

The First Tactile Maps for Visually Impaired and Blind Students in the Iraqi Kurdistan Region

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Absztrakt: Jelen kutatás kiemeli azokat a számítógép alapú térképi eszközöket, amelyek lehetővé teszik a Braille-írásos megoldások használatát Kurdisztánban, valamint segít bennünket annak megértésében, milyen kartográfiai keretrendszereket használhatunk, amikor vak és gyengén látó diákok részére készítünk térképeket. Emiatt gyengébb vizuális képességek esetében új technológiai munkafolyamatokat kell kidolgozni az említett technikai megoldások megfelelő fejlesztésére. A látássérült és vak diákok speciális igényeket támasztanak a társadalommal szemben, például a Braille-írás használata a térképek megértésére, hogy a többi látó diákkal egy szintre kerüljenek. Ezekben az esetekben az elemzések az alkalmazott eszközök előnyeinek és hátrányainak tanulmányozásán alapulnak. Az eredmények tesztelése mindenekelőtt rávilágít a kurdisztáni látássérült és vak diákok kihívásaira, amikor a térképi információk elemzésével új ismereteket igyekeznek megszerezni. Az eredmények azt mutatják, hogy a GIS-szoftverek és ebben a konkrét esetben az ArcGIS hatékony lehetőséget kínál a tapintható térképek elkészítésére, valamint felhasználható egy földrajzi, közigazgatási és tematikus térképeket tartalmazó atlasz (esetünkben Irak iskolai atlaszának) létrehozására. Ezek a térképek fejlesztik a látássérült tanulók képességeit, miközben a régiókban alkalmazott tantervben alapuló oktatási tevékenységet is fejlesztik. Ily módon segíthetünk a kurdisztáni látássérült diákoknak abban, hogy jobban megértsék a térbeli ábrázolásokat, valamint a specifikusabb térképi ábrázolásokat (pl. tematikus információkat).

Abstract: This research highlights technological map tools that make the use of braille-based solutions in Kurdistan possible, as well as help us to understand the cartographic frameworks used when making maps for blind and partially sighted pupils. Therefore, in the cases where the visual abilities are poor, there is a need to devise new technological work processes for the appropriate development of the said technical solutions. Visually impaired and blind students in society require specialized needs such as braille usage in understanding maps to put them in unison with other visually upright students. Analyses, in this case, are based on the study of merits and demerits of the applied tools. Testing of results, above all, highlights the challenges the visually impaired and blind students in Kurdistan go through when they struggle to gain new knowledge in analysing the map information. The results show that GIS software and in this specific case ArcGIS offers a powerful way to create tactile maps, as well as can be used to create an atlas (in this study the School Atlas of Iraq) that includes physical, political and thematic maps. These maps serve or develop the capacities of students with visual disabilities, while improve teaching activities based on the curriculum used in these regions. In this way, we can help students with visual disabilities in Kurdistan to understand better spatial representations as well as more specific map representations (e.g., thematic information).

Kulcsszavak: GIS szoftver, tapintható térképek, vakok, oktatása

Keywords: GIS software, tactile maps, sightless, education

Introduction

Cartography is an essential scientific (and artistic) discipline due to the extensive implication for the students in educational institutions. However, the discipline has been impacted by the influence of modern technology. Because of the modern technological advances in learning institutions, there has been a shift in mapping information to the students in cartographic disciplines. The tools used to deliver cartographic information to the students has changed over the recent years. Modern cartography has been improved to promote inclusiveness in information delivery; for instance,

the improved technicalities have got a solution to offer learning experiences to visually impaired students. In the tools improved in this paper, disabled students can access the maps by independently exploring the students' capabilities. Besides, the statistical analysis of data of the Kurdistan Region implies the need to apply modern technologies or improve traditional methods to enhance the functionality of the maps through improved visual abilities. The technological solutions are essential in promoting the educational approaches in the region for students with visual disabilities. The technological advances aim to counter the traditional frameworks

in society and implement modern ways in the educational field through curriculum changes to improve the learning frameworks among students with visual impairments. Besides, the paper focuses on developing new solutions in using cartography for blind and partially impaired students in Kurdistan, which help the students to study the maps despite the low vision ability, helped by using new technologies. This new technology includes incorporating the braille system in the educational frameworks to improve the mapping information transfer. Therefore, maps are the most significant solution in offering geographical data for visually impaired persons. Current

cartographers utilize Geographical Information System (GIS) to develop paper maps that can be modified into touch display, where the visually impaired individuals can opt for various settings and keys, for instance, measurement and colour to represent various data forms (Olczyk, 2018). Furthermore, the research assessed the factors that prompt non-professionals to deviate from utilizing GIS technology in preference for conventional maps. From the responses availed by the participants during testing tactile map in the Kurdistan schools, there is a motivating outcome of low vision persons utilizing maps in the future, since they believe that it is essential to integrate the maps into the learning institutions' curriculum (Zada, 2019). Moreover, there is a need for the designation of the digital maps and the description of maps that are touchable by hand and paper to achieve and create an atlas, including physical and political maps. This will help boost the students' visual abilities and the manipulation of the spatial representations and the resolutions school curriculum in Kurdistan.

Location and Population Background

The research focuses on the Kurdistan Region, which is an autonomous region in Northern Iraq. It borders the Kurdish regions of Iran to the east, Turkey to the north, and Syria to the west, along with the rest of Iraq to the south. The Kurdistan Region combines with the governorates of Halbaja, Dahuk and Sulaymaniyah to make up the semi-autonomous region of Kurdistan and includes the regional capital of Erbil, seat of the Kurdish Regional Government (KRG). The size of the Kurdistan Region in Iraq is around 46,861.41 square kilometres according to the Kurdistan Regional Statistics Office (KRSO, 2015). The total size of population the region is 6.171083 million people (KRSO, 2021). The Kurdistan Regional Statistics Office estimates that each year 137,000 people add to the Kurdistan Region population (KRSO, 2015).

Unfortunately, the census of 2020 did not include the type of disabilities and there are no numbers of people with disabilities in the Kurdistan governorates (KRSO, 2015). However, according to Alborz and Al-Obaidi (2011), Erbil governorate contains the largest proportion of disabilities within their respective populations and the cause of disability across all age groups was overwhelmingly 'born with disability'. Additionally, the highest percentage of disabilities caused by work, diseases, war, and landmines was found in Erbil (Alborz and Al-Obaidi, 2011).

Resuming Braille Education in the Iraqi Kurdistan Region (IKR)

The Northern IKR has taken significant steps to improve regional education standards. Accordingly, English language classes in early grades and promoting creative thinking in classrooms were incorporated into school curricula. The educational reform in the Kurdistan Region will be used as best practices for other regions of the country where there is a need for educational improvement. In the Iraqi Kurdistan Region sight, students have full access to study all map facilities including the library maps for students, to be familiar and achieve map information easily. However, blind and low vision students must have access to this type of information, and it cannot be apart from it. Unfortunately, the lack of tactile maps is mainly obvious in Kurdistan Iraq educational system. As school is the first step to develop map knowledge that reaches people from early school life, and then they start gathering locational information in different sources. For those reasons, schools should offer professional maps for those students who enjoy science subjects and more information about the location, resulting in students who have a better idea about maps and can explain their opinions more obviously and in a more graphic way using map materials. It should be noted that all students with low sight and blind people must learn according

to the same programme accessible on the public and private schools in Kurdistan Iraq. The educational programmes in Iraqi Kurdistan have a full range of educational sources that they can use during their classes. On the other hand, both low vision and especially blind children not only need a teacher with a special knowledge, who can carry out the programme using oral teaching methods, but also with the help of teaching aids. One such source is a tactile map. The source of blind and visually impaired in tactile map works in Kurdistan Iraq is insignificant or it can be said that the supplementary of the tactile map in Kurdistan Iraq does not exist. This research allows to have hope that the new tactile maps for Iraq generally and Kurdistan particularly will be appearing soon as well as the research becomes the part of the school curriculum for developing map skills for blind and low vision students.

Identifying ArcGIS software in this research

The research operated with the ArcGIS software to process and model data, of which a few pieces are of special importance. ArcGIS 10.5 analyses the boundary shape file and was used to develop maps specifically for those in need (such as blind or visually impaired people). In addition, it helps to adapt traditional methods for thematic representation, as well as simplifies the process of representation and categorization of thematic content and the base map elements. According to Hardy and Lee (2005), when the user comes to use XTools Pro, it will be used for the analysis of the adaptation solutions accuracy within the GIS environment with the help of the generalization method. XTools Pro is a very popular extension for ArcGIS Desktop with full features that provide users with different tools for working with geospatial data, table management, spatial analysis of vectors, and shape conversions. The tools in ArcMap are especially useful for helping users to create maps. On the one hand, these

tools are not as extensive as the tools that can be found in some drawing programs. On the other hand, with these tools, the users can easily get dynamic maps with all the intelligence provided by GIS. In addition, ArcGIS is effective for creating exclusive map designs since it has a complete control feature. For instance, as soon as the user sets up maps in ArcGIS to better understand the customer's requirements, she/he can easily obtain various map elements. Besides, the user can benefit from the options to export maps by files with extensions as pdf, ai, jpg, svg, etc.

It is also possible to use other mapping programs for additional options. According to Wabiński & Mościcka (2019), these days, special tactile maps are created with different technologies and advanced methods. This facilitates the process of making unique maps without paying much for the tools. According to Hardy and Lee (2006), the availability of the improved ArcGIS software made it easier to manage the exporting of maps. It follows that some ArcGIS formats, like shape files instead of map drawing by hand or using some equipment, can be integrated. There is also a benefit of avoiding wrong directions, test errors, and not accurate shape to support the speeding up of the processing. It is noteworthy that most data have a locational context, which can be identified on the maps. In such a way, we can assume that ArcGIS software can be used by a specialist to represent the real world in a comfortable and understandable way for people with problematic vision. In addition, the research used some sample maps through GIS to collect and analyse data to find the best solutions for them. At same time other graphic software such as Corel Draw or Adobe Illustrator, as well as GIS software as Quantum GIS can do the same processes. Nowadays, tactile maps are made by using different technologies and advanced methods to provide simpler and lower cost solutions for representing data on maps and the strategy to create a tactile map is easy depending on

the availability of required tools and resources. (Bauza et al. 2019).

Standardization of Braille and tactile graphics.

This research facilitates the use, teaching, and production of Braille. For that reason, the design map should follow the standard tactile graphic, which publishes rules and provides opinions concerning to Braille in all existing techniques. It deals with rules now in existence or to be developed in the future, in collaboration with using English Braille. During the research project, different problems were found when partially sighted and sightless students used tactile maps in and outside schools. By this reason, the study chose some procedures that help us to find a solution for those problems, as well as to categorize them according to the primary components of a tactile map:

1. Area: A representation of a region that has a particular significance for the map. For example, it might demarcate states and counties on a political map or lakes and forests on a physical map, using lines and fills of different colours. In thematic maps, they represent changes from one area to another (e.g., in a climate map). Typically, areas illustrate the actual, non-imaginary content.
2. Line: Lines are used as visual representations of linear objects and concepts, such as rivers, roads, and essential geographic boundaries. If we are using graphs on our map, then lines define shapes' outlines, divisions, measurable lengths, and angles. They may be utilized for illustrating either actual or abstract data.
3. Point: A point is a symbol that marks a specific place on a map. Typically, it appears within an area or directly on a line and provides factual data such as locations of city centres, centroids of provinces, starting point of a text or label (e.g., geographic name), etc.

4. Label: A label consists of words, letters, or numbers utilized for identification of objects showed on a map, such as lines, areas, and point symbols. The use of words facilitates the comprehension of information, compared to keys and symbols, although using full words might make a tactile map too cluttered. A minimum of 12 points font size, though the Royal National Institute of Blind People (RNIB) recommends 14 points to reach more people with sight problems. For a map with braille writing, the font size should be at least 20 points and the character spacing must be at least 2 points (Jones, 2021).
5. Graphic information density: The density of information presented on a tactile map must be consistent with the resolution of the human touch. Normally, a person can distinguish two separate points if they are at least 2.4 mm away from each other. Therefore, symbols in the map that represent its content, such as lines, points, textures, as well as texts, should be placed at least 6 mm from each other. The distance between symbols can be less than 5 mm only if two texturally contrasting elements (e.g., solid line and Braille text) are close to each other, but it never can be less than 3 mm (Olczyk, 2018).
6. Patterns, textures, and colours: During printing, the colour choice for coloured objects must be consistent with the needs and abilities of visually impaired users. To indicate separated areas on a map, highly contrasting colours should be used. Additionally, various textures should be utilized to accommodate the map for blind users. It has been established from the experience that one map can contain no more than six different textures, including the smooth background (Olczyk, 2018).
7. Sheet orientation signs: Maps created on separate sheets should use a cropped right upper corner instead of a protuberant triangle to indicate the correct orientation (Olczyk, 2018).

8. Titles and capitalizations: On the coloured version of the map, titles and capitalizations should be printed in contrasting colours without shading with the font size of at least 16 points (Mitchell & Environmental Systems Research Institute, 2005). They should be placed next to the braille writing. The used key and abbreviations must be consistent with the guidelines. In the current project the researcher has chosen the upper case for all mapping and guidelines because it is more readable than the other case styles, especially for visually impaired readers. At same time, upper-case text was also perceived at a greater distance by students, which helps them to read on speed and recognize words and letters easily.
9. Abbreviation system: The creation of abbreviations for toponyms must not be based on orthographic abbreviations. The information on encoded areas should be placed in the abbreviation key in the guidelines (Table 1).
10. Map word binding: The nomenclature should contain explanations of all the names used in the map. Transcriptions of keys and abbreviations should be presented on the map itself, on an attached legend sheet, or in separate guidelines. A textual description of the map or map collection must accommodate the needs of blind, visually impaired, and sighted users (Figure 1).

Table 1. List of 'keys' used in front of abbreviated proper names on the map for blind pupils

Abbreviation Letter	Province	Abbreviation Letter	Province
BB	BABYLON	MU	MUTHANNA
DU	DUHOK	SD	SALA AL DIN
ER	ERBIL	BG	BAGDAD
KI	KIRKUK	DI	DIYALA
NA	NAJAF	BA	BASRA
NI	NINAWA	AN	ANBAR
QA	QADISSAYA	MS	MISSAN
SU	SULAYMANIYAH	KA	KARBALA
WA	WASSIT	DQ	DHI QAR



Figure 1: Key Information

Findings and discussion

The interactive tactile maps require knowledge that is obtained through education frameworks set out in the core curriculum. Education has come up with various methods to solve the challenges associated with the new technological frameworks, such as the utilization of the ArcGIS tools. Due to the educational frameworks, there has been a greater development in the interpretation of interactive digital maps, such as the provision of the braille system, which helps the use of these maps. Moreover, with

the introduction of Braille in the educational core curriculum, there has been an easy way to serve the visually impaired people in the society and the students in the learning centres to

ascertain proper understanding and use of the maps. In this research, some political and physical samples are designed to familiarize maps to the visually disabled by clarifying basic

map elements and by providing the skills necessary for successful map reading. The text, diagrams, map symbols and sample maps has evolved only after extensive testing amongst blind and visually impaired people, ranging from primary and young high school students to mature adults. Tactile maps were made and tested in close collaboration with 100 visually impaired people aged between four and eighteen years old. The principles and methods studied and tested in the project are relevant to the design of a range of standard tactile maps, from maps with simple information to complex geographic topics. The emphasis is on using methods of map-making for a limited number of rather than on production of great numbers of maps. Additionally, maps were prepared in two languages, one for braille readers and the other for readers needing bold print and for parents and teachers assisting braille readers. Low vision maps are made for readers with varying degrees of seeing difficulty. Names written with capital letters, large fonts and bold type occupy the same space on maps as braille is used. In addition, the degree of generalization and simplification of map detail necessary for the efficient map reading by users with severe visual impairment is about the same as for tactual map reading. It is important to note that various nations and tribes live in this region, so the most favourable language, which proved to be more familiar among people with vision impairment, is English. Hence, the English language is favourable in the generation of braille. Moreover, the maps contain abbreviated names; the abbreviation system built with the public country codes that are visible on the real life and it can be noted that all codes are written with two letters. On the other hand, some of the places do not have a specific code – like the names of all Iraqi provinces –, so the researcher prepared the standardization codes according to the name of the places and using two letters taken from the original name places (Table 1). Developing the abbreviation letter is the only way to

achieve our main objective, which is facilitating map reading for the blind, at same time that the graphic of the map was completely developed, due to having more spaces to write both texts and shown more graphically rather than words (Zada, 2020). The following samples set out an approach to tactile map design and production that will enable cartographers and other specialists in any country to prepare raised graphics that can be understood by, and meet the needs of visually impaired people. Maps are simply a guideline to enhance student's "with low vision and blindness" information map about Geography. These maps will serve them to be independent and familiar with province names and regions in Iraq, as well as understanding maps better and developing the skills necessary to make map reading an enjoyable and valuable experience.

First Sample

Political Iraqi Maps:

1. Iraq, located in the west of Asia, bordered on the north by Turkey, east by Iran, south by Saudi Arabia and Kuwait, on the southeast by the Persian Gulf, and on the west by Syria and Jordan (Figure 2). Following this map and all the other Iraqi maps in general, the small marker with yellow shadow was used to indicate the border of Iraq, but the bigger point in size with a red shadow is used to separate Iraqi borders from its neighbours. A light blue polygon with the straight line indicated the Persian Gulf for all Iraqi maps.
2. Borders of the Kurdistan Region in the north of Iraq are symbolized with a horizontal line with green shadow as shown in map in Figure 3. It has three governorates named Erbil, Slemani, and Duhok, while Halabja was recently added as a fourth one. Some parts in the Kurdistan governorates are called disputed areas in the Iraqi structure, but largely under the control of the Kurdish people. These areas haven't yet officially kicked off preparations to hold

the independence referendum in Kurdistan areas outside the administration of the Kurdistan Region.

Second Sample

Physical Iraqi Maps:

1. Figure 4 shows Physical Iraq map with reduced details into three patterns. The clear brown polygon represents the arrangement of mountains such as high, low and extremely rugged mountainous. The simple hash line with green shadow shows the plain for Al-Jazira and Mesopotamia. In addition, straight line with beige shadow was used to represent Western and Southern Desert.
2. Furthermore, Iraq has three different types of climate: dry arid (desert, BW, violet area with dots inside referring to the south of Iraq), dry semiarid (steppe, BS, pure pink area referring to the centre of Iraq) and Mediterranean (CS, green shadow with vertical lines located in the north of Iraq) represented on the map in Figure 5.

The findings are that use of GIS to create tactile maps was widely accepted and understood by all individuals and all were satisfied and excited with the printed sample maps. Low visions and blind individuals can use this technology to access the information and knowledge that has been scarce for a long time. Additionally, tactile maps can help this group to learn about geographical information, and its aim is using, maintaining, or improving physical abilities and skills, while offering contentment, and in some instances, it entertains observers. However, the lack of tactile maps in the educational system in Kurdistan regions especially and Iraq in general, should have been mentioned: blind and low vision students should learn according to the same system that normal students use to learn with maps at school. Unfortunately, they are not instructed and miss leded sometimes due to not having this kind of sources at school. The author hopes that can

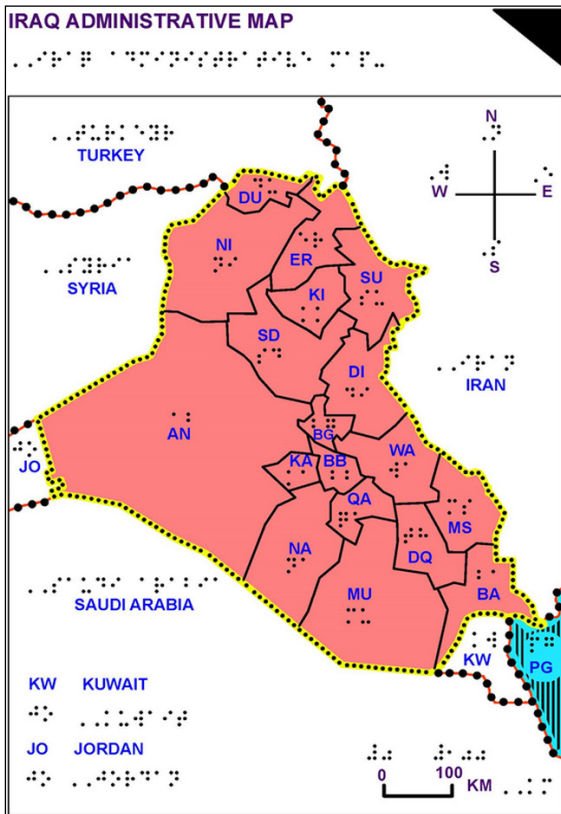


Figure 2: Iraq Administrative Map

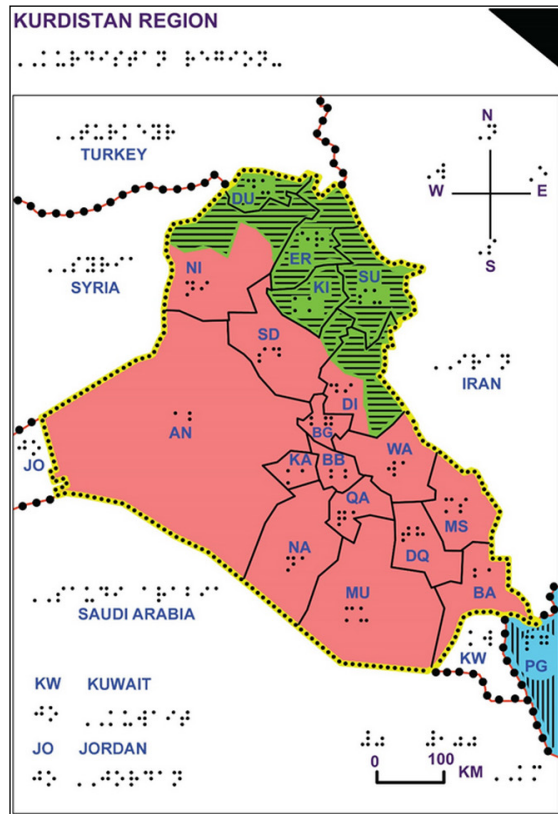


Figure 3: Kurdistan Region

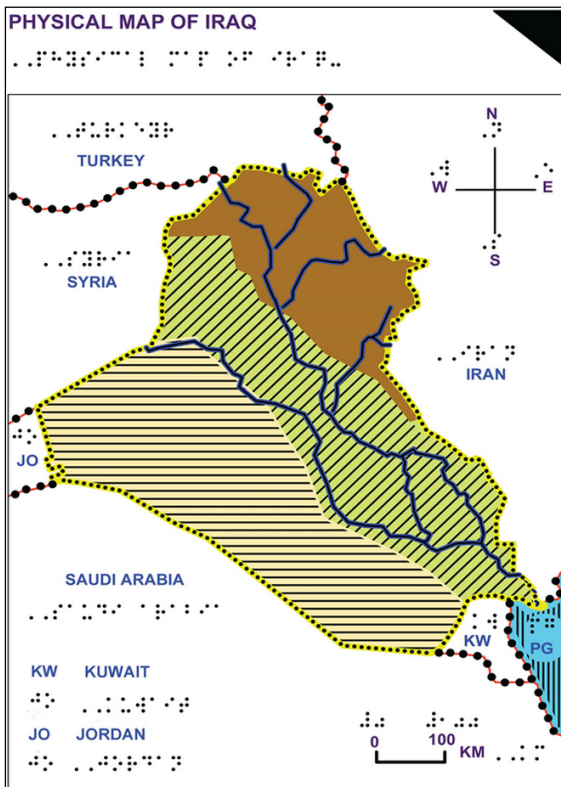


Figure 4: Physical Map of Iraq

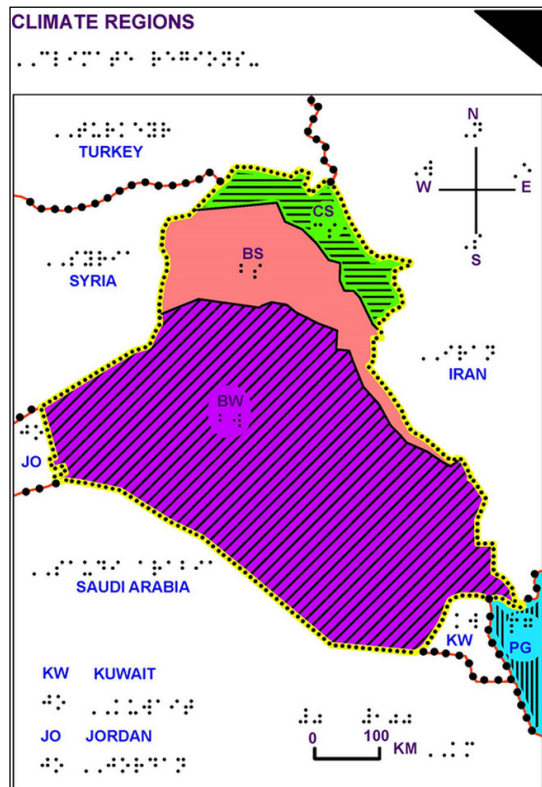


Figure 5: Climate Region

work with the government to improve equity and quality in the education system for those sectors of people. The obtained results are very useful for blind and low sighted students to

communicate information through the key and abbreviations on the map due to finding the geographical location easily. Based on the results of research we can hope that tactile map

could be used in many more places in the future, not just at the school, such as in malls and other public spaces for blind people with special needs to raise the practical value of tactile

maps in Kurdistan regions in Iraq. However, we must do more if we are to address the huge gap between the low levels of learning and the skills required for developing countries to grow. We need to print many more maps or this product for the girls and boys in school beyond the primary years.

Conclusions

This paper proposes the use of the braille tactile maps, which are essential in enhancing the functionality of the blind or the partially sighted students, such as the provision of ease access and use of the maps. These maps are essential because they can provide easy updating frameworks since the technology is ever changing; indeed, the technology is more dynamic since it is developing day by day, but the digital braille tactile maps can incorporate those innovations, which come along with the development of printing technologies. Over and above, the solution must come along with the increased staff in schools and the increment in the computers and other devices essential in the incorporation of the advanced technologies. For instance, mobile phone gadgets have enhanced the learning experience in children more so in exposing the students to the latest information and latest technological advancements. Interactive tactile maps are viable, accessible maps for blind students in the Kurdistan governorates. Samples were also developed, which followed the cartographic and technological rules developed for tactile maps to be used by Iraqi Kurdistan students. The tactile maps used as samples were developed for Iraqi Kurdistan students, but the general rules determined in this research can be applied in other regions or countries too. For example, it is obligatory to add braille to the developed tactile maps to improve the students' haptic senses. In addition, tactile maps must facilitate map reading by developing abbreviation letters and creating a standard map graphic that has spaces

for scripting raised texts that are less wordy and graphical, which all are applied in maps samples. Besides, graphic shapes such as lines, areas, and points are significant for map reading; hence, they should be included so all shapes are simplified (generalized) during the use of ArcGIS software.

The purpose of this research was to identify effective strategies for dealing with maps for blind and visually impaired people, developing specific samples in ArcGIS software. Based on the analysis conveyed, it can be concluded that there are multiple and important behaviour modification rules for the improvement of this type of graphical map designs. Future studies on printing and publishing tactile maps for their use within the braille-using community should be explored further. Those studies should also take into consideration variations in the quality of graphic outputs, the available fill pattern options and the ability to modify or create fill and printing patterns, as well as the availability of the braille alphabet for the software. In addition, the future progress might focus on the application of the audio devices to be autonomous among the student with visual impairments in the society. However, the current strategic framework in this research focuses on designing interactive tactile maps and the description of maps, which are touchable by hand including physical, political, and thematic maps. From all the above analysis can be seen that the research offered and opened a new service for the blind and visually sighted community to take more actions for it.

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