IV. КАРТОГРАФІЧНІ ДОСЛІДЖЕННЯ

УДК 084.3:796.56+373
DOI: https://doi.org/10.17721/1728-2721.2024.88-89.5

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CREATING OF SPORTS MAPS FOR SECONDARY SCHOOL

Background. *Modern education is impossible to imagine without gaining practical skills and abilities that are difficult to obtain only in the classrooms of the school. Training that forms practical competencies is more effective. Orienteering is a type of activity that combines physical, practical and intellectual components. This is effortless to do when organizing training sessions "plain air" in the green areas adjacent to university buildings. However, the deficit of appropriate cartographic material, namely the quality sports maps, prevents such training sessions for students. Thus, it is relevant to study the functionality of available GIS software. The purpose of this study is to reveal the possibility of using and the availability of sports orientation in general secondary education institutions and to develop an algorithm for creating a map and a route for conducting orientation with students on the example of Tetiiv Lyceum No. 2 of the Kyiv region.*

Methods. *The research methodology is based on the analysis and generalization of geo-information software for creating sports maps, the analysis of the suitability of satellite images of the territory of Ukraine and other cartographic materials. The GIS mapping method was used – from the selection of the optimal projection and the corresponding coordinate system to the creation of a sports map in the Open Orienteering Mapper program.*

Results. *The main stages of creating a sports map are: preparing the base map; mapping the territory – creating a map;distance planning;preparing the map for printing. To create a substrate, we recommend using the "SASPlanet" program. You can use the "Open Orienteering" program to create an actual cartographic work – a sports map. It is better to plan, create a race distance, design and prepare a map for printing in the "Purple Pen" program. The algorithm for creating a sports map with the possibility of further mapping with the help of free GIS support is presented on the example of the territory of the town of Tetiiv, Kyiv region.*

Conclusions. **The practical significance and novelty lies in the fact that an algorithm and toolkit are presented for the full organization of classes, the acquisition of practical skills, and the holding of orienteering competitions on the territory of an educational institution.**

Keywords: *orienteering, sports map, secondary school, GIS, Open Orienteering Mapper.*

Background

In countries where geography, as a science and an educational discipline, has gained significant development, it is a common practice to involve children in sports orienteering – a type of active recreation, which is designed to teach schoolchildren to orient themselves in the area using auxiliary tools – a compass and maps. In addition to the fact that students learn to apply the acquired knowledge in practice, they also engage in physical training, which, of course, has a good effect on their health. That's why teachers' initiation of such classes and competitions is especially important now, when schoolchildren mostly lead a sedentary lifestyle and are poorly aware of where they may need the knowledge they have acquired at school.

A study of the experience of foreign countries allows us to single out Great Britain as a country where in school education considerable attention is paid to sports orientation. So, for example, approximately 55 % of schools in Great Britain can offer students this sport. In addition, teacher training is also actively conducted here. To understand why they should teach children in the future, teachers can choose one of the many courses offered by the government or private companies. Also, UK associations can offer teachers and quality equipment for a certain price. It is worth noting that in the 1990s there was stagnation in school guidance in Great Britain. Over time, the number of competition participants decreased. Because of this, the country was forced to partially reform education and direct schools to interest students in orienteering. In order for children to test their own strength, in Scotland, for example, school orienteering festivals are held every year in early June. The Scottish School Guidance Association also offers teachers special programs that they can use to teach children. Measures taken by the government helped to overcome the stagnation and over time the number of students interested in orientation increased again.

In New Zealand, where orienteering is practiced mainly in high school, there are several levels of competition, including regional and national. Also, depending on the difficulty of the route, they are marked with different colors: white – for beginners, yellow, orange and red – more difficult (respectively, red routes are considered the most difficult). In addition, there are 18 orienteering clubs operating in the country. In such clubs, during training, students acquire the necessary knowledge, skills and abilities, develop more professionally, and participate in various competitions.

In Japan, orientation is taught in geography lessons, accordingly, the whole class participates in learning (it can contain up to 40 people). Training is often held on the school premises, where it is easier for students to master the basics. Thanks to this, schoolchildren develop basic skills and skills in working with a map. Over time, teachers make the routes more difficult, and at the end of each such session, students can receive feedback with an analysis of their results. Also, at the school, student orientation clubs can be created, which contribute to the deepening of

ISSN 1728-3817

acquired knowledge and skills and the further development of schoolchildren. In Japan, orientation is considered very important, because the terrain can change due to frequent cataclysms (earthquakes, tsunamis, typhoons), and therefore it is necessary to be able to quickly adapt to an unfamiliar environment in order to survive (Kobayashi, 2019).

Quite interesting is the experience of the Swedish Orienteering Federation (the federation has about 75 thousand athletes and 600 clubs), which since 2018 increased investments in the secondary education system and supported the implementation of a new curriculum aimed at studying and knowing maps. One of the aspects of the cooperation is the introduction of a training day (fortbildningsdag), during which advice and methods are provided on how to organize orientation in the school education system, starting from primary school.

Thus, based on the experience of other countries, we can see that it is quite possible to solve the most common problems, which are low activity and interest of students in sports orientation. This necessity led to the conduct of a study, the results of which are presented in this article.

Ya. Galan proved the positive impact of sports orientation on the health of students by conducting a pedagogical experiment where the general physical characteristics of schoolchildren were compared before and after classes in this sport (Galan et al., 2016). P. Huikko and S. Raus have compiled an online guide for teachers that contains a lot of necessary information for teaching student orientation (Huikko, & Raus, 2020). Metrôlho proposed the use of special web applications during orienteering competitions. Such programs allow 1) to improve control over the course of the competition; 2) using existing functions to make the process more gamified, which will interest students; 3) reduce the use of paper, because when using the application, there is no need to print the maps (Metrôlho et al., 2019). P. Fränti also proposed the use of mobile applications and presented the mobile game O-Mopsi, which is intended for orientation and increasing physical activity of schoolchildren (Franti et al., 2017). Guo Cheng presented the Cinton geoinformation system, the main purpose of which is to reduce the rather heavy burden, which is usually placed on the organizers of the competition, and help in solving several problems: fixing the unfair passage of the route;possible injury to the participants and the timeliness of providing assistance to them (Cheng, Xing, & Wang, 2019). L. Datsenko presented the main features of sports cards and the requirements for their creation (Datsenko, 2008). K. Bobrysheva and O. Hrynyuk considered the algorithm for creating a basis for a sports map using SAS Planet and Global Mapper software (Bobrysheva, & Hrynyuk, 2016).

Having analyzed the main topics of the publications, the following conclusions can be drawn. Most of the works are devoted to theoretical and methodological aspects of orientation, as well as the use of various applications directly during training, games and competitions;however, at the same time, there are very few studies that address the issue of creating sports maps and planning distances for competitions, which determines the relevance of this study. As a rule, this information can be obtained only at specialized seminars or courses, which is almost not available for most teachers.

The purpose of this study is to reveal the possibility of using and availability of sports orientation in general secondary education institutions and to develop an algorithm for creating a map and a route for conducting orientation with students on the example of Tetiiv Lyceum No. 2 of the Kyiv region.

Methods

The research methodology is based on the analysis and generalization of geo-information software for creating sports maps, the analysis of the suitability of satellite images of the territory of Ukraine and other cartographic materials. The GIS mapping method was used – from the selection of the optimal projection and the appropriate coordinate system to the creation of a sports map in the Open Orienteering Mapper program.

Results

The latest approaches in education convincingly show the importance of acquiring practical skills and abilities. However, for this, it is necessary to increase the professional competence of geography teachers by offering them courses and available equipment. In addition, the acquisition of digital competences not only by students, but also by teachers is very important nowadays, because with the help of technology, a better effect can be achieved in the educational process. With the help of special programs, teachers will be able to create sports maps of the area for holding competitions and, accordingly, plan distances. Geography teachers must have such skills, because if they lead a club and conduct competitions, they will need to use sports maps of the chosen area, and they do not exist for every territory. So, in similar situations, they will have to be created independently. For competitions, it is also necessary to be able to develop sufficiently clear and understandable distances, taking into account the age and experience of the participants. That is why the study of software for creating sports maps and distances is quite relevant for geography teachers. Nowadays, cartographic materials are available not only in the classic, paper format, but also in digital format. In addition, it should be noted that nowadays there is enough software that allows you to independently create a diverse cartographic product. Most of them are paid, but at the same time there are enough with a cheaper license for the educational process or even free.

OCAD is a recognized leader in the field of creating sports cards. The free analogue of the OCAD program is Open Orienteering.

There are various applications for creating maps. Some of them have paid and free versions, which, accordingly, differ in sets of functions. In this article, we offer to consider the software "SAS Planet", "Open Orienteering" and "PurplePen".

To create a map, you should have a basis, the so-called "base map", which uses space images of the territory. It should be noted that most resources prohibit the use of their images for commercial purposes. But there are resources that not only do not prohibit, but also allow editing of their maps, such as Open Street Map. In this case, the algorithm for working with the "SAS Planet" resource will be presented to obtain the creation of a map on a non-commercial basis for the purpose of training and organizing a higher quality educational process.

The "SAS Planet" software provides access to a large number of different map support, among which there are, of course, the most popular space images from Google Maps and Bing Maps resources. These two resources represent high-quality space images of the entire planet, taken in the last few years. In addition to access to various map materials, this program provides the ability to save images of the territory with georeference, which facilitates their further use. It should also be noted that to select a picture of the territory, you need to use all available services. So, in our case, the picture taken from the Bing Maps resource turned out to be more successful and suitable for further use (see Fig. 1).

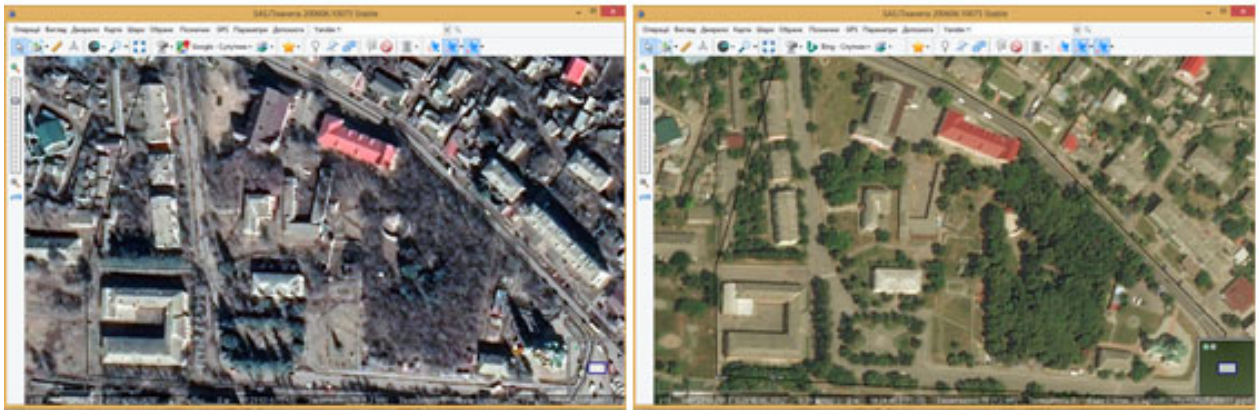

Fig. 1. Comparison of satellite images from Google Maps (left) and Bing Maps (right) for the selected area

An important aspect of research is the selection of the scale of the picture. On the one hand, the larger the scale, the better the detail. But, it should be understood that such a picture has considerable "weight", which makes it difficult to work with it. It is recommended to use the Z-19 scale, which is sufficient for creating maps of urban development or, as in our case, maps of the school and the surrounding area.

With the help of the tools presented in the "SAS Planet" program, it is possible to choose precisely the territory that is planned to be mapped. To do this, you should use the "Area" tool in the configuration that is suitable for the selected territory. It makes no sense to cover as much territory as possible, because this will only increase the "weight", but will not affect either the quality or the clarity of the picture. For a more successful (without loss of quality) saving of a picture of the selected area and the ability to always have access to it, we recommend loading it into the cache, but not only at the selected scale, but also two more previous ones (in our case, these are Z-17 and Z-18). Thus, the cache will contain images of the territory of different scales, which, when "gluing" them together, will reduce the loss and pixelization of the territory. When gluing images together and saving them later, you should pay attention to two points: 1) choosing a projection (we recommend using the Mercator projection, the WGS84 coordinate system and the set of geodetic parameters – EPSG:3395); and 2) choosing the binding format (we recommend using the binding file extension.w (shorttext)).

So, the interface of this software is quite convenient and it is quite easy to learn how to work in the application. The only problem that may arise when creating a polygon is that if the point of the polygon is placed too close to the edge of the working area, the program will suddenly show a completely different place (for example, fields outside the city limits). In contrast, after saving, the polygon does not disappear anywhere, and if necessary, it can be adjusted only by entering the program. It is also necessary to take into account that satellite images of the chosen place may be outdated, this is a significant disadvantage and may have a negative impact on the following stages.

Thus, as a result of work in the "SAS Planet" program, a polygon (with a scale of Z-19) was created on the basis of a satellite image of the central part of the Tetiiv town and Tetiiv Lyceum No. 2 (see Fig. 2) with preserved georeferenceinto the WGS84 coordinate system.

Fig. 2. A picture of the selected territory in the Tetiiv town and the created polygon

ISSN 1728-3817

To create a cartographic work, and in this case a sports map, we used the "Open Orienteering" software. This program is open source, thanks to enthusiastic programmers and cartographers. Its biggest advantage of the program over OCAD is the possibility of installation on the Android platform, which makes it possible to use it in the field. This aspect is important not only for creating maps, but also for teaching, because the teacher can show the object both in the picture and "live" directly in the field.

To successfully work in the "Open Orienteering" program, you must follow the following recommendations:

1. When creating a new map, you should choose a scale of 1:4000 (recommended by IOF for sprint maps within the urbanized area) and a set of signs ISSprOM 2019_4000 (the latest set of signs at the moment).

2. Download the base map that is the basis for mapping in JPEG format.

3. Carry out georeferencing of the image (base map), which occurs almost completely in automatic mode (we do not recommend changing and leaving the proposed options for placement and scaling of the image), you only need to enter the determined value of the magnetic declination, which is obtained from the service of the National Office of Oceanic and Atmospheric Research.

These recommendations mainly refer to the creation of maps specifically for school orientation and the educational process. Of course, they can be interpreted and used to create similar maps of urban development.

Thus, we get a prepared and tied basis for creating a map. Next, you should proceed to display the relevant objects, which are already displayed in this program with the appropriate conventional designations. Line and planar callouts can be displayed to scale, point calls can only be out of scale. In addition, the color of conventional designations assigns them to a certain group. But here you should pay attention to the specifics of the use of colors on sports cards. For example, the degree of vegetation permeability (degree of permeability) is indicated by white, light green, green and dark green colors. Anthropogenic objects and rocks/stones indicated in black, etc.

When creating a sports card, we recommend following the following algorithm:

1) first display the roads, the width of which is given on a scale, which will allow dividing the map into areas that should be mapped in the future;

2) to display significant planar objects, such as forest plantations, open natural areas, flower beds, wide sidewalks, asphalt platforms, water bodies, etc.;as a rule, these objects are tied to main roads;

3) houses shown to scale;

4) linear objects, including off-scale roads;

5) out-of-scale point objects.

When mapping the territory, you should immediately mark dangerous areas. This will need to be taken into account when planning the distance. Such areas are marked accordingly, "closed" for running.

So, working in this program is somewhat more difficult than in the previous one. In addition, the work in "Open Orienteering", in this case, is much longer compared to "SAS Planet" and is not limited to several days, as it requires scrupulous work with the objects – marking them as accurately as possible and making sure that there are no gaps. Also, as mentioned in the part about the previous program, satellite images of the territory may be out of date, so further research requires detailed and careful clarification of the location of objects on the terrain. Thus, it should be noted that the field stage is extremely important and cannot be neglected when creating sports cards.

Also, an additional advantage of this program is the ability to create copyright symbols. While working with existing characters is not too difficult, entering your own character is much more difficult. The program is quite poorly used for creating vector images, if you consider the possibilities of "Open Orienteering" from the side of graphic editors, where, of course, you can easily create the necessary marks if you have elementary skills in working with such programs. In fact, this system relies on creating signs using coordinates. After understanding the basics of working with such a system, three author's conventional signs were created for the designation of benches, playgrounds and Orthodox church buildings. Also, with only the existing notations, a fountain mark was created.

It should be noted that in this case we neglected the terrain. We assumed that the area of the site is relatively small, and the relative height difference is so insignificant that it will not affect the chosen direction of movement of the participants of the competition.

So, as a result of the work done, a sports map of Tetiiv Lyceum No. 2 and the surrounding area (see Fig. 3) was created on a scale of 1:4000.

Fig. 3. Map of a part of the center of Tetiiv town and Tetiiv Lyceum No. 2

The final stages of working with the map are planning the distance and preparing the map for the competition. All this can be done in the free program "Purple Pen".

When preparing a map for the competition, we recommend following the following algorithm: create a map of the distance into which you need to load a file with the map (it must first be saved in the .ocd extension without a background) and the scale that was previously in the map (as, for example, in ourcase – 1:4000); we recommend naming the file according to the name of the competition (in our case, "School Competitions").

At the same time, an important aspect is the determination of the map printing format, because the map should fit on the sheet, but at the same time not fill it by 90 %, you should leave space for the legend, inscriptions, logos of sponsors, etc. (so in our case the A6 format in the futurewas changed to A5).

1. Arrangement of "start", "finish" and "control points". All these points have been determined in the field and it remains only to place them in the appropriate places on the map. The latter should cover as much of the territory as possible, while avoiding dangerous areas, some of which can be additionally marked as prohibited zones. A total of 12 checkpoints have been set up, as well as two road crossings with very low traffic, where students will be under the supervision of judges.

2. Creating a legend. Each of the control points must be described (in notation) so that it is clear what exactly it is – a corner of a building, a tree or a group of such, a turn in the road, etc. Actually, most often such objects are found at the created distance, since they are quite easy to navigate. Also, such a description should indicate the direction where the control point is located relative to a certain object or where one can walk to reach it.

3. The distance is created almost automatically. You should create a distance type and select the start, finish and control points required for this distance. The program itself will create the given distance and calculate its length. In our case, there was only one distance intended for children and it was named according to the age category – "11–14 years old". It includes all control points.

4. Placement of the legend. The legend should be placed on the sheet in such a way that it does not overlap the map and especially the distance.

5. Issuance of the card. In this case, the design consisted of adding a frame, scale, author of the map, its title, the date it was created, the coat of arms of the city, and a legend. This can be done using the tools available in the PurplePen program. It is worth noting that in the presented example, the colors for the inscriptions and frames were created using the program's functions, and were not chosen from the standard set, since those colors are more difficult to combine harmoniously with each other. There may also be difficulties with adding wildcards. When saving the file in PDF format, they may be displayed too vaguely or may not be visible at all. To avoid this, you should save with a significant resolution, at least 300 dpi.

6. Preparation for printing. For printing, it is better to choose the CMYK color scheme, where colors will be more accurately transmitted, while RGB will make them too bright, and some of the colors will change beyond recognition.

As a result of working with all the presented programs, an A5 format map was obtained with a prepared distance for the competition ≈ 1,4 km long (see Fig. 4).

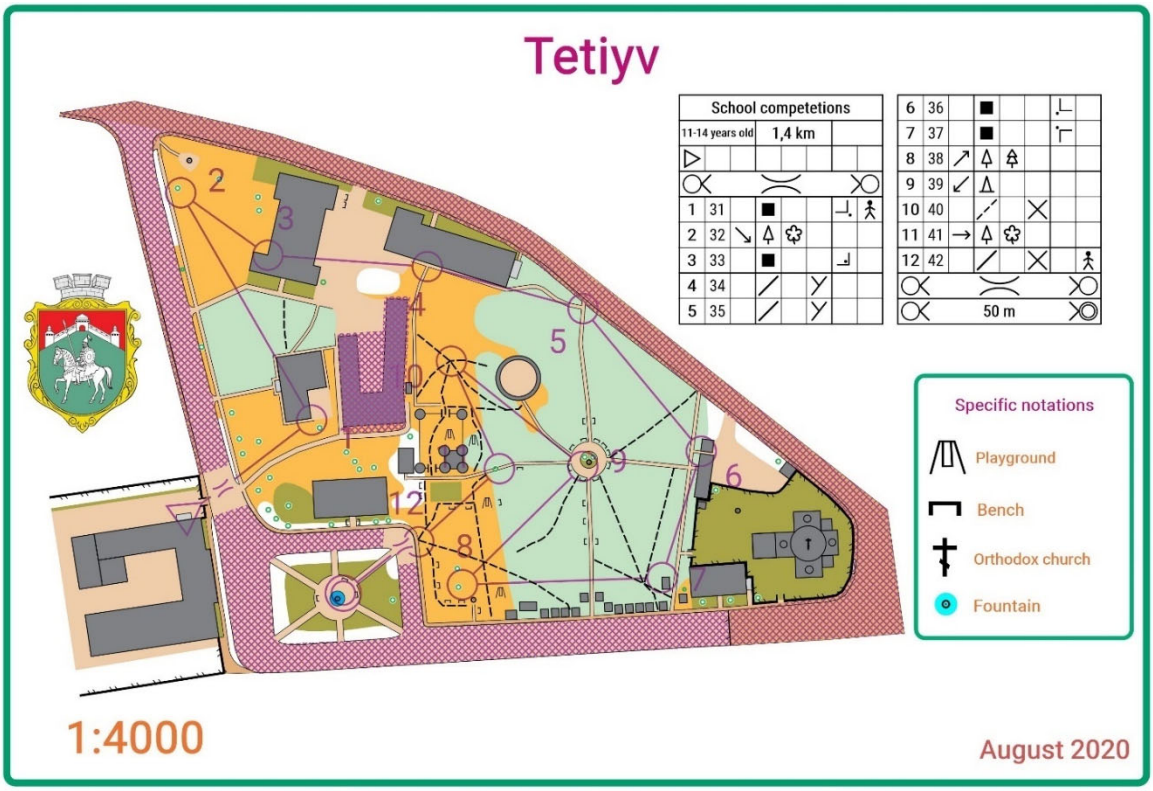

Fig. 4. Sports map with distance

Discussion and conclusions

So, orienteering is a sport that develops not only physical abilities, but also logical thinking, decision-making speed, the ability to "read" a map, orient oneself in space. And its main advantage is age availability (at competitions, groups of "children" with a minimum age of 6 years and older are

forming more and more often). In addition, orientation can be conducted in the sports hall and school yard (the so-called "labyrinth") or on the territory adjacent to the school. The main obstacle is the lack of specific cartographic material – sports maps. Urbanized areas are quite easily deciphered from space photographs. This article presents an algorithm for creating sports maps of urbanized areas using the example of Lyceum No. 2 in Tetiiv town. The main stages are: preparation of the base of the map (the so-called "base map"); mapping the territory – creating a map;distance planning;preparing the map for printing. Different free programs are used at each of the stages. To create a substrate, we recommend using the "SASPlanet" program. You can use the "Open Orienteering" program to create an actual cartographic work – a sports map. It is better to plan, create a race distance, design and prepare a map for printing in the "Purple Pen" program. Anyone can master the functionality of the presented programs, as their interface is quite convenient. Training teachers to create sports maps can be a step to intensify the activities of clubs related to orientation, and will also be useful for conducting thematic excursions and visualization when studying certain topics. In addition, high school students can be involved in creating maps, for example, creating a map of their home territory.

The scientific novelty of the study consists in determining the main stages of creating sports cards and compiling an algorithm for each of the stages presented in the work. The determination of the methodology for creating cartographic works for orienteering competitions constitutes the scientific and practical significance of the conducted research.

Authors' contributions: Oleg Gryniuk – conceptualization, methodology, revision, editing; Antonina Yurieva – original draft, creating a map.

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Отримано редакцією журналу / Received: 16.02.24
Прорецензовано / Revised: 27.03.24
Схвалено до друку / Accepted: 25.05.24

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СТВОРЕННЯ СПОРТИВНИХ КАРТ ДЛЯ ЗАКЛАДІВ СЕРЕДНЬОЇ ОСВІТИ

В с т у п . ***Сучасна освіта має формувати практичні компетентності. Спортивне орієнтування в закладах середньої освіти поєднує в собі і фізичну, і практичну, і інтелектуальну складові. Його доволі легко організувати на навчальних заняттях "просто неба", поряд із закладом освіти. Проте відсутність відповідного картографічного матеріалу, а саме спортивної карти, перешкоджає проведенню таких навчальних занять як для учнів, студентів, так і для викладачів. Отже, актуальним є вивчення функціоналу доступного програмного забезпечення ГІС. Мета цього дослідження – розкрити можливість використання й доступність спортивного орієнтування в закладах загальної середньої освіти й розробити алгоритм створення карти та маршрут для проведення орієнтування з учнями на прикладі Тетіївського ліцею № 2 Київської області.***

М е т о д и . ***Методика розвідки базується на аналізі й узагальненні геоінформаційного програмного забезпечення для створення спортивних карт, розгляді ресурсів придатності супутникових знімків території України та інших картографічних матеріалів. Використовувався метод ГІС-картографування – від підбору оптимальної проєкції та відповідної системи координат до створення спортивної карти в програмі Open Orienteering Mapper.***

Р е з у л ь т а т и . ***Основними етапами створення спортивної карти є: підготовка основи карти (т. зв. "підложки"); картування території – розроблення карти; планування дистанції; підготовка карти до друку. На кожному з етапів використовуються різні безкоштовні програми. Для формування "підложки" рекомендуємо скористатись програмою "SAS Planet". Для створення власне картографічного твору – спортивної карти – можна використати програму "Open Orienteering". Запланувати, організувати дистанцію змагань, оформити й підготовити карту до друку краще в програмі "Purple Pen". Представлено алгоритм створення спортивної карти з можливістю подальшого картування за допомогою безкоштовного ГІС-забезпечення на прикладі території м. Тетіїв Київської області.***

В и с н о в к и . ***Навчання вчителів створенню спортивних карт може стати кроком для активізації діяльності гуртків, пов'язаних з орієнтуванням, а також буде корисним для проведення тематичних екскурсій та унаочнення при вивченні певних тем. Практичне значення і новизна полягають у тому, що представлено алгоритм та інструментарій для повноцінної організації занять, отримання практичних навичок, проведення змагань зі спортивного орієнтування на території закладу освіти.***

К л ю ч о в і с л о в а : ***Спортивне орієнтування, спортивна карта, заклади середньої освіти, ГІС, Open Orienteering Mapper.***

Автори заявляють про відсутність конфлікту інтересів. Спонсори не брали участі в розробленні дослідження; у зборі, аналізі чи інтерпретації даних; у написанні рукопису; в рішенні про публікацію результатів.

The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript; in the decision to publish the results.