many instances, pupils left the symbol unanswered, while in other cases, they identified and perceived it as a tomato. Consequently, it was determined that the existing symbol should be replaced with a completely new and more comprehensible representation (Figure 26).

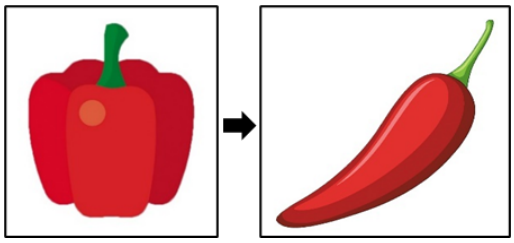

Figure 26. *The symbol of Pepper; left side - first version used in the test, and right side - improved version.*

CONCLUSIONS

This paper presents the development and evaluation of symbols designed for an atlas tailored to primary school pupils in the Republic of North Macedonia. This study was conducted as a component of the "Atlas of North Macedonia for Primary Schools", a compilation specifically designed for primary school pupils in the Republic of North Macedonia. The symbols were meticulously crafted to align with the cognitive abilities, age group, and spatial thinking skills of the target audience. Extensive testing was conducted with 567 primary school pupils from different grade levels to ensure the clarity and comprehensibility of the symbols. The findings reveal that pupils generally possess a good understanding of symbols representing common elements like fruits, vegetables, and grains. However, symbols depicting significant landmarks or objects representative of various cities were less familiar to the pupils. Their recognition of symbols primarily depended on their proximity to the cities, regions, or landmarks depicted. This indicates the importance of designing symbols that are locally relevant to the pupils. Based on the evaluation, certain symbols required improvements to enhance their clarity and accuracy. The paper presented redesigned versions of symbols that were frequently misidentified or misunderstood by the pupils. The modifications aimed to address the identified issues and ensure a more accurate representation of the intended objects. The research has implications for educational practices in primary schools. The carefully crafted symbols serve as visual aids that enhance young learners' comprehension and appreciation of North Macedonia's diverse characteristics. By creating symbols that reflect the unique identity of each city and region, the atlas aims to foster a sense of connection and familiarity among pupils with their country's geography and culture. Moreover, the process of designing and testing the symbols provides insights into the cognitive development and perception of primary school pupils. Understanding how children interpret symbols and images is essential for developing effective educational materials that cater to their cognitive abilities. In conclusion, the presented research contributes to the field of educational cartography and visual communication for primary school pupils. The atlas symbols have been carefully designed to align with the pupils' cognitive abilities and spatial thinking skills. The results of the symbol testing demonstrate the pupils' general comprehension of the symbols, while also highlighting the need for improvements to ensure accurate recognition. Future research may focus on exploring additional factors that influence the pupils' interpretation

of symbols, such as cultural backgrounds or geographic exposure. Moreover, ongoing evaluation and feedback from teachers and pupils can facilitate continuous improvements to the symbols' design and effectiveness in enhancing geographical understanding among primary school pupils. Overall, this study serves as a valuable contribution to educational cartography and educational geography and has practical implications for improving the visual representation of geographic information in atlases aimed at primary school pupils. The designed symbols offer a unique and accessible approach to familiarizing young learners with the diverse cities, landmarks, and natural resources of the Republic of North Macedonia.

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