

# CARTOGRAPHIC COMPETENCE OF A GEOGRAPHY TEACHER – CURRENT STATE AND PERSPECTIVE

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## **Abstract**

*The national educational program in Slovak Republic is an obligatory document which specifies the general objectives of education and key competencies to which the learning has to lead. Competencies should be the main carrier of the idea that students should not learn only by memorizing facts, but they have to be competent to apply their knowledge in solving life situations. Therefore, the key competencies are obligatory for all teachers. In the case of geography teachers cartographic competence is necessary. Besides traditional form of acquisition of this competence, it is currently necessary to directly interconnect it with digital competence. The aim of the paper is to analyze the current state of cartographic competence using a survey on the sample of geography teachers at primary and secondary schools as well as students of geography teaching. Its results will contribute to the proposal of changes in undergraduate training of future geography teachers.*

**Keywords:** national educational program, key competences, cartography, education

## **INTRODUCTION**

A competency is more than just knowledge and skills. It involves the ability to meet complex demands by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context (OECD, 2005). Competences, particularly key competences, in Slovakia are part of the national educational program (NEP). They are divided into three categories: Use of tools interactively; Interact in heterogeneous groups; Act autonomously (ŠTÁTNY PEDAGOGICKÝ ÚSTAV, 2016).

Key competences of NEP are based on the EUROPEAN REFERENCE FRAMEWORK - KEY COMPETENCES FOR LIFELONG LEARNING (2006) in which eight key competences are determined (MADZIKOVÁ, KANCÍR, 2015):

1. Communication in the mother tongue,
2. Communication in foreign languages,
3. Mathematical competence and basic competences in science and technology,
4. Digital competence,
5. Learning to learn,
6. Social and civic competences,
7. Sense of initiative and entrepreneurship,
8. Cultural awareness and expression.

Competences should be the main carrier of the idea that students should not learn only by memorizing facts, but they have to be competent to apply their knowledge in solving life situations. Therefore, the key competences are obligatory

and important for all teachers. Key competences of teachers are focused on three areas - student, educational process, and professional self-development. Teachers should dispose, except others, with the relevant professional competence which is based on the scientific bases of subjects of their own specialization. In the case of geography teachers/students, in addition to the geographical literacy also cartographic literacy is necessary.

Besides the traditional form of acquiring this competence (work with real and print maps, atlases, models), it is currently necessary to directly interconnect it with digital competence using modern information and communication technologies. By using them, it is possible to extend the cartographic competence of geography teacher/student.

It is cartography that represents the field with a number of options for implementation of information and communication technologies, in particular geoinformation technologies (GIT), into the teaching process itself. The use of GIT simplifies the process of analysis and presentation of geographic information and accelerates the resolution of geographic tasks during teaching process, which is confirmed in the works of VAN DER SCHEE (2003), KRUMSVIK (2008) or KREIJNS et al. (2013). Geoinformation technologies are primarily used as a supplement or certain extension of cartographic content in geography lessons. GIT can be divided, given their educational potential, into 4 groups (MADZIKOVÁ, KANCÍR, 2015): 1. Internet portals dealing with remote sensing (websites providing current and historical satellite or aerial images); 2. Map servers (interactive online maps which are differently content-oriented e.g. general-geographical maps, tourist maps, historical maps, etc.); 3. Geoinformation technologies using GPS (standalone GPS devices, smartphones); 4. Educational software of different specialization (different maps editors, multimedia CD-DVD, etc.).

The aim of the paper is, on the basis of relevant information in the national educational program of geography at primary and secondary schools, in teacher training at universities, in other literature as well as by the questionnaire survey, to analyze the current state of cartographic literacy on the sample of geography teachers at primary and secondary schools as well as students of geography teaching. The results of the research have an ambition to propose changes in undergraduate training of future geography teachers so that the geographic and cartographic competence (or even geoinformatic competence) can be the usual and normal part of a broader understanding of literacy of every educated person.

## **CREATION OF CARTOGRAPHIC COMPETENCE – THEORETICAL ISSUES**

Opinions on the concept of competence vary and, moreover, it is being associated/confused/replaced with other terms e.g. literacy, standard, expected output, indicator, etc. (VALENTA, 2015a,b). In this paper we understand the acquisition of basic literacy as a prerequisite for obtaining key competences. In this sense, the basis for obtaining cartographic competence is considered the mastering of its contents – partial literacy relating to the following topics – work with the globe (Earth's model), work with the map, fieldwork, use of sources of cartographic information, use of geoinformation technologies.

In the work *About School Cartography and Teacher Training*, ALMEIDA (2009) puts emphasis on quality training of future teachers, but also highlights the continuous cartographic education of teachers. The importance of developing map skills among pupils is being addressed by HANUS, MARADA (2014) who also deals with an overview of the works on this issue. Inspirational information for examination of cartographic skills and the level of their acquisition by pupils at the second level of primary school and lower grades of multiannual high schools on a sample of pupils from South Moravia Region in the Czech Republic is provided by MRÁZKOVÁ (2013). The development of graphical and visual literacy of pupils by using the work with the map is addressed by ŘEZNÍČKOVÁ (2010). Geoinformation literacy based on geographic, cartographic and informatic literacy is elaborated by VOŽENÍLEK (2004). Slovak authors who experimentally dealt with the research of some issues of cartographic literacy (reading and creating maps) are represented by PRAVDA (2001). General cartographic minimum and its position in the school system of Slovakia is presented by BALÁŽOVIČ (2014).

There are several teaching resources available for the creation of cartographic competence from the didactic point of view (textbooks, workbooks, atlases). Working with the cartographic material is one of the special teaching methods (MADZIKOVÁ, KANCÍR, 2015). Organizational forms of obtaining cartographic competence are as follows according to the place of realization of the teaching process: 1. school - lesson in the classroom, 2. outside school - in the field (walks and excursions). A specific form for gaining cartographic competence is interest activities of pupils. These are e.g. competitions such as Geography Olympiad, Secondary School Professional Activity, orientation run or Barbara Petchenik Children's World Map Competition, etc. A specific role has the use of information and communication technologies, especially, geoinformation technologies.

Currently, the separate subject called Cartography is not taught at primary schools in the Slovak Republic. The first elementary knowledge are gained within the scope of the subject Regional Studies (in Slovak - Vlastiveda) at the 1st level of primary schools (ŠTÁTNY VZDELÁVACÍ PROGRAM VLASTIVEDA, 2011, INOVOVANÝ ŠTÁTNY

VZDELÁVACÍ PROGRAM VLASTIVEDA, 2015, 2015). This subject is a propaedeutics for future school subjects Geography and History. Acquisition of cartographic competence at the 2nd level of primary schools is mainly implemented through the subject of Geography (NOGOVÁ, 2010a, INOVOVANÝ ŠTÁTNY VZDELÁVACÍ PROGRAM Geografia – nižšie stredné vzdelávanie, 2014), however, within inter-subject relations it is used mainly in the subjects of History, Biology, Protection of Man and Nature as well as in cross-cutting topics Regional Education (or Multicultural Education) and Environmental Education.

At the secondary level, the situation related to cartography is differentiated. Only at secondary vocational (geodetic) schools, the subject Cartography is taught usually in connection with geodesy and cadastre. At the other secondary schools it is again related to the subject of Geography (NOGOVÁ, 2010b, INOVOVANÝ ŠTÁTNY VZDELÁVACÍ PROGRAM Geografia – gymnázium so 4-ročným a 5-ročným vzdelávacím programom, 2014). A common feature of innovative state educational programs for primary and secondary school is the continued reduction of curriculum content and dynamics of decline and growth of the lessons.

At universities, teaching/study of cartography is also differentiated. In the case of university study of Geography, Cartography is a separate subject and it is an integral part of teacher training programs and also one-field study programs usually within the first year of study. As an independent study program called Geodesy and Cartography, it is studied e.g. at the Slovak Technical University in Bratislava, University of Žilina, and at the Technical University of Košice.

Geography, which is inextricably linked to cartography regarding the content, thus develops especially those key competences which have mainly spatial and integral nature (ČERNÁ, LIKAVSKÝ, 2014):

- NEP of geography in primary schools - development of communication, understanding and interpretation of information,
- NEP of geography in secondary schools - development of social and civic competences, cultural awareness and expression,
- Geography/cartography and geodesy at universities - deepening of key competences and the acquisition of professional competencies based on scientific knowledge of the relevant study program.

Key competences are presented and briefly characterized in the graduate profile, but their planned level or assessment is not specified.

## RESEARCH METHODS

The questionnaire survey was realized in 2016 on the sample of geography teachers at primary and secondary schools (57) from the Nitra Self-governing Region and Trenčín Self-governing Region as well as (19) students of geography teaching program from the second year of their master study at the same department as authors.

Teacher questionnaire comprises three main parts: 1. Information on respondents, 2. Content of cartographic competence, 3. Use of geoinformation technologies. Part of the questions/tasks were closed with the possibility of choosing the answer and the other part was open for adding information. For some of the questions, which had to express an opinion of teacher/student on selected topics, we used one of the most preferred methods in educational research - Likert 5-point scale to determine the importance of respondents' opinions on selected questions (GAVORA et al., 2010), which were then evaluated and graphically interpreted.

Student questionnaire was almost identical with the teacher questionnaire. The difference was in the student's status which means that individual questions/tasks were reformulated in relation to their study.

## RESEARCH RESULTS

### 1. Information on respondents

The research sample of *teachers* consisted of 11 male and 46 female teachers. The questionnaire was completed by 41 teachers from primary schools and the other 16 were from secondary schools including 8-year high schools. The average age of men was 45.72 years (most of them were in the age category 40-44 years) and the average age of women was 47.93 years (most of them were in age categories 40-44 years and 50-54 years). The average length of teaching experience was at the level of 19.68 years.

The research sample of *students* consisted of 5 male and 14 female students studying academic subjects in combination with geography. These students will finish their study in 2016 and they will become qualified teachers of geography in primary and secondary schools. The average age of men was 23.5 years and the average age of women was 24.4 years. In their future teaching practice, women prefer teaching in primary schools while men prefer secondary schools.

Comparison of the two research samples reflects the high degree of feminization of education in Slovakia which in the school year 2015/16 amounted to 84.57% of women out of the total number of teachers in primary and secondary schools in Slovakia (ÚSTAV INFORMÁCIÍ A PROGNÓZ ŠKOLSTVA SR, 2016).

## 2. Content of cartographic competence

Content of cartographic competence was based on an analysis of the required cartographic knowledge, skills and abilities which are declared in state educational programs for teaching geography subject at primary and secondary schools as well as at the university - workplace of authors. It was structured into four segments: work with the globe, work with the map, fieldwork, sources of cartographic information.

Work with the globe represents the first group of analyzed information. Up to 77.19% (50) of *teachers* do not deal with terms ortodrome and loxodrome during the lessons, 45.61% do not teach the history of cartography and 12.28 % cartography as a scientific discipline. Similarly, they do not require understanding of relief representation on the globe, determining absolute and relative elevation (21,05%), and scale on the globe (12.28%). They do not consider necessary to explain the local latitude (1.75%), prime meridian (7.02%), colors on the globe (5.26%), description on the globe (5.26%). According to teachers at all age categories, the most difficult for pupils is to know to identify the main points on the globe, to determine the position of a point, to determine the distance on the globe, and to work with the scale of the globe. In terms of orientation on the globe, more than half of teachers (50.88%) do not pay attention to measuring distances on the globe or calculating distances (45.62%). As for the orientation on the globe, they consider demanding for pupils to determine the degrees of geographic coordinates and to work with the date line. During the transmission of knowledge and skills through the globe, teachers most often work with one standard globe (77.20%), several standard globes with different scales (29.82%), digital globe (14.04%), and combined traditional and digital globe is used by 14.04% respondents.

When acquiring cartographic competence by using maps, up to 80.7% of teachers do not consider necessary to teach terms ortodrome and loxodrome. 40% of teachers do not teach knowledge of mathematical cartography in the form of cartographic projections, cartographic distortions and they do not even teach to use methods of cartograms and cartodiagrams. Only 10.52% of teachers supplement the knowledge. For example, women in the age group 40-44 years supplement the knowledge about major cartographers, define contours and their relevance to the morphometric characteristics of the relief. Moreover, men in the same age category point out new methods to represent relief using GIS and 3D models while older male teachers aged 60-64 years rather use practical experience (work with the map, fieldwork using maps). The most problematic for pupils is, according to them, to determine the geographic coordinates, geographic location, work with the scale of the map, and determining azimuth. Up to 60% of teachers do not consider necessary for pupils to know the publisher of state map series and publishers of other cartographic products, to know sellers of cartographic products, and to know how to purchase (print or digital) maps. From the content point of view, 30% of teachers do not lead pupils to create their own maps. This is probably due to the fact that 70.18% of the teachers use mainly maps in atlases during the work in the classroom (78.95%). Given the fact that almost half (43.86%) of the teachers work with contour maps of different scales and 42.11% of teachers use fieldwork, we can assume that it is almost identical group of teachers. Problematic in relation to pupils are considered the mathematical competences in calculating the distances, azimuth, conversion of length units, determining the cardinal directions or position of a point on the map.

Fieldwork is preferred by 42.11% of teachers (of which 28.07% are women and 14.04% are men). GPS device to determine the location in landscape is not used by 56.14% of teachers. 52.63% of teachers do not even use very popular geocaching game in which pupils could easily and playfully acquire knowledge and skills related to the acquisition of cartographic competence. Fieldwork is applied more by male teachers aged 45-49 years who prepare various routes for pupils (e.g. in the form of cycle routes associated with geocaching). In the opinion of teachers, pupils have problems with orientation in the field using maps, compare the content of the map with objective reality, and to work with GPS device.

The main source of cartographic information is considered by 78.95% of teachers to be school world atlases and atlases of the Slovak Republic, and the Internet (24.56%). Only 10.53% of teachers (8.77% of men and only 1.75% of women) use print contour maps such as tourist maps, cycling maps, maps for orientation run at scales of 1:5 000, 1:10 000, 1:50 000. According to teachers, they buy these maps in bookstores. The "map service of Geodetic and Cartographic Institute in Bratislava" as the exclusive seller of the state map series was not stated by any of the teachers.

In terms of the content of cartographic competence, *students* consider the work with the globe as natural as working with the map. Only 21.05% (15.79% female students and 5.26% male students) think that the terms ortodrome and loxodrome were not part of the theoretical knowledge within the scope of the subject Cartography. Moreover, 15.79% of female students think that during their studies they did not learn to work with the scale of globe, measure and calculate distances on the globe. Other students (remaining 84.21%) reported that the acquired competences are problematic for pupils. Knowledge related to the globe will be taught by 63.17% of the students using combined standard and digital globes while 31.58% of them would only use the standard globe.

When working with the map, 31.58% of students stated that they would not teach the issues of ortodrome and loxodrome. Also surprising was that 10.53% of students claimed that cartography as a scientific discipline has been defined and the issue of generalization of map content was not addressed. 26.31% of students also indicated that they consider problematic the concepts of cartographic projection, cartographic distortion, ortodrome, loxodrome, azimuth. In teaching knowledge and skills with the use of map, students would use mainly maps in the atlases (57.89%), contour maps at different scales (52.59%) and combination of print and digital maps (42.10%). The positive fact is that 78.95% of students would work with the map in the field and 52.63% in the class which means that almost 30% of students are interested in the work with map only in the field (26.32%). We believe that this is related to our five-year effort to teach geography and therefore cartography in the field - in the local landscape. It is thus students who have fixed many skills in natural environment not only within the scope of cartography, but also other geographical disciplines of physical and human geography.

Teachers prefer to work in the field within the scope of the subject Protection of Man and Nature while students consider necessary to work in the field in longer-term and also during the whole day. Therefore, they chose excursions and walks in the first place. We consider positive that 69.91% of the students acquired knowledge and skills with a GPS device. Nevertheless, 36.85% of them do not know what geocaching is, 31.58% of them did not learn to compare GPS with a map, and 21.06% of them did not learn to find location in the landscape using GPS. These only about 30% of students apparently did not use the optional seminars dealing with this issue during their 5-year study.

As for the issue of using sources of cartographic information, the finding that 78.95% of students would use readily available tools such as school world atlas, Internet (31.58%) and digital maps (26.6%) was surprising. We suppose that they did not realize that if they want to teach the work with a map in the field, they must use maps of large scales in the form of topographic and tourist maps rather than school atlases which have small scale and are related more to the regional geography and not to the local landscape.

Comparison of teacher and student questionnaires brought interesting findings. Up to 78.95% of students have acquired knowledge from cartography also by using the globe. This conclusion was reached on the basis that 21.05% of the students reported that they did not meet with the term ortodrome and loxodrome during their study. Furthermore, they knew the other terms. In contrast, 77.19% of teachers reported that they do not deal with the terms ortodrome and loxodrome. These are the terms which should be known e.g. in connection with shipping lines shown in the atlas or in connection with the history of GPS. Some teachers also reported that they do not deal with concepts like prime meridian, colors on the globe, and description on the globe. Here we assume that it is a basic knowledge that pupils acquire at the first level of primary school within the scope of the subject Regional Studies (ISCED 1) and there is no need to pay attention to them again. Opposing opinions can be seen in the use of cartographic aids. While 63.17% of the students would use a combination of standard and digital globe for the acquisition of cartographic competences, 77.2% of teachers use only standard globes.

When obtaining cartographic competences by using maps, the knowledge were acquired by 68.42% of the students. Students (57.89%) as well as teachers (70.18%) would use especially maps in the atlases and contour maps at different scales (students - 52.59%, teachers - 43.86%). Up to 78.95% of students and 43.86% of teachers intend to teach in the field. This positive outcome of the upcoming generation of teachers is the result of educational activities of pedagogues during 5 years of study whereas the geographic and cartographic skills are fixed by students mainly in the landscape. Not very positive are considered the results achieved by teachers - whether it is the relatively low interest in the fieldwork or that they do not consider necessary for students to know the publisher of state map series and the publishers of other cartographic products or to know sellers of cartographic products and to be able to order and purchase maps (print or digital).

In the context of teaching in the field, students would use mainly longer excursions or shorter walks. Up to 70% of the students is familiar with GPS device while teachers amounted to only 43.86% in this category. This representation of teachers is considered sufficient because their average age is around 47 years. These are the skills that teachers acquired additionally during their teaching practice and thus the need for further education was confirmed. In terms of using sources of cartographic information, 78.95% of students as well as teachers considered school atlases the best teaching aid.

### 3. Use of geoinformation technologies

Currently, geoinformation technologies (GIT) are still seen as a supplement or as a certain extension for teaching (not only) cartographic content in geography lessons. However, the constant expansion of GIT in schools provides a prerequisite for their further development in the educational process which is related to the issues concerning the competencies of current and future teachers in relation to GIT. Respondents expressed not only their experience with the use of GIT, but also opinions on their use in the lessons. This segment of the questionnaire contained questions related to acquired knowledge of respondents with the use of GIT, participation in training activities, use of specific GIT and aids, frequency of their use and techniques for their mediation to pupils during the phases of teaching. We studied also whether pupils are interested in working with GIT and if they help pupils to better master the curriculum. Moreover, we studied the level of importance of knowing GIT in relation to cartographic competence in terms of both pupil and the teacher view.

Most of the surveyed *teachers* (56.2%) evaluated their knowledge with the use of GIT as a beginner. Expert or advanced knowledge of the use of GIT was marked by 36.95% of respondents while 6% of respondents do not use GIT in education at all. From the viewpoint of gender and age, no statistical significance was found in relation to the knowledge of the use of GIT. Training activities related to GIT were attended by almost 9% of teachers while the most frequently reported were seminars for working with GIS and tablet. The most widely used group of GIT or aids which was indicated by respondents were teaching web portals (76.09%). This is the most used form especially because they contain a large number of material which is also useable through GIT. The second largest group (67.39%) were interactive Google Maps which are used by most respondents mainly for teaching the content of regional geography. More than 50% of teachers use YouTube and multimedia CD-DVD which are thematically varied. Tablets are used by 17.39% and GPS devices by 19.57% of respondents. Software to produce maps in schools has only minimal use (4.35%). As for the frequency of use of GIT, we can say that most teachers prefer only occasional work with these technologies. Increased interest of pupils in the curriculum by using GIT was reported by 63.04% of teachers while 19.57% of the respondents did not provide any answer. To some extent the opposing is the fact that 58.7% of teachers believe that the traditional way of teaching has the same results as the teaching with the use of GIT.

Interesting finding was that up to 68.38% of *students*, future teachers, consider their knowledge with GIT as expert or advanced. The remaining respondents marked their knowledge as a beginner. 73.64% of students positively responded to the possibility of further education especially the use of applications in tablets and production of maps in GIS software for primary and secondary schools. Students would use in teaching mostly cartographic content from the stated groups of GIT. GIT groups (applications in tablets and smartphones, YouTube, GPS devices, multimedia CD-DVD, teaching web portals, Google Maps) were used by 55 to 75% of respondents. The difference with the teachers can be seen in their opinions on the frequency of the use of GIT in geography lessons. Most of the students would use geoinformation technologies once a month (or a week) while their greater usability is seen in outdoor teaching (geocaching, orientation in the field, exploring the local landscape, work with GPS). Up to 75% of respondents believe that GIT help pupils in learning the curriculum and majority of them consider working with GIT as attractive.

From the survey of both groups of respondents several different opinions can be seen. The most notable difference was identified in the knowledge regarding GIT. This is logical since the current preparation for the teaching profession is greatly enriched by the acquisition of digital competence, which was missing to some extent in the past or it was based on the technological equipment of that time. The assumption that the knowledge of current teachers in using GIT is closely correlated with the age of respondents was confirmed. Relatively greater differences can be observed in the evaluation of GIT groups which are used by teachers and students. Generally speaking, the higher involvement of GIT into the teaching process by students is logically opposing to the reality of using GIT in schools by teachers.

### CONCLUSION

Cartographic information provided by various sources are important means of geography teaching and creating cartographic competence. The process of its development is not the simple aspect of education and it develops gradually through lifelong learning. Pupils gain basic cartographic competence in primary school and thus it is important that the preparation of future teachers of primary education would take into account not only the specificities of developmental psychology of pupils, but also modern trends of both sciences - cartography and geography. Only by this way it is possible to ensure that pupils acquire the real ideas about the real world from the beginning.

Synthetic evaluation of the process of obtaining cartographic competence was investigated in both groups of respondents separately and in relation to pupils through respondents' opinions on the importance of working with the globe, map, fieldwork, sources of cartographic information and use of GIT by using Likert 5-point scale (1 - most important, 5 - least important).

From Figure 1 it can be concluded that **teachers** give maximal importance especially to work with the map not only in relation to themselves (73.91%), but also in relation to pupils (63.04%), which is the logical result of a dominant position of the map as a means of obtaining (also) cartographic competence. Significant position with the maximum importance in this context has also fieldwork (for teachers 52.17%, but in relation to pupils only 30.43%). Work with GIT is most important for 30.43% of the teachers, but in relation to pupils it has maximal importance only for 15.22% of them. Work with the globe has about 4.35% higher preference than the work with GIT and in relation to pupils this preference is also higher by 2.17%.

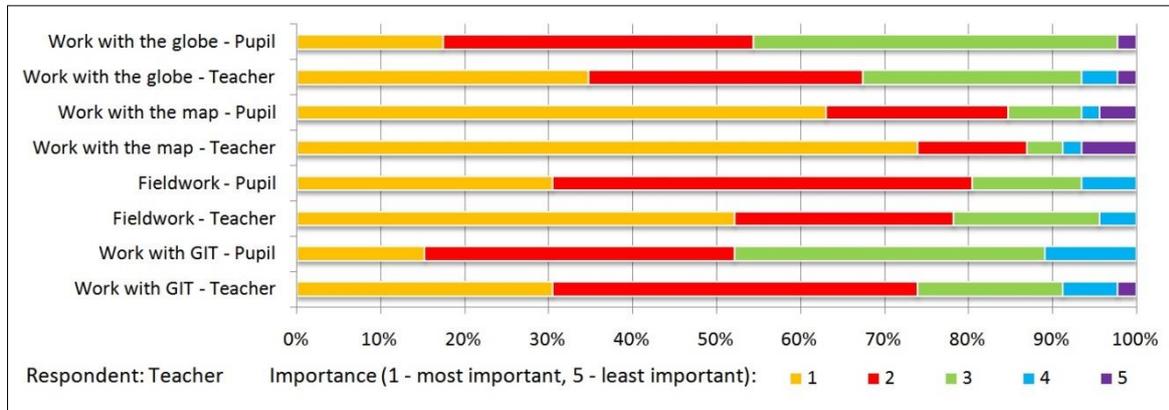


Figure 1. Evaluation of the content of cartographic competence by teachers in relation to themselves and to pupils

Similarly as teachers, also **students** expressed their opinions on the importance of content forms for acquiring cartographic competence in relation to themselves as (future) teachers and in relation to (future) pupils. Students in relation to themselves as future teachers prefer working with the map (89.47%) and their opinion is similar in relation to their future pupils (84.21%). The work in the field has the second place (78.95% for future teachers, 68.42% in relation to future pupils). Work with the globe is more important for students - future teachers (68.42%) than for their future pupils (21.05%). On the other hand, the last fourth place was given to the work with GIT in relation to themselves and also to their future pupils (Figure 2).

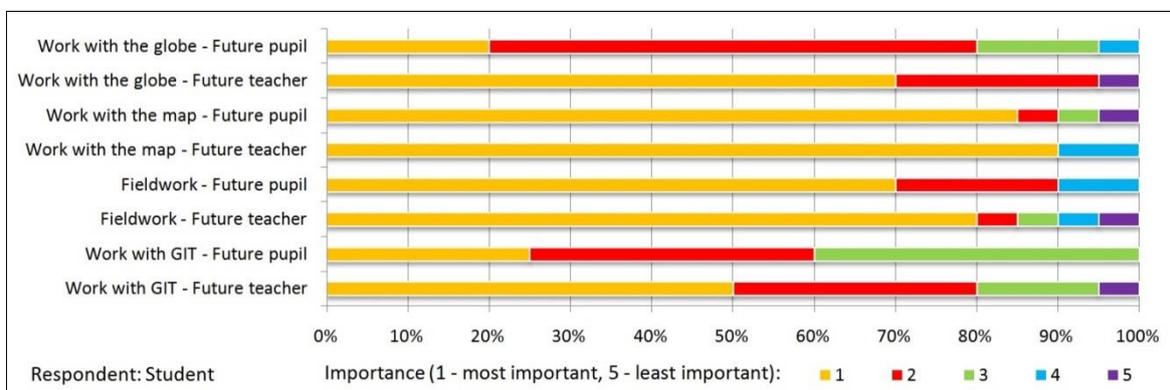


Figure 2. Evaluation of the content of cartographic competence by students in relation to themselves (as future teachers) and to their (future) pupils

Regarding the evaluation of questionnaire results of both research samples, several findings were made. Working with the map and fieldwork are a key area for acquiring cartographic competence. The work with the globe has an additional function. The use of GIT in last place of preferences is not surprising in the case of teachers, whose average age is higher than in the case of students, but it is quite surprising in the case of students - future teachers. It seems that in the educational process in primary and secondary schools the development of GIT have not had a major impact on the creation of cartographic competence so far. Nevertheless, it will be necessary to continuously pay attention to this phenomenon in the educational process because it is important for acquiring the digital competence. The same applies for those parts of the content of cartographic competence which were identified as problematic for pupils, students, and teachers. In order to remove the problem parts, there are several educational strategies - to improve the educational process at the authors' workplace by higher number of contact hours with students or to create educational activities for teachers within the lifelong learning.

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