DOI:10.17951/h.2018.52.5.81-94

A N N A L E S
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA

VOL. LII, 5 SECTIO H 2018

Maria Curie-Skłodowska University. Faculty of Economics. Management Information Systems Department

ŁUKASZ WIECHETEK

ORCID ID: https://orcid.org/0000-0001-7755-2282
lukasz.wiechetek@umcs.pl

How Business Students Gain Knowledge and Skills Related to Geographic Information Systems. The Results of GIS Project Development

W jaki sposób studenci kierunków biznesowych zdobywają wiedzę i umiejętności z zakresu systemów informacji geograficznej. Wyniki badań ankietowych dotyczących realizacji projektu GIS

Keywords: GIS; geographic information system; GIS education; GIS knowledge; QGIS; ArcGIS; GIS project; students' opinions; quantitative analysis; survey

Słowa kluczowe: GIS; system informacji geograficznej; edukacja GIS; wiedza GIS; QGIS; ArcGIS; projekt GIS; opinie studentów; analiza ilościowa; ankieta

JEL code: L86; M20; D83

Introduction

1.1. Geographic information systems (GIS)

GIS can be defined as a computerised system for capturing, storing, analyzing, and visualising data related to positions on the earth's surface [National Geographic Society, p. 1]. It can help to understand spatial relationships, patterns and trends. It is a system for processing and sharing spatial information and can be used as a tool for visualising different phenomena and processes. GIS can be used in many areas of human activity, such as entertainment, education, and professional work (Table 1).

Table 1. The main areas of GIS usage

Area	Description
Archaeology	Location and documentation of excavations
Architecture	Urban and regional spatial planning, preparation of building plans
Army	Planning and monitoring of operations, tracking the enemy
Aviation	Analysing connections, locating aircraft, planning of airports
Building administration	Developing plans of buildings, facilitating inventory
Education	Locating educational centres, spatial presentation of phenomena related to education
Emergency services	Quick locating of accidents, identification of risk zones
Environmental protection	Analysing pollution, tracking pollutants, monitoring environmental phenomena
Forestry and agriculture	Developing maps of agricultural land and forests, identification of risk zones
Geology	Presenting the earth's structure and processes that occur inside it
Infrastructure management	Planning and designing infrastructure, performing infrastructure inventory
Insurance	Analysing the spatial variability of events and their risks
Marketing	Planning advertising campaigns, performing market analysis of their effectiveness
Meteorology	Visualising the forecast, showing weather variability over time
Public administration	Land and real estate management, monitoring urban development
Seismology	Presenting areas with high risks of earthquake, visualisation of the earth's structure
Statistics	Visualisation of social, economic and demographic phenomena and their evaluation
Tourism	Preparing tourist routes and maps of tourist attractions
Trade	Visualising market analysis, planning of business hub localisation
Transportation	Optimisation of routes, designing of transportation systems

Source: Author's own work.

According to Google Trends (Figure 1), there is currently a stable level of interest in the area of GIS. The biggest interest was recorded at the beginning of the 21st century. People interested in GIS were looking mostly for GIS maps, GIS data, GIS-related jobs and GIS tools.

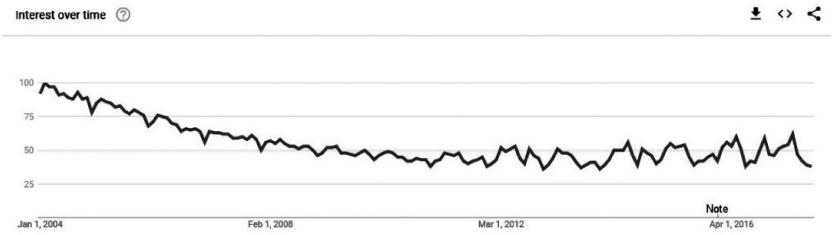

Figure 1. Interest in GIS terms during the period from 2004 to 2016 – web search

Source: Author's own work based on Google Trends.

Constant interest in the area of GIS can also be noticed in YouTube search results (Figure 2). YouTube users interested in GIS are mostly looking for videos about map creating and using GIS tools. Video tutorials on YouTube can be considered useful sources of knowledge and skills in the area of GIS tools. The results presented in

the next chapter confirm that young people often gain new knowledge and skills by watching video tutorials.

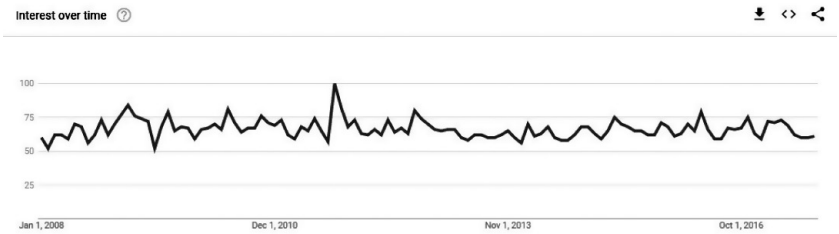

Figure 2. Interest in GIS terms during the period from 2004 to 2016 – YouTube search

Source: Author's own work based on Google Trends.

Currently, a variety of GIS tools are available. One class is desktop GIS, which can be defined as on-premise software (installed on a local computer) allowing for collection of data, performance of broad analysis and creation of maps. Another type is web GIS, an on-line system for quick map creation that does not need to be installed on the end-user's computer. Finally, many software vendors provide mobile GIS tools that offer access to GIS systems from mobile applications (Figure 3).

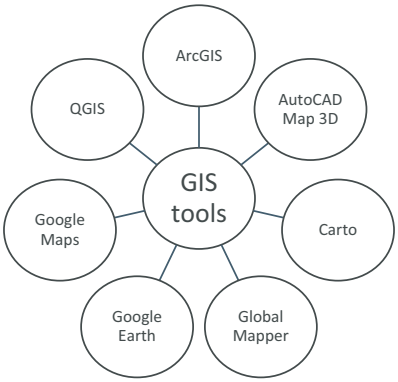

Figure 3. The most popular GIS tools

Source: Author's own work based on G2 Crowd, GISplay, and Software informer.

2. The GIS course programme

2.1. GIS in business education

Nowadays, geographic information systems are quite often incorporated into high school programmes. One of the main sources of information necessary for good curriculum development is the Body of Knowledge for Geographic Information Sci-

ence and Technology (BoK) [Wallentin et al., 2015, p. 439]. It was created by GIS community (GIS professionals and educators) and contains a list of requirements and skills in the area of GIS, including tools and technology. It is a source of information for analytical and visualisation methods, GIS project design and data modelling and manipulation [DiBiase et al., 2006, p. I].

Changes in technology triggered changes in GIS course programmes. Modern GIS courses should be updated with programming modules, use online tools and prepare responsive projects that can work not only on commonly used computers but also popular mobile devices [Wallentin et al., 2015, p. 439].

Some effort should be taken in order to prepare trainers and educators, equipping them with up-to-date data, frequently used GIS tools and GIS cases for analysis and visualisation. This can be achieved by organising university geographic information service centres that offer comprehensive GIS services [Holstein, 2015, p. 48].

Some information about GIS can be incorporated into various subjects in the business curriculum. After finishing a "GIS basics" programme, students will know how to use GIS tools and data sets to understand spatial relationships, patterns and trends, and how to solve cases related to different subjects. For example, a new way of enhancing marketing learning was proposed by Miller et al. [2014, p. 31] who developed the RacerGISOnline system and incorporated it into different marketing courses. King and Arnette [2011, p. 325] proposed techniques for step-by-step integration of spatial information into a business curriculum.

Introducing GIS into business education can bring numerous benefits, but it can also be a source of new problems. Problematic issues may affect students, teachers and administration staff. From the student point of view, the introduction of new technologies requires learning about another IT tool, and they may be overwhelmed with a lot of technology, concentrating on the tool and not on a business problem. From the business teacher's point of view, problems may occur related to limited knowledge and skills in the area of GIS. Miller et al. stated that integrating GIS solutions into business classes can cause some administrative/budget problems, especially in the need for expensive software and the availability of high-performance hardware for performing fast analysis and visualisation [Miller et al., 2006, p. 75].

2.2. Organisation of GIS classes

Geographic information systems at the Faculty of Economics of Maria Curie-Skłodowska University was part of a subject entitled "E-logistics and GIS" prepared for first-year master's students of logistics. The classes consisted of lectures (15 hours for full-time students and 9 hours for part-time students) and laboratory classes (15 hours for full-time students and 9 hours for part-time students). During the lectures, students learned about the following topics:

- introduction to GIS systems,

- public geoinformation systems,
- main areas of GIS applications,
- popular GIS tools,
- perspectives of GIS development,
- information security issues.

During the laboratory classes, students divided into groups for GIS projects. The general schedule of laboratory classes is presented in Figure 4.

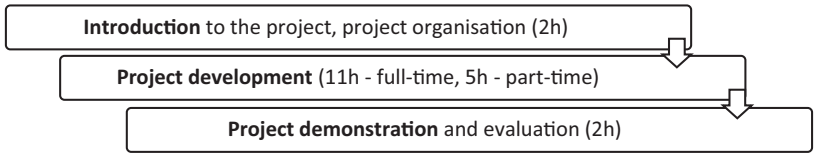

Figure 4. Schedule of GIS lab classes

Source: Author's own work.

Students worked in groups (3–4 members). All necessary materials were available on an e-learning platform. The project was prepared using five IT tools: access to the materials (e-learning platform – Moodle), project description (mainly Microsoft Word), data preparation (mainly Microsoft Excel), project presentation (mainly Microsoft PowerPoint) and a chosen GIS tool for project preparation and visualisation.

During the final meeting, selected group members presented developed projects. They had to give a short introductory presentation and alive GIS demonstration. Developed projects were mainly related to: transportation, education, trade, infrastructure management and sport. The best presented projects were about: parking places near the university, bike paths in the city, an interactive map of the Faculty of Economics, countries of origin of Erasmus students at the faculty, dangerous crossroads in the city, examination centres for drivers in a given voivodeship, and petrol stations near the university.

After all final presentations, at the end of the course, students were asked to fill in the survey about their knowledge and skills in the area of GIS.

3. Students' knowledge and skills in the area of GIS

In order to know students' opinions about GIS, the author prepared a questionnaire that contained 31 short questions addressing knowledge of GIS terms, sources of knowledge about GIS, GIS areas of usage, benefits from using GIS, preferred GIS tools, and barriers that emerged during GIS project development. The questionnaire was prepared using the LimeSurvey tool, published online and completed by students after the last meeting (in January 2017).

3.1. The research questions

The research and observation were performed in order to answer the following research questions:

- What are the main sources of knowledge and ways of learning about GIS?
- What are the students' opinions of the main areas of GIS usage?
- What applications are preferred for developing GIS projects?
- What features should a good GIS application possess?
- What kinds of problems can emerge during GIS project development?
- What knowledge and skills can be acquired during a GIS lab class?

3.2. The characteristics of the respondents

The course on GIS was attended by 116 students, all of whom were asked to take part in the research. The GIS survey was filled in by 96 respondents (70 full-time students and 26 part-time students). Characteristics of the surveyed students are presented in Table 2.

Table 2. Characteristics of the surveyed students

Characteristic		Number	(%)
Gender	woman	46	48
	man	50	52
Age	20	3	3
	21	6	6
	22	38	40
	23	27	28
	24	13	14
	25	6	6
	>25	3	3
Type of study	part-time	26	27
	full-time	70	73
Status	employed	44	46
	not employed	52	54
Interest in IT technology	definitely no	0	0
	rather no	12	13
	no opinion	21	22
	rather yes	48	50
	definitely yes	15	16

Source: Author's own work.

Among the respondents aged from 20 to 28 years, 52% were men and 48% were women. Majority of the respondents were full-time students – 73% (27% part-time). What is interesting is that almost half of the surveyed students were employed (46%). Most of the respondents showed great or moderate interest in IT technology (16% and 50%, respectively).

3.3. Data analysis

Terms associated with GIS

At the beginning of the questionnaire, the respondents were asked about words/terms they associate with GIS. Each respondent could type three words (Figure 5).

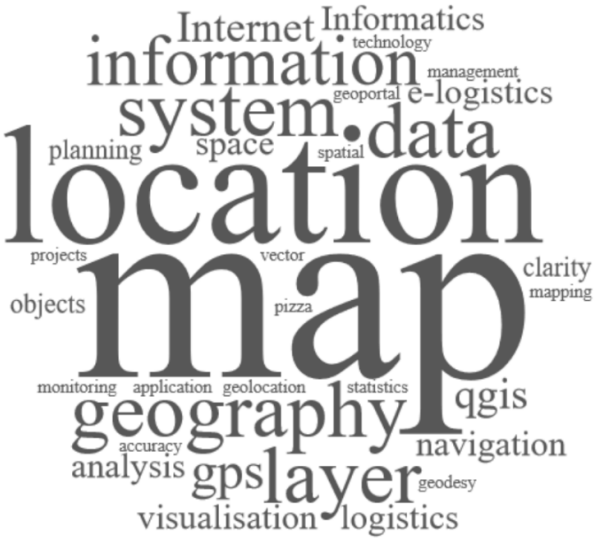

Figure 5. Terms associated with GIS

Source: Author's own work with [wordclouds].

Students wrote 97 unique terms related to GIS. The respondents mostly associated GIS with mapping and location in space, but also with a variety of IT solutions and different areas where GIS solutions could be used. The most frequent terms associated with GIS were "map", "location", "system", "geography" and, "layers". These terms were used more than eight times.

Knowledge about GIS

To ascertain the sources of GIS knowledge, respondents could choose more than one answer from the list. Majority of the students indicated university courses (96%) and Internet sources (46%) as the main sources of information about GIS. Journals/business reports and social media were the least frequently mentioned (13% and 6%, respectively). A small group of respondents (4%) learned about GIS from this research. It is worth noting that the respondents indicated watching video tutorials (66%) (Figure 6).

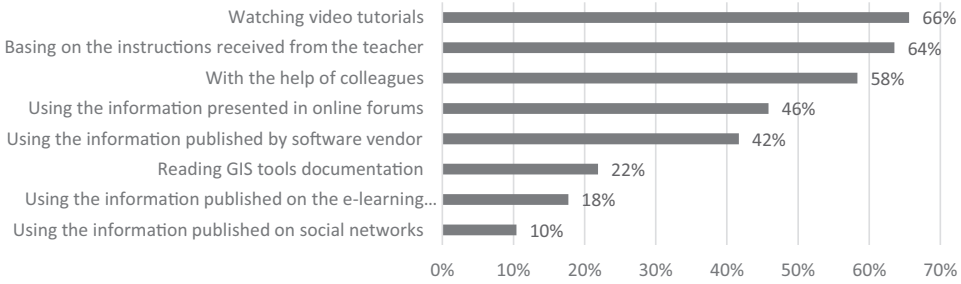

Figure 6. Ways of acquiring knowledge in the area of GIS

Source: Author's own work.

Quite popular ways of acquiring knowledge included instructions obtained from the teacher (64%) and colleagues (58%), and reading information posted on forums or published by software vendors (46% and 42%, respectively).

The main areas of using GIS

Students of logistics stated that GIS solutions can be mainly used in transportation, geodesy, public administration, building administration, tourism and the military. The above areas were indicated by 64% of respondents or more (Figure 7).

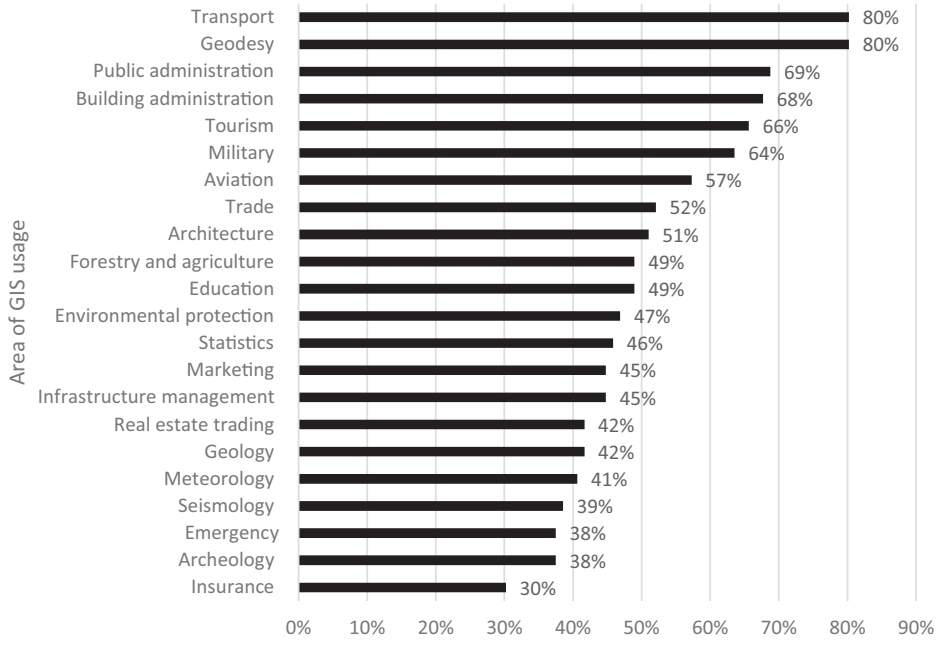

Figure 7. Main areas of GIS usage

Source: Author's own work.

Among the least marked areas are seismology, emergency, archaeology and insurance. These items were selected by less than 40% of respondents. The results may be a bit surprising, but one must remember that the respondents were students of logistics at the Faculty of Economics, so they have knowledge of the earth's construction, documenting of excavation processes, and problems and needs of rescue teams.

Applications used for project development

In order to know which applications were used in the project preparation stage, a multiple-choice question was used. Students could choose more than one application from the list of tools presented during the lecture (Figure 8).

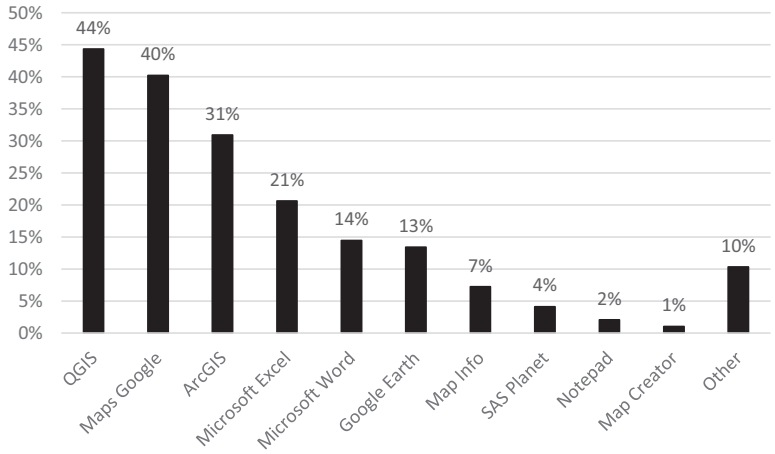

Figure 8. Used applications

Source: Author's own work.

Most of the students used one of three applications: QGIS, Google Maps and ArcGIS (44%, 40%, and 31%, respectively). These tools were chosen mainly because of availability (QGIS and Google Maps are free, and ArcGIS had a 30-day trial period). Another important factor was the ease of use of Google Maps. ArcGIS and QGIS were initially a little difficult to use, but this inconvenience was compensated by their broad functional capabilities.

Each respondent could also indicate three advantages of an application used in the project. After finishing the GIS project, the respondents said that, in their opinion, the most important attributes of used applications were ease of use (44 times), free to use (32 times), and transparency (28 times) (Figure 9).

Respondents mostly stressed ease of use (44 times), free to use (32 times) and transparency of the interface (28 times). Other important features were broad functionality, online availability, speed of the application, availability of program extensions and access to training materials. The least frequently mentioned attributes

included availability of a Polish language version, built-in maps and the ability to use them on mobile devices.

Figure 9. Important attributes of used GIS applications

Source: Author's own work with [wordclouds].

The main problems that emerged during project development

At the end of the questionnaire, the respondents were asked about the main problems that emerged during project implementation. Each respondent could highlight up to three problems. The most frequently mentioned issues were grouped into categories related to data, export, knowledge, organisation of work, technical problems, teacher's support, and problems with a tool (Figure 10).

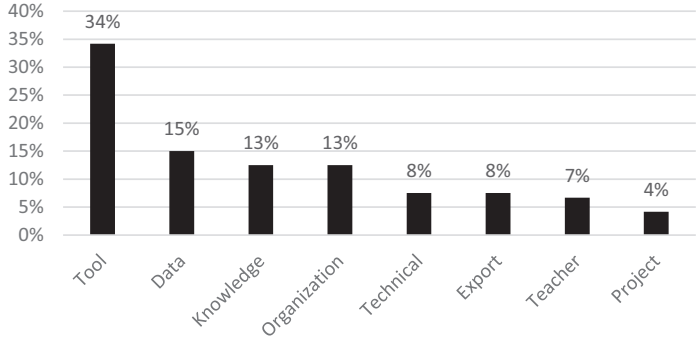

Figure 10. Categories of problems

Source: Author's own work.

The most frequently indicated problems were related to tool usage and functionality (34%), data access (15%) and lack of basic GIS knowledge (13%). Respondents also highlighted some organisational problems (13%). They did not report many technical problems (not related to GIS tools) and there were also few problems related to the teacher (Table 3).

Table 3. Main problems indicated by students

Category	Problem	Category	Problem
Data	accuracy of data	Project	finding a problem to solve
	data acquisition		no idea for the project
	data collection	Teacher	commands hard to understand
	data selection		difficult commands
	few data sources		not enough help from the teacher
	grouping data		not enough introduction to the problem
	hard data availability		supporting videos difficult to understand
	no detailed maps	Technical	hard to work without Internet access
	too much information		slow Internet
Export	exporting a map		problem with program downloading
	exporting to mobile apps		problem with a computer
	problems with map publication		uploading a map
	problems with map sharing	Tool	advanced tool features
Knowledge	do not know how to start		configuration problems
	do not know which plug-in to install		errors in the application
	lack of experience in such programs		hard to use
	lack of tool usage skills		installation
	no initial ideas		level of complexity of the program
	poor knowledge of the program		lots of options
	selection of the project topic		no exact tutorials
	lack of initial knowledge of GIS		not very stable
Organization	contact with the group		poor help system
	difficult cooperation with group members		problem with map import
	long time of project implementation		problems with choosing the right software
	not enough time		poor program support
	not enough time to expand the project		some items of the program were not free
	time-consuming work		the demo version had limited capabilities
	no time to get to know the application		the program was hanging
Project	a lot of ideas for the project		time limitations of free software
	complexity of the project		application too slow

Source: Author's own work.

In the area of tool performance and functionality, students indicated that applications had too many options and were hard to use, and sometimes programs were slow and unstable. Sometimes, it was hard to find necessary information in the help

system or understand published training materials. Respondents also had some problems with data – sometimes it was hard to find, while some groups had too much data that caused problems of selection and analysis.

Lessons learned during the project

Finally, the students were asked about new knowledge and skills acquired during the project development. Each respondent could write three short sentences (three competences). Analysis of the obtained answers shows that during the classes students acquired new competences mainly in the following categories:

- theoretical knowledge on GIS,
- installation and configuration of GIS tools,
- GIS tools usage,
- maps creation,
- need for making backups,
- searching for data on the Internet,
- group work,
- patience, time limit,
- creating a presentation,
- performing live demonstrations.

It can be stated that course attendants gained knowledge in the area of GIS but also practical skills like GIS tool installation, configuration and usage. They also emphasized the possibility of developing interpersonal skills through group work and project presentation.

Conclusions

The research performed at the end of GIS classes and the author's observations show that young people were keen to use GIS tools and examine their possible uses. After finishing the project, 70% of respondents wished to use GIS in their future education or work. The performed data analysis and observations allow us to conclude that:

- At the beginning of the project, the students had a lot of concerns. They had problems with the data collection procedure and lack of knowledge and skills in using GIS software. Therefore, the teacher had to show portals with free spatial data (e.g. OpenStreetMap) and showed them how to use the simplest GIS tools (Google Maps) (Table 3).
- Students acquired knowledge about GIS mainly by watching video tutorials and following the instructions received from the teacher and colleagues. These types of materials (links) were presented on an e-learning platform.
- The main organisational problem was not enough time and no ideas for the project area (subject). Unfortunately, we could not extend the time for project development. Students had to work more at home.

- Course attendants could use any GIS tool in project development. Most of them used QGIS, ArcGIS and Google Maps. These applications were chosen because of availability without extra payment or agreements. Other important factors were functional capabilities, simplicity and ease of use.
- The main problems related to the used GIS tools were too many options, difficult usage, instability and low speed. Students also indicated some problems with using help files and understanding included tutorials. To eliminate these problems at the beginning of the course (after the introduction), the teacher should demonstrate how to use sample GIS software in the areas of data import and analysis, map creation and publishing of a project.
- It is worth mentioning that having good university infrastructure (computers and network) for the GIS course can be achieved without extra expense. The author recommends using free GIS and DBMS tools and using open spatial data sets.

Research limitations and future research

Geographic information systems have a lot of areas of use and can be used in different fields of education. Therefore, new GIS courses should be prepared and analysed. The presented research was limited to students of logistics at MCSU, and therefore, future research should be performed to compare the results with different universities and countries. In the future, the author would like to examine differences in GIS knowledge, skills and willingness to use them between full-time (not working) and part-time (working) students, and to ascertain if perception of GIS depends on the level of general IT competence.

References

DiBiase, D., Demers, M., Johnson, A., Kemp, K., Taylor Luck, A., Plewe, B., Wentz, E., *Geographic Information Science and Technology Body of Knowledge*, Association of American Geographers, Washington 2006.

G2 Crowd: *Business Software and Services Reviews*, https://www.g2crowd.com/categories/gis [access: 09.09.2017].

Geoinformation Portal gisplay.pl. *Oprogramowanie GIS*, http://www.gisplay.pl/gis/oprogramowanie-gis.html [access: 28.09.2017].

Holstein, A.L., *Geographic information and technologies in academic libraries: An ARL survey of services and support*, "Information Technology & Libraries" 2015, Vol. 34(1).

King, M., Arnette, A., *Integrating geographic information systems in business school curriculum: An initial example*, "Decision Sciences Journal of Innovative Education" 2011, Vol. 9(3).

Miller, F., Mangold, W., Holmes, T., *Integrating geographic information systems (GIS) applications into business courses using online business geographics modules*, "Journal of Education for Business" 2006, Vol. 82(2).

Miller, F., Mangold, W., Roach, J., Brockway, G., Johnston, T., Linnhoff, S., McNeely, S., Smith, K., Holmes, T., *Racer GIS online: Enhancing learning in marketing classes with web-based business GIS*, "Marketing Education Review" 2014, Vol. 24(1).

National Geographic Society, http://www.nationalgeographic.org/encyclopedia/geographic-information-system-gis/ [access: 29.09.2017].

Software.informer. *Most popular GIS software*, http://gis.software.informer.com/software/ [access: 29.09.2017].

Wallentin, G., Hofer, B., Traun, C., *Assessment of workforce demands to shape GIS&T education*, "Transactions in GIS" 2015, Vol. 19(3).

Wordclouds, www.wordclouds.com [access: 27.09.2017].

W jaki sposób studenci kierunków biznesowych zdobywają wiedzę i umiejętności z zakresu systemów informacji geograficznej. Wyniki badań ankietowych dotyczących realizacji projektu GIS

Celem artykułu było przedstawienie wyników badań ankietowych dotyczących wiedzy i umiejętności studentów w zakresie systemów informacji geograficznej. Wskazano podstawy teoretyczne GIS, zaprezentowano propozycję kursu pt. „E-logistyka i GIS", który został przygotowany dla studentów kierunku logistyka Uniwersytetu Marii Curie-Skłodowskiej w Lublinie. W głównej części opracowania opisano wyniki badań ilościowych dotyczących zdobywania przez studentów wiedzy i umiejętności związanych z GIS, które przeprowadzono w czerwcu 2016 r. wśród studentów logistyki (n = 96).

Na ich podstawie należy stwierdzić, że studenci utożsamiają GIS głównie z mapami, lokalizacją i przetwarzaniem danych. Zdobywają oni wiedzę i umiejętności w zakresie GIS głównie poprzez oglądanie kursów wideo, realizując zadania zgodnie z instrukcjami otrzymanymi od nauczyciela oraz obserwując i podpatrując działania swoich kolegów. Główne problemy, które wystąpiły podczas realizacji projektu GIS, dotyczyły braku podstawowej wiedzy z zakresu przetwarzania informacji geograficznej, pozyskiwania ciekawych danych do analiz oraz stosowania bardziej zaawansowanych funkcji analitycznych oprogramowania GIS.

How Business Students Gain Knowledge and Skills Related to Geographic Information Systems. The Results of GIS Project Development

The aim of the paper was to present results of research on students' knowledge and skills in the area of geographic information systems (GIS). The article outlined the theoretical background of GIS and presented the course framework entitled "E-logistics and GIS". The course was prepared for students of logistics at Maria Curie-Skłodowska University in Lublin. The main part of the article contained the results of quantitative research in the area of gaining knowledge and skills related to GIS that was performed in June 2016 on a group of students of logistics.

The performed research showed that students associate GIS mainly with maps, location, and data processing, and they acquire knowledge and skills in the area of GIS by watching video tutorials, following instructions received from the teacher and by observing and listening to their colleagues. The main problems that occurred during GIS project development were related to GIS tool usage, data acquisition and lack of basic knowledge.