GIS IN HIGHER EDUCATION IN POLAND
CURRICULUMS, ISSUES, DISCUSSION

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edited by Iwona Jażdżewska

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CURRENT STATE AND FUTURE PERSPECTIVES OF UNIVERSITY EDUCATION OF GIS AND GEOINFORMATION IN POLAND

STAN I PERSPEKTYWY KSZTAŁCENIA W ZAKRESIE GIS I GEOINFORMACJI W POLSCE NA UNIWERSYTECKICH KIERUNKACH GEOGRAFICZNYCH

Introduction

Geographic Information Systems (GIS) have found a permanent place in education at universities, not only in strictly geographic, geologic or geophysical departments and faculties. The interest in geographic information systems as a research tool and a tool for implementing one's qualifications and accomplishments in business practice is exhibited by specialists in virtually all areas of knowledge (Zwoliński 2010, Churski, Zwoliński 2011), if not as a whole, then at least in areas concerned with phenomena occurring in the geographical space. Among the scientists and specialists in various disciplines other than earth sciences known to the authors and presenting their achievements at conferences, especially high interest in the development and application of the GIS may be seen among experts in such areas as archaeology, philology, history, ethnology and anthropology, psychology (environmental), sociology, economy, biology, experts in environmental protection, safety and crisis management, and many others. On the other hand, geographic information systems are obviously a particular object of interest to the extent of computer sciences and other technical sciences, as evidenced by regular, interdisciplinary conferences for specialists in various disciplines devoted to the problems of geodatabases, geotechnologies (geoinformation technologies), i.e. algorithmisation and the geospatial data, called geocomputaion or, more broadly, computational science and its applications[1]. Technical sciences worth mentioning surely include geodesy, environmental engineering, architecture, construction, highway engineering, etc.

1 http://www.iccsa.org/, http://www.geocomputation.org/ [15–03–21]

However, the following facts and conclusions are meant to discuss the narrower subject matter of the transformations in the GIS education in recent years at the university level in Poland as a part of geographical studies, i.e. concerning the place, significance and changes of the GIS and geoinformation/geoinformatics in the case of the Bachelor's degree studies, engineering studies, the Master's degree studies and post-graduate studies in various disciplines and specialisations in the main units of universities, faculties and institutions authorised to award scientific titles in geographical sciences. Formally (according to the standards of the national qualifications framework[2]), geography is one of life sciences[3], but several faculties and specialisations are shared with other areas, e.g. cartography or remote sensing are classified as technical sciences (along with geodesy), while social and economic geography is a social science. We should also mention land management and (geo)tourism, that cannot be considered as purely geographic education.

In such a situation, a graduate of geography emerging onto the labour market should at least have knowledge and qualifications in the GIS and geoinformation specific to the specialisation and which furthermore would provide for a competitive advantage over other specialisations. In order to appropriately define what competitive advantage means for a geographer and an expert in the GIS/geoinformation/geoinformatics in the labour market, we should quote the definitions of geographic information systems and geoinformation (spatial data). However, we cannot discuss this problem separately from the internal determinants of the development of geographic research, i.e. the debate concerning the relationship between geography as a research discipline and the long-postulated area visible in the scientific life in conferences, seminars and through existing and new scientific societies, known as the GIScience (geographic information science), geomatics, geoinformation or geoinformatics. The aim is, however, to uncover those significant aspects of the situation, that directly influence the subject matter and scope of the GIS/geoinformation/geoinformatics education at universities, and not just a description of scientific discourse.

2 Regulation of the Minister of Science and Higher Education dated 08.08.2011 on areas of knowledge, fields and science and arts, and scientific and artistic disciplines.

3 On June 21, 2013, the Committee of Geographical Sciences of the Polish Academy of Science adopted a resolution by which they approve the concept of working towards classifying geography as a double-area (life sciences, Erath science and social sciences, economic science) in the scientific structure of Poland.

Terminology

There are many definitions of the GIS (Zwoliński 2009, 2011). Each one emphasises the role of three components: spatial data, computer software and hardware, and the community of the GIS users. According to Eurostat (2011[4], 2015), a geographic Information System (GIS) integrates hardware, software and data for capturing, managing, analysing and displaying all forms of geographically referenced information (i.e. on the surface of Earth). It allows you to map where things are, map quantities, map densities, analyse spatial relationships and visualise data and statistics in ways that reveal interactions and patterns. This broad definition presented on the website of the European Statistical Office shows the wide acceptance of the technological instruments of geoinformation, treated both as research tools and practical enterprise activities.

A wide introduction of the GIS into geographical science and education results in a research paradigm shift in this discipline, which may be compared to the "quantitative revolution" in the second half of the 20th century. Back then, due to the wide introduction of mathematics and statistics to geography, the discipline developed through the progress in mathematically described methods of spatial analysis. Many of them were hard to use as, we should remember, the researchers did not have appropriate hardware or software. Now, thanks to this possibility and the development of the GIS, we are witnessing the next paradigm shift in geography.

Geoinformation systems also have their roots (at least partly) beyond geography, although they widely use the achievements of cartography. They also stem from various other sciences as well as enterprise. The process of development of geoinformation technologies is (still) happening in the context of the relationship between science, economy and society, and the most significant impulses for the development of the GIS also come from outside of geography and, sometimes, outside science – they are the result of concrete economic applications.

Challenges of Geographic Information

These facts divided the society of geographers, scientists and lecturers (similarly to mathematics and statistics in the previous century) in the world (Wright et al. 1997, Goodchild 2010) and in Poland (Churski, Zwoliński 2011,

4 Eurostat, 2011. Geographic Information System (GIS). Online:http://epp.eurostat.ec.europa.eu/portal/page/portal/gisco_Geographical_information_maps/introduction [March 2011]

Jażdżewska 2014). Some treat geoinformation technologies as (slightly more complex) tools, boiling the problem down to the ability to use software packages as well as the familiarity with and ability to use their functions (outsourcing is sometimes used). Others see geoinformation sciences not only as universal tools and research technologies but as the modus operandi of studies and applications used for algorithmisation of research problems in geography, cartographic visualisation and the introduction of artificial intelligence elements, that will lead to the formation of new directions and specialisations in geography. A spectrum described by these two extreme approaches of academic lecturers towards geoinformation technology is very wide but everyone accepts the presence of the GIS in the geographic curriculum. It is not without significance, that the definition of geoinformation claims it is a science of geographic information (GISc), which redefines and develops the currently accepted concepts, theories and views of geographical sciences in information science categories that provide new possibilities of interpretation (Zwoliński 2009). This dual perception of geographic information systems and geoinformation has resulted in the GIS&T document (2006), which delineates the areas of interest of the scientific and technological approaches.

In this context, the question arises (which will remain open) about the influence of the current practice of research and education in various fields of geography on the use of the GIS tools and on the development of curricula in the geographic information system education.

The GIScience/geoinformation/geoinformatics is seen as an artificial, interdisciplinary, multi-dimensional discipline, which geographers share with other areas, as evidenced by the names of some units and departments in geographic faculties. On the other hand there are opinions that the GIS may only be useful in further development of traditional specialisations of geography. What remains to be achieved is the modus vivendi but that does not solely depend on the scientific discourse in geography. This is evidenced, among others, by the popularity of the GIS and GPS technologies in the society at large (e.g. through universally available navigation software, Google Maps and Google Earth or mobile applications), that used to be considered to be specialist qualifications in geography and cartography no longer than a dozen years ago. This transitive status of geoinformation technologies in geography may also be illustrated by the number of active professional associations of various geographic specialisation in recent years, independent of the already existing committees within the

PTG (cartographers, geomorphologists, climatologists, hydrologists, landscape ecologists), that actively work to promote the GIS in their respective specialisations.

The situation in geoinformation technology education is also influenced by the experience of graduates and freshman students. Students' expectations and awareness of geoinformation technologies differ. A lot depends on the ability to promote geoinformation specialisations and majors, complete information about the scope of education and competences. No less important … is the habit, shaped during curricular and extracurricular education, … of using printed maps, atlases and guidebooks (Werner, 2013), as well as the ever more widely available geolocation tools. The main argument is the students' and graduates' growing trust in themselves and their qualifications in the labour market and further education. On the other hand, the first encounter between geography students and the (undoubtedly) steep learning (and understanding of algorithms) curve of geoinformatics remains contrary to the ease of use of modern software. This results in such comments as: "not my cup of tea, the lectures were interesting but that's not my level yet", "too many applications!"[5].

One solution to this problem was a proposition submitted a couple of years ago to create either a geoinformation/geoinformatics specialisation within the field of geography or to create a separate field of geoinformation/ geoinformatics (Kozak et al. 2009) which is already being implemented at several universities. The importance of geographic information systems for geography was also emphasised by Jażdżewska and Urbański (2013) who also presented an extensive discussion of the approach to the GIS in Polish science, pointing to its flexibility and universality of application in numerous fields.

These external conditions for education in the field of geoinformation technologies at universities' geography units are also supplemented by two factors that apply to all advanced education facilities. The first is related to the development of technical culture in the society, described by sociologists as the generation X, Y, C and now Z[6] (McCrindle 2009, Piotrowska 2011, 2015), as the consequence of the implementation of the more and more advanced ICT[7] and GIS technologies. The second one is

5 Excerpts of comments from student surveys after selected classes in geoinformation technology subjects

6 Generation X – those born in the years 1965–1983, Generation Y – in the years 1984–1997, Generation Z – after 1995 (September 2007).

7 Information and communication technologies.

Fig. 1. Tag cloud composed of names of subjects (or their elements) in GIS /geoinformation/ geoinformatics in undergraduate studies at universities, in geography, geoinformation and geoinformatics majors. The sizes are proportional to the number of occurrences (own studies based on information from individual units, courtesy of: Jacek Kozak, Leszek Gawrysiak, Mariusz Szymanowski and university websites)

related to social (demographic), economic and organisational transformations – the Bologna process and the implementation of state qualification frameworks in university education. The coincidence of the three factors is reflected, among others, in a summary of majors and specialisations in geographical information systems, geoinformation and geoinformatics at the university level (cf. attachment).

The most important questions posed by the university applicants for geography, geoinformation and geoinformatics studies are related mainly to the benefits of studying them[8], often comparing them to geodesy and cartography, spatial planning at various universities, taking into consideration employment opportunities after they graduate. Aspirations, skills and abilities of candidates, as well as their expectations of their future professions are met with varied responses, even though the full offer and information presently concern the Master's degree studies since only few universities offer such courses in the field or specialisation of the GIS/geoinformation/geoinformatics in geography majors, as was the case in Poznań beginning in 2002/2003 (Zwoliński 2012). Additionally, they are being developed (Łódź, Warszawa, Toruń) or restructured (Kraków).

Current State of Geographic Information Education

A detailed list of the main subjects of education (and their descriptions) in the areas of the GIS/geoinformation/geoinformatics at the undergraduate

8 e.g.: http://wizaz.pl/forum/showthread.php?t=765216

level in geography, geoinformation and geoinformatics majors and specialisations is available on university websites (cf. attachment). Therefore the study was limited to uncovering the shared scope and presenting the names as a tag cloud (fig. 1). Composite names using the conjunction and were separated, provided that they could be presented as separate, and the names and inflections of nouns were standardised (e.g. geographic information systems were replaced with the GIS, and spatial data infrastructure – with the SDI).

A variety of specialisations of geography treats the GIS instruments, in conjunction with WebGIS, as necessary tools, analogous to the statistical and mathematical methods, by integrating them into the achievement of research and application goals. Their use is often associated with the collection and creation of (integrated and distributed) multiresolution and multirepresentation (Gotlib, 2009) spatial databases. Huge databases are created containing, among others, geospatial data for economic and social purposes, sponsored by international, state and public benefit organisations and often made available free of charge for scientific and educational use. At the other end, there are specialisations concerned more closely with designing algorithms and tools that often focus on new software functionalities (subprograms, models, plugins) and whole systems for analyses, visualisations, syntheses and simulations.

Methods of Geographical Information Education

Thus, we can define a certain spectrum of education and qualifications goals planned by the authors of the GIS/geoinformation/geoinformatics specialisations at the bachelor's degree level: from methodology-oriented with some geographical knowledge involved (including engineering studies, algorithms, system and application programming languages, databases), through routine and application use of the GIS programming tools, and the organisation of spatial data (databases), to solutions to specific problems in one or more fields of geography or, more broadly, earth sciences, using the GIS software. But in every field, the GIS/geoinformation/geoinformatics education is interdisciplinary and parallel to education in various other fields.

In all geographic units discussed, education in geoinformation technologies is compulsory and (in the case of the bachelor's degree-related training course) present as a separate major (in Poznań, Łódź and Lublin) and specialisation (in Słupsk, Warsaw, Gdańsk, as geoanalytics in Szczecin). In all cases, though, it is interdisciplinary education related to acknowledged,

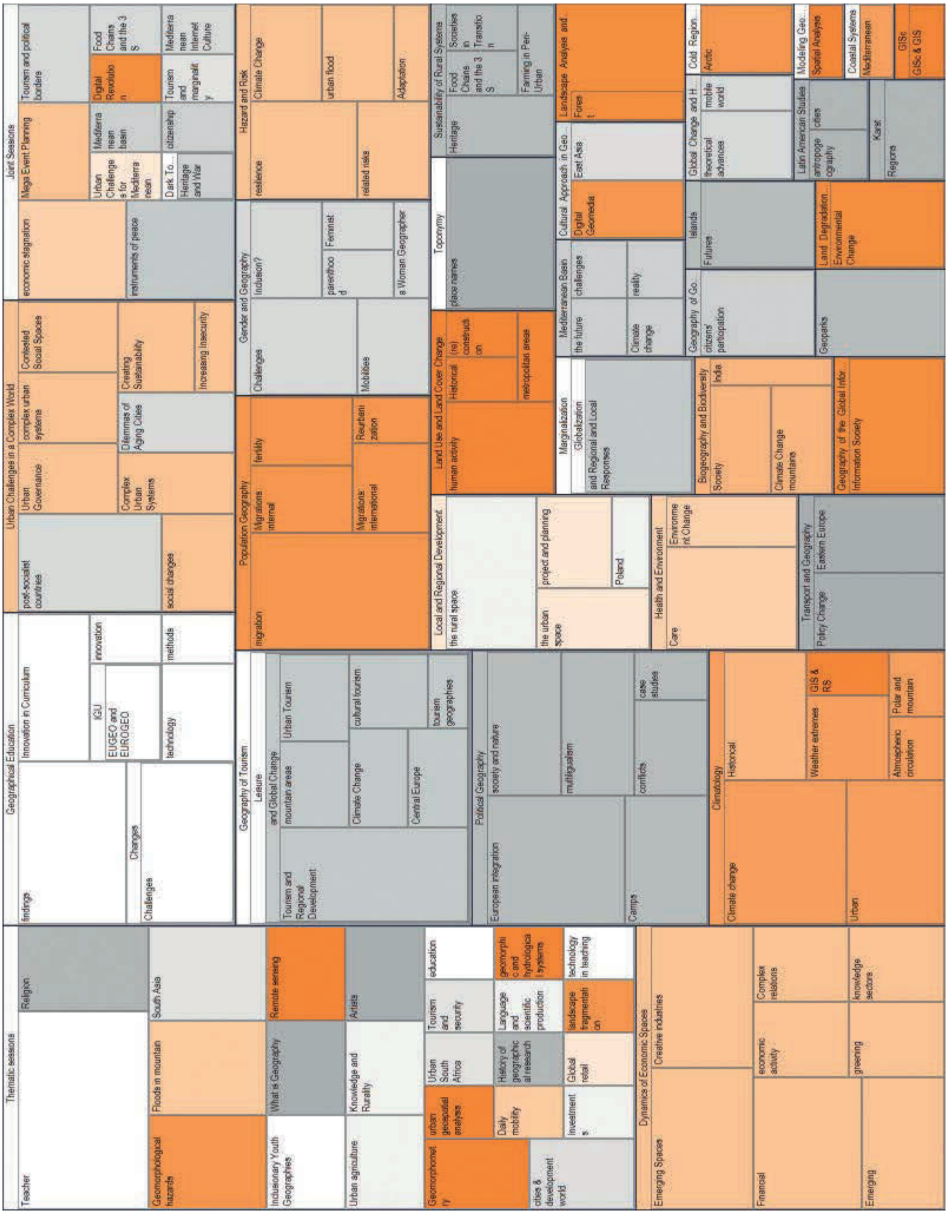

Fig. 2. Session names and main themes at the 25th Regional IGU Conference in Cracow, 18-22 August 2014. (treemap, own study based on conference materials. Shades of orange signify sessions with papers with considerable GIS tool content)

leading fields in science: geography and geoecology in Poznań; geography, information technology and mathematics in Łódź; mathematics in Lublin; geography in Słupsk; cartography and remote sensing in Warsaw; oceanography in Gdańsk; earth sciences in Szczecin.

Such positioning of training courses and specialisations in the field of geoinformation technologies and their coexistence with other disciplines stems, among others, from their utilitarian perception and is mainly the product of the formal division of science[9]. All of the majors and specialisations listed emphasise in their graduates' descriptions the benefits of qualifications in geoinformation (and/or geoinformatics) in the labour market[10],

The situation is similar in the case of full-time master's degree-related courses. Most geography units offer specialisations in the GIS/geoinformation/geinformatics in the course of the master's degree studies, related either to earth sciences (such as cartography, remote sensing, geoecology, oceanography – in Warsaw, Sosnowiec, Toruń and Gdańsk, as a part of geography in Kraków), or separate interdisciplinary majors combined with disciplines from other sciences (such as photointerpretation, mathematics, information technologies in Łódź or mathematics in Lublin), while in Poznań geoinformation is related to geoecology. Observing the recent and common changes in curricula of universities' geography units, including the GIS/geoinformation/geoinformatics, we may assume that this situation will continue into the near future, as it is connected, among others, to the unstable state policies regarding science and, concurrently, with the popularisation of the geotechnological paradigm in earth sciences. Developments in geoinformation technologies, combined with such processes as ICT development, including cloud computing, big data, wireless networks and mobile devices, real time data processing or augmented reality also constitute an obvious additional factor[11].

At the Polish Geographers' Forum in Poznań in 2011, a graphical visualisation of expected applications and development of geotechnology was presented, that could significantly influence the shaping of the labour market and geography education (foresight: geospatial technology projection, Werner, Opach 2013). By highlighting the milestones in the GIS

9 even though geoinformation technologies are also the sole subject in large number of bachelor courses in the same universities

10 for geography graduates.

11 Courtesy of, cit.: Zbigniew Zwoliński, Horyzonty geoinformacji. GIS w nauce, Lublin, 23.06.2013

Fig. 3. Tag cloud – common names of thematic sessions at the 26th Regional IGU Conference in Cracow and the names of subjects (or parts of them) at GIS/geoinformation/geoinformatics specialisations of undergraduate studies at geography, geoinformation, geoinformatics majors at universities. Size – proportional to the number of repetitions (own study)

development, analysing the current and expected areas of applications, phases of development, i.e. pioneer, institutional, scientific and public (crowdsourcing), as well as the penetration of the GIS into the economy and social life, such as telemedicine, security and media, we may anticipate the shape of the future labour market and thus specify the needs for the geotechnology education. This is undoubtedly related to the implementation of specific scientific and research purposes, for which financing could be raised.

It appears, that at least three paths to realise this purpose in geographical units have emerged. The first one is related to (i)the dynamic development of traditionally formed areas of geography, provided that they would use IT tools for this purpose, as was the case with mathematics and statistics. Without losing sight of the existing scientific purposes, specialists in these areas will be able to carry out new research and application tasks, pose new problems and expand their geographic competences, e.g. in hydroinformation (Graf 2010). The second one depends on the creation of (ii)interdisciplinary research centres dedicated to complex social or natural issues, or to other complicated problems that may require the cooperation of specialists in many areas. Their research and cooperation could form the basis for multi-area education, above all in geotechnology. Such issues may include integrated environmental monitoring (Zwoliński 1998, Kostrzewski 2012) or the development of metropolitan areas (Kaczmarek 2012). The third one is associated with the emergence of (iii)new interdisciplinary problems at the intersection of two-three disciplines, which will result in the formation of new research areas. A classic example from the past is biogeography. Currently, we can observe e.g. the convergence of computer graphics and traditional cartography (Fiedukowicz et al. 2014) or the integration of hydrological modelling with geographic information systems (Gudowicz, Zwoliński 2009).

The above mentioned paths are selected by the interested parties themselves (consciously or unconsciously, i.e. strategically or tactically). But this is insufficient. By going down any of these potential paths, each of the basic geographic units has equal development opportunities, depending solely on the opportunity to obtain financing for their development. Defining scientific problems, obtaining funding and the development of education in geotechnology and related areas can be started with any of the above listed steps. But, surely, the execution of just two of them will not be sufficient to ensure continuity in research and education.

Geographical Information at the IGU Conference

The above considerations may be easily questioned as they are based on incomplete information, assumptions, and the information we have collected concerning curriculums at geographical units of Polish universities will be verified and (probably) modified in the future. As it happens, though, between 18 and 22 August 2014 in Cracow the second regional International Geographical Union (IGU) conference to have been organised in Poland took place[12]. We can thus analyse the position and significance of the GIS/geoinformation/geoinformatics in presentations at the IGU commission and joint sessions, as well as the disciplines most closely associated with these topics.

The conference's motto was Changes, Challenges, Responsibility. It is assumed that the conference is a platform of exchanging ideas and discussions among specialists in various areas of geography. In the context of this paper, it may also serve as a touchstone and reference point for con-

12 On the 80th anniversary of the 16th IGU Congress in Warsaw on 23–31 August 1934 (Jackowski et al. 2014).

structing the GIS/geoinformation/geoinformatics curriculums at universities' geography faculties. A summary of (abbreviated) session names and main themes of the conference is presented in the fig. 2 as a tree map. The size of fields in the map is proportional to the number of presentations. For the sake of legibility, only (subjectively) chosen main themes in different sessions were included. Conference materials provided by the organisers were used. The colours of the map have been (subjectively) chosen to signify the relation to the geoinformation and GIS with shades of orange.

Since it is not the purpose of this article to sum up and assess the regional IGU conference in Cracow, we may briefly conclude that there is still a vast area of issues that are not yet tackled using the geoinformation and GIS approach (bearing in mind that this assessment is subjective).As far as thematic sessions are concerned, the ones most advanced in utilising geoinformation technologies were those devoted to geomorphological and flooding threats, geomorphological and hydrological systems, remote sensing and geomorphometry, geospatial analysis of cities (urbanisation), landscape analysis and dynamics of economic spaces. An analysis of sessions organised by permanent committees of the IGU allows us to list several themes, in which geoinformation tools play a significant role. This includes sessions on climate (including a special session on the GIS&RS (Remote Sensing)), a series of sessions named Urban Challenges in Complex World, sessions devoted to Population Geography, Land Use and Land Cover Changes, the global information society, the digital revolution (Joint Session) in cultural geography Landscape Analysis and Landscape Planning. Geographical information and geoinformation system tools were discussed in the course of the GISc&GIS sessions, while the geographic system modelling was discussed in Spatial Analysis session.

In order to verify this relationship, conference materials were indexed and two sets were compiled – a list of classes offered at Universities and a list of session names (unfortunately, abstracts did not use keywords, which significantly hampered the analysis). Again, coinciding names were counted and presented as a tag cloud (see fig. 3).

In view of this analysis, the application aspects of using the GIS to study geographical problems, also related to the visualisation of environmental and socio-economic phenomena on maps that may also be used for monitoring purposes, are of utmost importance.

GID Labour Market in Poland

The Geoinformation is a rapidly evolving discipline, and its largest labour market may currently be seen in the US and Western Europe. Thus, according to the classification of professions created by the Bureau of Labor Statistic on behalf of the Standard Occupational Classification Policy Committee (SOCPC) of August 2012 and the American Bureau of Labor Statistic, the graduate may find employment in the following professions (currently emerging in Poland and listed as desirable): Surveyors, Cartographers, Photogrammetrists, code: 17-1020, 17-1021). Their tasks include the acquisition, analysis and interpretation of geographical information based on geodetic studies, aerial and satellite imagery, as well as documentation, research, preparation of maps and other spatial data in digital and graphical form for legal, social, economic, political, educational and project purposes. Their main tools constitute the geographical information systems (GIS). They also design and assess algorithms, data (spatial) structures, user interaction interfaces in geographical information systems and mapping systems. On the other hand, geographers (19-3092 according to the above-mentioned institutions) are involved with the functioning of natural environments and the formation of geographical space by uncovering and interpreting the interactions among natural and cultural phenomena. They conduct research into the physical (natural) aspects of the regions, including landforms, geology, climate, water, soil, vegetation, animal life and spatial effects of human activities on their territories, including social, economic and political features. They take into account the interconnectedness of regions with the local and global scale, also using mapping and geodetic techniques.

According to the Bureau of Labor Statistic (USA) the best-paid jobs in the United States include surveyors, cartographers, photogrammetrists, urban and regional planners, database administrators and software engineers.

In terms of the Polish occupational classification, according to the directive of the Minister of Labour and Social Policy of August 7, 2014 concerning the classification of professions and specialisations for the purposes of the labour market and the extent of its application, the following professions available to a graduate of geoinformation may be listed: specialist in earth sciences (2114), geographer (211402), other specialists in earth sciences (211490), as well as cartographers and surveyors (2165).

Numerous examples of interest – in the Polish labour market – in specialists in this field may be given. In February 2015 alone, the Careers Office of the University of Warsaw had the following (example) job offers for graduates in main specialist positions: environmental protection (GIS, land management), climate and meteorology, environmental protection (hydrobiology), geophysics, geotechnology and geological engineering, environmental protection (zoology), seismology and tectonics, environmental protection (botany). New positions appearing in job offers in Poland include: a GIS analyst, whose qualifications include both familiarity with the GIS software and the ability to write software (applications).

According to the report of the Ministry of Labour and Social Policy (Competition deficit and surplus in 2014), deficit sections (with more job offers than applicants) in 2014 included public administration and national defence, mandatory social security, and information and communication. The professional, scientific and technical section was relatively balanced. The geographer was mentioned in the 2015 MPiPS report as a profession with the labour market demand lower than the number of people seeking employment. It was, however, at the end of the list sorted from the professions with the lowest surplus index (the ratio of offers to the registered unemployed population).

It may be assumed that a new generation of specialists in geoinformation/geinformatics and geography equipped with the GIS instruments and qualifications will have numerous interesting job offers in the quickly evolving labour market.

Attachment

The list of universities and institutes educating geography with a specialisation in the geoinformation/geoinformatics, and geoinformation/geoinformatics majors at universities (for the academic year of 2014/2015).

No.	School	Unit	URL	Department	Detailes
1	Pomeranian Academy in Slupsk	Institute of Geography	http://geografia.apsl.edu.pl	Geography	Bachelor specialty: Geoinformation
2	Maria Curie-Sklodowska University in Lublin	Faculty of Earth Sciences and Spatial Planning	http://geoinformatyka.umcs.lublin.pl/ http://www.umcs.pl/pl/nauk-o-ziemi-i-gospodarki-przestrzennej,47.htm	Geography	
				Geoinformatics	undergraduate studies
3	Adam Mickiewicz University in Poznan	Faculty of Geography and Geology	https://wngig.amu.edu.pl/	Geography	Geoinformation specialty from year 1 – Bachelor and Master studies
				Geoinformation	MSc and MA studies
4	University of Gdansk	Institute of Geography	http://www.geo.univ.gda.pl	Geography	
5	Jan Kochanowski University of Kielce	Institute of Geography	http://www.ujk.edu.pl/igeo	Geography	
6	Jagiellonian University	Institute of Geography and Spatial Planning	http://www.geo.uj.edu.pl	Geography	courses at the undergraduate studies Master's degree, specialisation in Geographic Information Systems
7	University of Bydgoszcz	Institute of Geography	http://www.geo.ukw.edu.pl	Geography	

No.	School	Unit	URL	Department	Detailes
8	University of Łódź	Faculty of Geographical Sciences	http://www.geo.uni.lodz.pl	Geoinformation	undergraduate studies
					master's degree from 2015
9	Nicolaus Copernicus University in Torun	Institute of Geography	http://www.geo.uni.torun.pl	Geography	
				Environmental Geoinformation	Master's studies
10	Pedagogical University of Cracow	Institute of Geography	http://geografia.up.krakow.pl/	Geography with geoinformation	undergraduate studies
11	Szczecin University	Faculty of Earth Sciences	http://www.us.szc.pl/wnoz	Geography	Geoanalytics
12	Silesian University	Faculty of Earth Sciences	http://www.wnoz.us.edu.pl	Geography	Specialisation Geographic information systems – GIS
13	University of Warsaw	Faculty of Geography and Regional Studies	http://www.wgsr.uw.edu.pl	Geography	Specialty geoinformatics
14	University of Wrocław	Institute of Geography and Regional Development	http://www.geogr.uni.wroc.pl	Geography	

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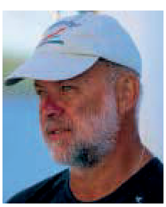

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ENGINEERING TASK-ORIENTED GIS EDUCATION, EXAMPLE OF THE COURSE AT THE AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY AGH IN CRACOW

EDUKACJA GIS UKIERUNKOWANA NA ZADANIA INŻYNIERSKIE NA PRZYKŁADZIE KURSU W AGH W KRAKOWIE

Introduction

Geographic space may be described as a model which is an extraction of essential objects in this space. For wide objects, such a model is built at various levels of detailing.

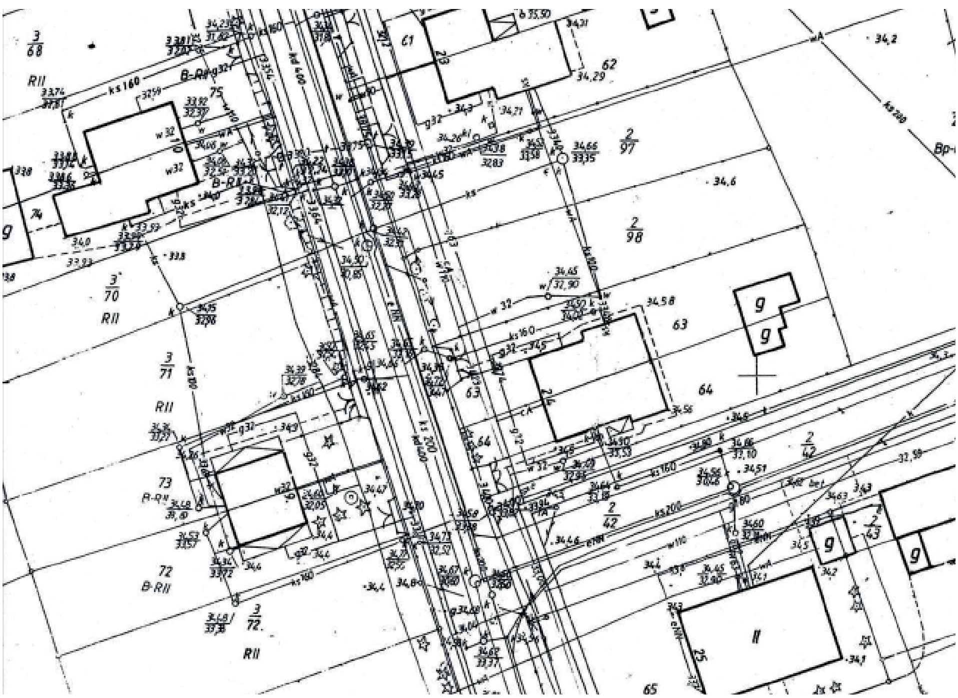

Fig. 1. A fragment of a large-scale map of an urbanised area, 1:500 map shows the above ground and below ground infrastructure in the area and land boundaries

There are two fundamental reasons for building such a model with a high degree of detailing, so it may be shown in a large-scale environment – for extensively developed areas – e.g. at the scale of 1:500 (fig. 1).

The first argument stems from the need for a detailed description of above ground and below ground engineering objects in order to provide rational spatial activity as well as safety. Such a description of spatial objects is ensured by a spatial information system which in the case of such a huge scale is called a terrain information system (SIT).

The second argument for detailed description of space stems from the need to provide a highly detailed plot boundary network, i.e. plots of the earth's surface that have clearly de-fined legal interrelations. The earth's surface is a particular kind of value as the limited extent and significant price of it forces high precision in registering plot boundaries. Apart from a land information system, the plot registry is another description of geographical space, also known as land registry. In this case, the boundary grid is overlaid with the grid of useful land and land valuation.

Both descriptions of the geographic space, the land information system and land registry, have their own separate, specific objectives, differences and similarities but they have to co-operate in any action taken in terms of the local space.

Land Information System and Land Registry – Similarities, Differences and Cooperation

The land information system (as a large-scale GIS) contains comprehensive information avail-able to all users. On the other hand, the land registry is based on an elementary fragment of the land, i.e. a plot. The land registry requires updating after each operation on the plot grid. For legal reasons, the land registry data is confidential to some extent in order to protect per-sonal particulars.

A common feature of both systems is the description of objects in real space. The land information system is aimed at a comprehensive description of space – it contains a description of the above ground and below ground infrastructure as well as descriptions of natural fea-tures, and above all the representation of topographic surface. In addition to formal data, the land registry only describes the spatial boundary grid, for which the grid of arable lands and evaluation outlines are complementary. The land information system provides up-to-date data, while the land registry also has to store historical data on legal changes of real space. The land information system is aimed at serving the purposes of a wide range of users showing versatile interests, while the land registry is intended for the administrators of given pieces of space in order to guarantee the related rights and allow them to use the property at their discretion. The land registry also serves the fiscal purposes.

These two descriptions of the real space in many cases must be used in conjunction as every action taken in the local space has to be linked to its ownership and thus it requires the geom-etry of the surroundings, the descriptions of infrastructural elements, and the ownership dis-tribution in the local space.

These two descriptions may be integrated in two ways. In the case of historical develop-ment, the description of space – a traditional land registry – has been computerised and served as the basis for the description of infrastructural elements. This is how the so-called multitask-ing land register was created. Nowadays, due to the terrain information systems that widely describe the real space, such systems are usually expanded on the basis of the land registry data, thus creating a complete and coherent description of the geographical reality.

Characteristics of Education in the Field of Geodesy and Cartography in the Course of First Degree Studies

Education in the field of Geodesy and Cartography comprises a group of vocational subjects concerning techniques for determining the position of objects and description of the real space as well as a group of subjects needed for general engineering education, especially those di-rectly related to geodesy.

This first group corresponds to the basic tasks of geodesy and cartography, namely: de-termining the position on the earth's surface on a global, national, regional and local scale, mapping and creating descriptions of objects, bringing objects into the real space and research-ing the behaviour of objects in time.

When commenting on this fundamental group of vocational subjects, we should empha-sise that a large part of this group represents the modern measurement techniques such as the GPS, laser scanning technology and the use of electronic direct measurement equipment as well as the utilisation of source materials such as satellite and aerial images.

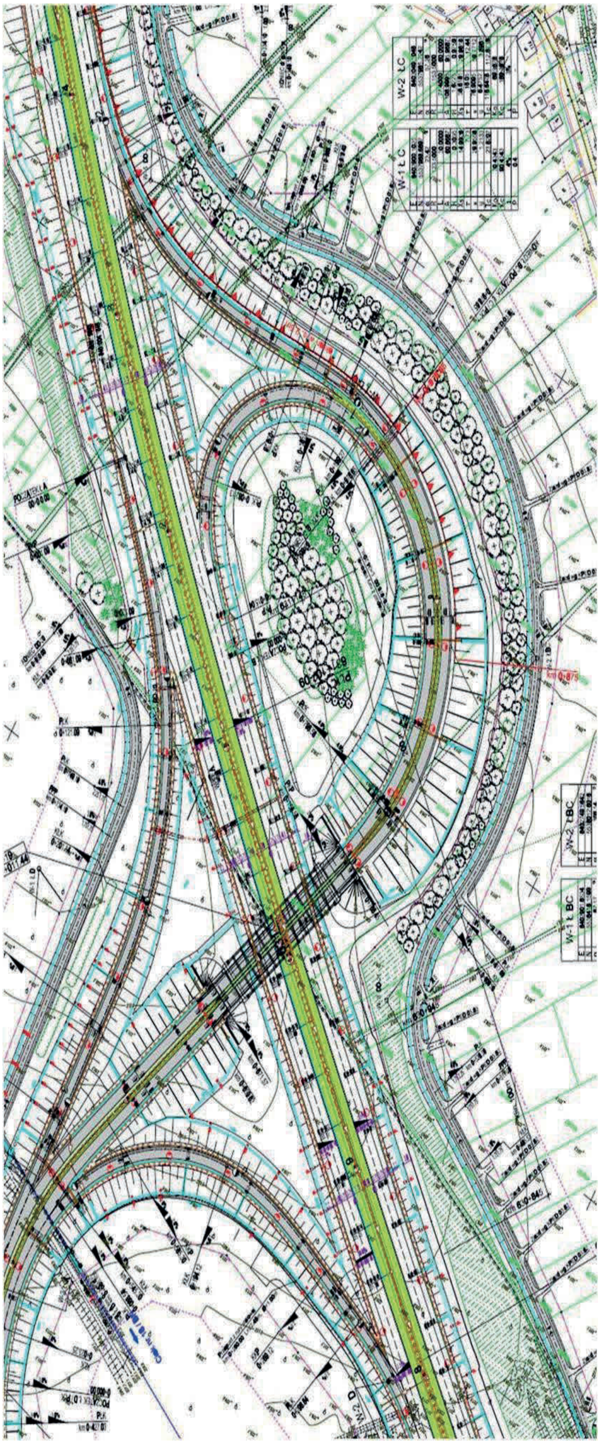

Fig. 2. Education in the field of computer graphic editors plays an important role in civil engineering design visualisation, the sample drawing contains a fragment of a highway junction plan (the drawing has been made available by the contractor of the A-4 for teaching purposes)

A leading role in the training programs is played by computer methods, including general computer education, engineering task programming, computer graphics editors (Figure 2) and the digitisation of the real space descriptions. This last group includes the GIS – with its sub-ject of the "terrain information systems" (SIT) or the large-scale GIS.

Further groups of subjects include engineering subjects, such as construction and engineering, as well as specialised measurements in these fields.

At the same time, students are educated in the field of the land registry, property admin-istration, and geodesic and cartographic law.

This last group of items includes issues of planning and arranging space in urban and rural areas.

GIS Education in Multi-level Engineering Studies

The GIS education in the field of Geodesy and Cartography at the Faculty of Mining Survey-ing and Environmental Engineering at the AGH University of Science and Technology in Cracow at the first-level education is included in the subjects of the "terrain information sys-tems" and GIS. The major subject of the SIT includes approximately 60 hours of classes. The approximation stems from the fact that the Department is now switching to 14-week semes-ters. Given the fewer hours of classes, the GIS includes elements of remote sensing data ac-quisition. Those training courses are expanded using electives that offer a more thorough in-sight into chosen specialised applications.

Other earth science-related faculties also include the basic GIS courses. The Faculty of Geology, Geophysics and Environmental Protection includes a subject named the "spatial in-formation systems and GIS". In the case of the major of "spatial management" (which also includes many engineering features at the Bronisław Markiewicz State Higher School of Technology and Economics in Jarosław, the mandatory GIS education is split into two train-ing course subjects, with 60 hours of lab classes.

At the Faculty of Mining Surveying and Environmental Engineering of the Academy if Mining and Metallurgy (AGH), the second stage of education includes the specialisation in the field of "geomatics". By means of this specialisation, students are taught subjects that ex-pand their knowledge in the advanced GIS tools and various applications of the spatial infor-mation systems.

As far the third degree education is concerned, namely in the case of post-graduate edu-cation programmes, there is a subject named the "spatial information system" which is taught at various levels: it either expands the knowledge of less advanced students (who have taken various majors) or students with some experience gained in their first and second degree edu-cation.

We should add, that the employees of the Faculty of Mining Surveying and Environmen-tal Engineering of the AGH University also provide the one-on-one GIS training courses as a part of the first degree engineering studies as well as for the purpose of MA theses ending the Master's studies.

Lectures and presentations as a part of the annual GIS Day in November are another form of education. This form of education is dedicated to the high school and primary school students. As a part of universal education organised by various institutions, especially Univer-sities of the Third Age, there are the GIS lectures provided as a part of open social education.

Special Features of Description of Real Space in Large-scale Environment

Engineering education should include not only the existing state of knowledge but should also take into account the future that the students will face after they graduate. Education should therefore expand the graduate's knowledge in subjects of scientific developments and applications in a given field. This paper, while tackling education, includes an outline of two exemplified trends in the development of the terrain information systems (chapters 5 and 6). Another argument for discussing the trends in scientific development is to show a university not only as an education institution but also as a centre for scientific research which includes its own and others' achievements to the extent of education.

The principles of documenting buildings in large-scale maps that are now commonly used represent buildings as outlines at the ground level (fig. 1 and 3). The interior of the building usually has a separate, detailed documentation. This way of documenting buildings in large-scale maps is widely acceptable. However, representing a building as an outline leaves an empty field in a map where its interior should be depicted. Empty fields in building outlines create discontinuity in mapping, that may account for as much as 30% in densely developed areas. According to the author, this creates a disintegration in the description of the land development and interior descriptions. There are many tasks that require determining the

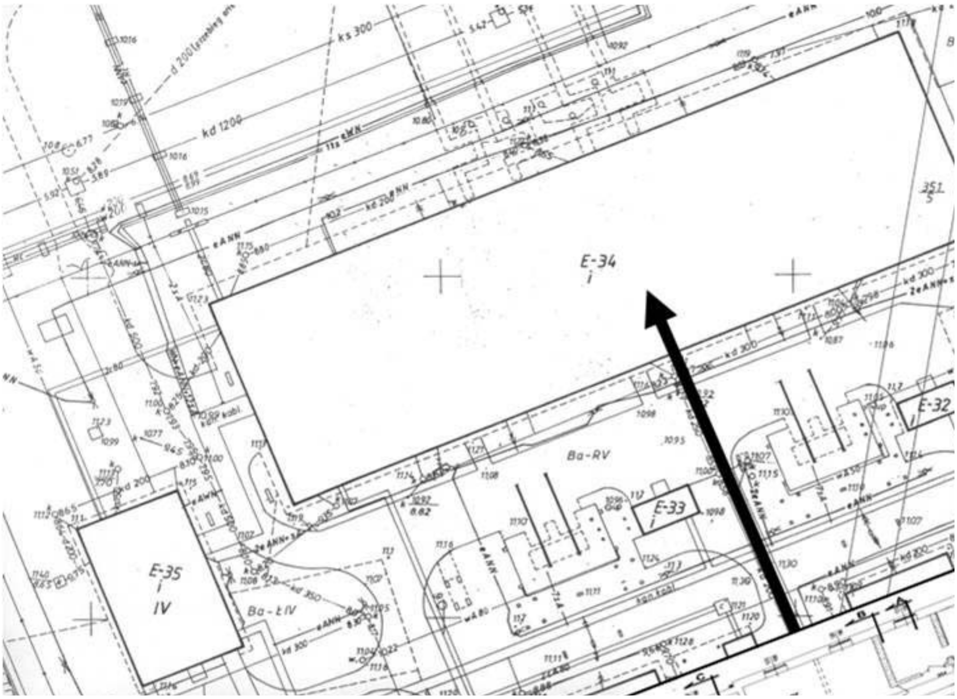

Fig. 3. Integration of the representation of a building, in the form of a contour, with plans of its interior, that ensures the continuity of documenting space and allows for the performance of many analyses in terms of the GIS for disaster management (Eckes, 2008a and 2008b)

relationship between the interior of a building and the surrounding terrain, including decisions in crisis management.

In order to integrate the description of the interior of the building with descriptions of the surrounding area, the author has suggested in his work (Eckes, 2008a) to expand the functionality of the terrain information system to include documentation of the internal space of buildings (fig. 3). This method of documentation ensures contiguous description of space, technological coherence and document storage in a single place. Furthermore, this method of documentation, based on the GIS technology, allows for performing numerous analyses using system tools. The record of buildings' internal geometry made using the principles of the GIS has allowed for running a series of analyses for the purposes of crisis management. The results of these analyses are presented in Eckes's works (Eckes, 2008a and 2008b).

Integration of Land Information Systems With Expert Systems

Large-scale maps are characterised by their genesis – these maps are created as a result of di-rect field measurements or laboratory studies. At this stage of data acquisition the land details are generalised. Due to the high accuracy of these measurements, up to 1 cm for a certain group of field details, the shapes of mapped objects remain highly similar to the shapes of real objects (fig. 1 and 3), all the more so, as the large-scale map creation uses a formalised proce-dure for creating such images: a clear procedure for shaping the map image, a set of principles, and a certain library of signs.

In the geographic reality, there are a lot of geometric, physical and functional principles and so, by virtue of a high degree of similarity between the mapped objects and real life ob-jects, these principles are reflected in a large-scale map.

In the traditional version, the map image as an end product of the process of land imag-ing was only controlled by a man. Such control is not objective and depends on numerous personal factors: experience, perception, reliability, and fatigue.

The author used his work (Eckes, 2007), among others, to present a concept of building an expert system which could help control the map image. In this work, he summarises the attributes and relations that may serve as the basis for forming expert principles. These attrib-utes and relations are classified in four groups:

- the attributes of the structure of objects' images,
- the relationships among various objects in a map,
- the relation of objects to physical or geographical factors,
- the relationship among objects and the externally binding standards – norms, regulations, and development plans.

The Figure 4 provides examples of these principles in a large-scale map. These principles may be verified by an expert system integrated with the land information system. Such an expert system may detect errors that were created in the process of data acquisition and may thus support a man in checking the correctness of a map. It may also detect irregularities that exist in the real world.

The integration of the land information systems with expert systems is a great opportuni-ty for improving the quality of the data acquisition pro-

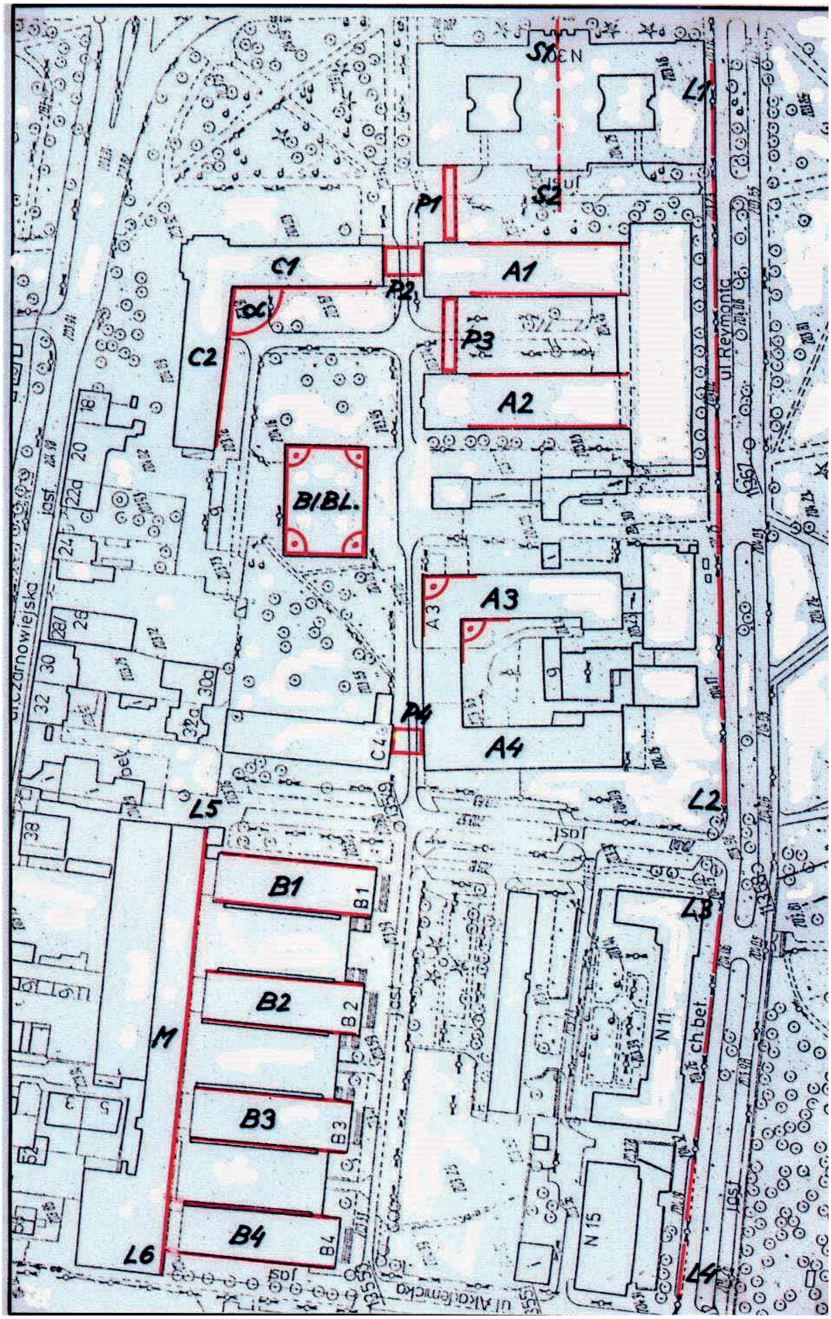

Fig. 4. The attributes of the structure of objects' images – the AGH campus buildings, marked in red: parallelism, squareness, symmetry, and the relationship among objects: repetition, parallelism, equal spacing. The attributes and relationships may serve as the basis for expert rules.

cess in terms of the GIS. The large-scale environment provides numerous factors for creating expert rules. In the case of medium-scale environments, due to the process of generalisation, we may notice a significant drop in the number of these factors, even though they still exist, and the integration of the GIS in a medium-scale environment with expert systems may also have many practical benefits.

Summary

The GIS education at technical universities is influenced by many internal and external fac-tors. Some of them have a negative impact but there are also positive external factors.

Based on personal experience (Eckes, 2009) at a university with a long tradition of teach-ing the GIS, several negative factors may be listed. The main one hampering regular updating and modernisation of curricula stems from the lengthy procedures for the curriculum approval. The development of new technologies does not support quick publication of new handbooks, either. Considerable effort made on writing them is wasted by a long publishing cycle, as a result of which the book is out of date after a couple of years. Another undoubtedly negative and important factor involves mass education in the field of Surveying and Cartography, es-pecially in universities lacking properly experienced staff, appropriate equipment and software (Gaździcki, 2014). The mass education and financial difficulties cause continual pressure to replace lab classes (in groups of a dozen or so students) with project groups that are double of that size. This affects the quality of education as the teacher is not able to personally address individual students.

On the positive side, we may above all refer to the general public's need for information about the environment we all live in. The GIS meets the needs of the information society. There are also relevant legal acts governing the circulation of information in the European Un-ion. There is also well-prepared staff with considerable experience.

The GIS technology as a computer method for describing and circulating information concerning the real space is included in computer education training courses and provides graduates with universal education, offering the large creative component. Such foundations allow the graduate to switch to working in related technical domains. At the moment of facing the demographic decline, we observe a positive phenomenon of eliminating the Survey-ing and Cartography training courses at universities lacking any tradition, experienced staff, and best available software. On the other hand, reputable universities have to compete for better performing secondary school graduates.

One definitely positive factor derives from the basic characteristics of the professional, advanced GIS software – it is universal and independent of scaling environment. The same software tools may be used to solve challenges in the local space, region, country, or even on the continent. This provides us with an opportunity to exchange experience among the users of the real space description to a varied extent as well as to bring about more universal educa-tion.

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GEOMATICS EDUCATION OF FORESTERS AT AGRICULTURE UNIVERSITIES

GEOMATYKA W NAUCZANIU LEŚNIKÓW NA UCZELNIACH ROLNICZYCH

Geomatics Education Within the Framework of Forestry Training Course at the University of Agriculture in Krakow, the Poznań University of Life Sciences and the Warsaw University of Life Sciences

The main place of work for foresters is a forest – a biologically active space. Geomatics allows measurement and documenting of forest space at varied levels of detailing – from a single tree, through stands (forests) to a forest complex and landscape. Geomatics technologies and the data gathered by means of such technologies are used for expanding the knowledge of how nature functions, so they become the foundation for decision making to the extent of forest management. They are also an important tool for nature and forest education and social communication (Grzegorzewicz 2001, 2002, Olenderek 2002).

After World War II, the issues of acquiring, processing, visualising and sharing spatial information in the analogue form were taught to forestry students in the course of classes and lectures on surveying and photogrammetry as well as forest management. They were using a splendid textbook "Forest surveying" by Zbigniew Łabęcki (Łabęcki 1978) as well as several other publications and textbooks on surveying (measurement) and photogrammetry. The first mentions of spatial and geographic information systems (GIS) appeared in lectures – at the Faculty of Forestry at the Warsaw University of Life Sciences (SGGW) – by Heronim Olenderek, the author of the "Concept and technology of drawing numerical forest maps" (Olenderek 1982). The development of the GIS education and later introduction of those systems into forestry was influenced by the seminar organised at the Faculty of Forestry at the SGGW in 1990, during which Jack Dangermond presented the paper entitled "ARC-INFO geographic information system". The Faculty received free licenses for the first fully professional software package, which allowed to launch IT lab classes with individual workstations. In the sixties, more precisely in the academic year 1965-1966 (Kozikowski 1967), photogrammetry was introduced into the curriculum for foresters, in its classical meaning of a science dealing with the acquisition of information concerning the size, shape, and location of objects based on measurements of photographic images. It is difficult to pinpoint the exact moment when remote sensing entered the curriculum in its initial narrow form of photointerpretation as allowed by the technology available at the time. It should probably be considered to be the moment when first papers on this topic were published by Jerzy Mozgawa (Mozgawa 1977) as elements of knowledge taken from scientific research always had an impact on classes for forestry students. It was then that first master's theses on this topic were written (Tab. 6). The development of geomatics techniques contributes to the conversion of photogrammetry and remote sensing from the analogue form into the digital one. Satellite positioning systems GNSS as well as aerial (ALS) and terrestrial laser scanning (TLS) systems enter that area of interest.

The first Polish studies on photogrammetry in the field of forestry were written by Tadeusz Gieruszyński (1948), Mieczysław Stanecki (1951) and Krzysztof Rudzki (1964). Photogrammetric issues (later also remote sensing issues – first in curricula, and also then in the name of subject) were included in textbooks by Dmochowski (1963), Olenderek and Piekarski (1969), Piekarski (1996, 2nd ed. in 2001), Adamczyk and Będkowski (2005, 2nd ed. in 2007), Okła (2010, 2013), and Będkowski and Piekarski (2014).

Upon the arrival of "the GIS era", the primary source of structured information about spatial and geographic information systems for over a decade was Jerzy Gaździcki's texbook entitled "Geographic Information Systems" (Gaździcki 1990). The GIS systems had sparked the interest of the State Forests for years, resulting in the launch of works on the State Forest Information System (SILP) in 1991. One integral part of the system is a spatial information database in the form of a digital forest map (LMN). This is also when the first study for foresters was created under the title "Spatial Information System in the State Forests – User Manual for the digital forest map" (Okła 2000). The implementation of the map lasted for many years and was completed on March 10, 2010 when it was installed in the last Polish forest district (Olenderek T. 2014). This long implementation resulted, among others, from the specific nature of forestry – the introduction of the LMN to a large extent involved new forest management plans which are sent to districts once every 10 years. The first and so far only academic textbook for foresters referring directly to the subject of the GIS was developed at the Poznań University of Life Sciences , formerly called the August Cieszkowski Agriculture University (Miś et al. 2001). In the following years, the State Forests contributed to the creation of a comprehensive two-volume textbook entitled "Geomatics in State Forests" (Okła 2010, 2013). It was prepared with the input from employees of the State Forests as well as the forestry faculties in Kraków, Poznań, Warsaw and the Forestry Research Institute in Warsaw. The textbook is available in its entirety in the Internet[1]. Along with other textbooks on photogrammetry and remote sensing, that has been mentioned earlier, it is the basic material for foresters studying the issues related to the GIS, photogrammetry and remote sensing as well as geomatics. In 2011 a new Manual for forest managemen[2], was published, the third volume of which was devoted to the principles of mapping forests (Wiśniewska et al. 2011). Those issues had always been present in previous editions of manuals for forest management but they had not been so prominent. For the first time, a professional catalogue of objects and symbols was prepared for the purposes of printing digital maps. It is important to mention that "forest" specialists in the GIS become authors of studies that transcend the professional community of foresters. For example, the textbook entitled "Handbook for trainees in LIDAR product use" (Wężyk 2014) was prepared for the purposes of trainings in the field of the most advanced geomatics technologies in the Computer System of Protection against extraordinary threats, while the Forest Research Institute has launched an internet-based social project "Laser Explorers" aimed at finding new archaeological sites (Zapłata et al. 2014).

Foresters find employment not only in the National Forests but also in the Offices of the Forest Management and Geodesy, national and landscape parks, Directorate for Environmental Protection, state and local government, institutions of forestry services, forest education, universities and research institutes, woodworking factories, and others. They are competing for these job vacancies with graduates from numerous other natural science courses – landscaping, biology, geography, spatial management, environmental engineering, environmental protection, agricultural and forest technology, wood technology, tourism and recreation, production engineering, and others. (Paschalis et al. 2014b, Grzywacz 2014). They are no strangers to unemployment, either. In the case of analyses and discus-

1 Corporate Portal for State Forests. http://geomatyka.lasy.gov.pl/web/geomatyka/nauka_public

2 State Forests: http://www.lasy.gov.pl/publikacje/copy_of_gospodarka-lesna/urzadzanie/iul

sions on that topic (Przybylska 2003), there were proposals to reform the studies and expand the curriculums by means of subjects that facilitate professional start, not only in forestry: legal and economic subjects, spatial development and computer science, including the GIS. Challenges for our country include clear development trends in the world (Mozgawa et al. 2001): the increasing importance of science and education, transformation of knowledge into production resources, development of information technologies, transformation of the production activities of many sectors (e.g. mining, metallurgy, and forestry) and the development of new jobs – mainly to the extent of computer sciences. As far as geomatics is concerned, graduates of forestry should (Olenderek H. 2014): have knowledge in measurement methods and the basics of instrumentation, data processing and assessment of data accuracy; be able to use modern technologies – conduct measurements of forest space and present their results using maps and photographs; have social competences – be able to work in a team and serve different roles in it, be aware of the need for continuing education, and complete their tasks with appropriate quality and diligence, and be able to prioritise them.

The profile of a graduate defines a set of competences gained throughout education that serve as the basis for an employer to employ a person equipped with expected skills (Kraśniewski 2011). The profile of a forestry graduate, which serves as a brief list of the most important effects of education (knowledge, skills, social competences), expanded with potential employment opportunities, is considered to be clearly formulated and well-suited to future professional challenges that foresters will face.

The educational standards for individual courses and levels of education at the beginning of this century (Regulation 2002) assigned 3400 hours to forestry (single degree, graduate studies), including 1900 hours for:

- 4 general education subjects (min. 380 hours),
- 14 core subjects (min. 655 hours), including the “forest surveying” (min. 45 hours),
- 13 major subjects (min. 865 hours), including “photogrammetry and geographic information systems” (min. 30 hours).

The educational standard for part-time studies, referred to as vocational studies, included fewer hours for “forest surveying” (40) but the same number of hours for photogrammetry and the GIS as in the case of full-time studies. Curriculums for individual subjects included the following for “forest surveying”: surveying, elevation and mixed measurements for forestry and environmental protection purposes; measurement methods;

surveying equipment. The "photogrammetry and GIS" curriculum included: acquisition of photogrammetric images, stereoscopic effect; photogrammetric equipment and mapping methods; classification of spatial information systems; computer cartography; hardware and software packages.

With the introduction of two-cycle studies (Regulation 2007), Bachelor's studies (engineering) included 2400 hours (210 ECTS), with a core group of min. 210 hours (21 ECTS), and 660 hours of major subjects (67 ECTS). Major subjects were divided into 8 scopes of teaching, including "geomatics in forestry". The contents of geomatics education: surveying measurement methods; global positioning systems; forest cartography; photogrammetric imaging and satellite imaging – utilisation; interpretation and digital processing of photographs and images. Spatial information systems; digital forest maps; digital terrain modelling; spatial analyses. Education was meant to result in skills and competences allowing the graduates to comprehend the specifics of acquiring spatial data concerning forests as well data processing and visualisation.

Master's studies (900 hours, 90 ECTS) included the core group of min. 30 hours (3 ECTS) and the major subjects of at least 210 hours (22 ECTS). Again, were eight scopes of education distinguished, including "geomatics in forestry". "Geomatics" training includes the integration of different sources of spatial data concerning forest environment. This results in skills and competences in analysing spatial data concerning forests.

Currently, according to the act (Act 2005), Bachelor's forestry studies (engineering) last 7 semesters, while Master's degree studies last 3 semesters. The advanced education reform in 2011 introduced the National Qualifications Framework – NQF, and the centrally ordained educational standards ceased to apply. Curriculums autonomically created by the universities are now based on the NQF as well as new conditions that have to be met by the description of the curriculum and qualifications (Regulation 2011a, 2011b). Eight areas of education were distinguished. In the descriptions of learning outcomes that have to be reached in the R. area, i.e. agricultural, forest and veterinary sciences (the Annex 7 to the Regulation 2011b), the issues related to geomatics are not explicitly referred to. We can say that these outcomes are merely related to geomatics.

The Annex 9 to the Regulation (2011) contains a description of learning outcomes leading to the engineering competences. Almost all outcomes in the form of knowledge and skills listed here are related to geomatics (we will not list them due to their volume), but similarly to the Annex 7, there are not direct references.

Subjects (modules, according to the current terminology) related to geomatics are currently present at all three levels, including postgraduate studies. Individual institutions use various module names, numbers of hours and composition of the curriculum. The purposes of these modules also differ – those may be classes for all students or electives. In a sense, students choose their future careers when they enrol in specialisations. Their number at the SGGW varies between several and a dozen, with some enjoying a lot of interest from the students. For many years, the most often chosen specialisations at the SGGW have included "the use of geographic information systems in forestry" (Porter 2003).

Proper geomatics education is thus included in a specialisation with numerous modules and hours (Tab. 3). The most important thing is, however,

Tab. 1. "Geomatic" modules mandatory for all students at the Faculty of Forestry, Poznań University of Life Sciences.

Module name	Education level (1, 2)	Number of hours in basic/extended version in full-time and part-time studies		
		lectures	classes	fieldwork
Forest surveying	1	12/18 (8/10)	12/21 (12/15)	6/6 (0)
Geomatics	1	10/16 (10/15)	30/44 (10/20)	0 (0)
SILP	1	6/10 (4/5)	24/35 (16/20)	0 (0)
Forest management	1	18/30 (15/20)	18/36 (20/35)	24/24 (0)
GIS in environmental protection	2	15 (9)	15 (9)	0 (0)
Environmental monitoring	2	15 (9)	15 (9)	0 (0)
Planning for Nature Conservation	2	10(9)	15 (9)	0 (0)

Source: Own calculations

Tab. 2. "Geomatic" modules mandatory for all students at the Faculty of Forestry, Warsaw University of Life Sciences.

Module name	Education level (1, 2)	Number of hours in basic/extended version in full-time and part-time studies		
		lectures	classes	fieldwork
Forest surveying	1	15 (10)	15 (10)	24 (18)
GIS	1	6 (5)	20 (10)	
Photogrammetry and Remote Sensing	1	10 (6)	13 (12)	
Geomatics in forestry	2	10 (12)	30 (15)	
Digital Processing of Remotely Sensed Data	2 – FIT	10	20	
Forest Information Systems	2 – FIT	8	20	
Spatial Analyses	2 – FIT	10	20	
Monitoring of Rural areas by RS Techniques	2 – FIT	15	15	
Forest Photogrammetry	2 – FIT	10	20	
GIS II	2 – FIT	10	20	
Map Editing	2 – FIT	10	20	
Research and teaching methods in forestry	3	18 (6 monographic lectures)		

Source: Own calculations

Tab. 3. The modules included in "Geoinformation technologies" specialization in first-degree studies at the Faculty of Forestry SGGW in Warsaw.

Module name	Number of hours of classes
Modern methods of measurement of the forest	30
Methods of spatial analysis in GIS	30
Digital methods in remote sensing	30
Photogrammetry and remote sensing in forest management	30
Cartographic methods of presentation	15
Elements of applied cartography	15

Source: Own calculations

that the participants of the "geomatics" specialisation write theses on that topic. Currently, the specialisation, named "Geoinformation technologies" has been launched only for full-time first and second degree studies at the Faculty of Forestry at the SGGW. The topics of these theses at three

Tab. 4. Theses (engineering and master's) related to geomatic subjects written at the Faculty of Forestry, University of Agriculture in Kraków (March 2015). Columns: surveying, photogrammetry, remote sensing, cartography, GIS (and SIS), GNSS (satellite navigation systems), ALS (aerial laser scanning) and TLS (terrestrial laser scanning), OTHERS (e.g. legal matters).

Years	GEO	PHOTO	RS	CART	GIS	GNSS	ALS	TLS	others	total
2001-2005		4	3		4	2				13
2006-2010			3		2	1	3	7		16
2011-2015		4	8		5	1	14	14		36
total		8	14		11	4	17	11		65

Source: Own calculations

Tab. 5. Theses (engineering and master's) thematically related to geomatic subjects written at the Faculty of Forestry, Poznań University of Life Sciences (March 2015), symbols as in Tab. 4.

Years	GEO	PHOTO	RS	CART	GIS	GNSS	ALS	TLS	others	total
2001-2005					4					4
2006-2010			4	1	10			3		18
2011-2015			4		2		2	7		15
total			8	1	16		2	10		37

Source: Own calculations

forestry faculties (Tab. 4, 5, 6) refer directly to surveying measurements, GNSS (GPS) systems, photogrammetry and remote sensing, spatial analyses using the GIS environment, terrestrial and aerial laser scanning, land register, etc. However, the SGGW has noted a decreasing interest in the GIS issues and geomatics in general.

Another form of engagement includes participation in scientific clubs (science camps, annual GIS Day events, conferences, etc.), as well as summer schools (Stereńczak and Będkowski 2009, Stereńczak et al. 2012, Wężyk and Szostak 2013, Wężyk et al. 2015). Universities also organise training courses and training sessions that most often involve the GIS software.

Geomatics education was also provided at the SGGW between 2002/2003 and 2008/2009 within the framework of postgraduate studies entitled "The use of GIS in forestry and environmental protection" (Będkowski 2004, 2006). The seven editions of those training courses had more than a hundred participants, mostly employees of the State Forests. The classes (approx. 270 hours) were conducted mainly by university personnel, including non-forestry related ones as well as representatives from the geomatics industry. At the SGGW in Warsaw as well as the UP in Poznań and the UR in Kraków geomatics is also included in other postgraduate training courses (from several to a dozen hours).

Tab. 6. Theses (engineering and master's) thematically related to geomatic subjects written at the Faculty of Forestry, Warsaw University of Life Sciences (March 2015), symbols as in tab. 4.

years	GEO	PHOTO	RS	CART	GIS	GNSS	ALS	TLS	others	total
until 1961	20									20
1961-1965	9	1								10
1965-1970	7	2								9
1971-1975	10									10
1976-1980	11	6	3							20
1981-1985	11	1	3							15
1986-1990	8	2	6	1	1					18
1991-1995	10	6	6	4	15					41
1996-2000	3	7	14	1	19	5			6	55
2001-2005	4	9	11	8	60	10			1	103
2006-2010	5	5	5	7	39	4	1	1	9	76
2011-2015	9		5	5	10	2	8		7	46
total	107	39	53	26	144	21	9	1	23	423

Source: Own calculations

Doctoral studies, both full- and part-time, that are aimed at writing doctoral dissertations in geomatics, are attended by few people. Some people prepare their theses outside of the university system. In recent years, every year approx. 2 to 5 people have defended their dissertations at the Faculty of Forestry at the SGGW.

In Kraków, geomatics education started in 1995/1996, while in Poznań – in 1997/1998 (Okła 2010). At the Faculty of Forestry, the University of Agriculture in Krakow, students become familiar with geoinformation technologies in the course of full-time and part-time studies of both levels as a part of "Introduction to geomatics in forestry" and "Geomatics in forestry" courses. As a part of optional subjects, the University offers: "Geomatics – map creation and presentation", "Using geodata in master's theses", "Mapping using GNSS technology", "Aerial and satellite remote sensing" and "Aerial and terrestrial laser scanning". For several years, the following training courses have also been offered: Introduction to Geomatics, Global Navigation Satellite Systems, Digital Photogrammetry, Remote Sensing for CEEPUS and ERASMUS students.

At the Poznań University of Life Sciences, classes in individual modules are offered in the basic and extended variant (Tab. 1). Due to the ongoing changes to curriculums, there have been significant shifts in the number of hours of geomatics training in recent years. They include "Photogrammetry and remote sensing" and "GIS", previously (until 2013/14) offered to the first year students, that have been combined into one subject, "Geomatics", and the number of hours devoted to lectures (extended version) was reduced from 40 to 16 hours. "Geomatics", previously taught to the second year student, became to be offered to the first year students and replaced by "GIS in environmental protection".

The SGGW in Warsaw includes classes in Polish in the course of both full-time and part-time studies at both levels of education (Tab. 2). For several years, full-time studies in English have also been offered in the field of the Forest Information Technology (FIT), being a joint undertaking of the Forestry Faculty at the SGGW and the Hochschule für Nachhaltige Entwicklung in Eberswalde, Germany. Students from different countries and continents begin studies in Eberswalde, continue in Warsaw, and can choose where to continue their third and fourth semesters. The emphasis is put on the issues of processing various forestry data using computer methods and tools.

Geomatic education of foresters is also supported by the cyclical conference "Geomatics in State Forests", formerly "GIS in State Forests". It is organised by the General Directorate of State Forests and the Department of Forest Management Planning, Geomatics and Forest Economics at the Warsaw University of Life Sciences in Warsaw. Every 2 years, participants from the State Forests, geomatic companies as well as universities and research institutes gather at the Center for Nature and Forestry Education in Rogów. One of the discussion panels is usually devoted to the GIS academic teaching and training. In this regard, the conference serves the purpose similar to the German GIS-Ausbildungstagung (Bill 2013, 2014) conferences organised since 1993, at which various experts in various areas of economy, education and science discuss the GIS education at various levels, from early primary schools to universities.

Unfortunately, we have been noticing some unfortunate phenomena that might hamper geomatics education. Students, the educational system and the personnel are all to blame. Students have considerable difficulty in operating software in English. It would seem that the right solution would be to use language packs, which has been welcomed by the students. However, we think that learning some topics in Polish affect the future opportunities as the GIS technologies are tightly connected to the English language. There is also a lack of the GIS classes with fieldwork, especially as far as measurement data acquisition and processing are concerned, as well as verification of obtained data in real life. The GIS knowledge should be reinforced through students' own work and assigned tasks, which is only possible during classes. As it turns out, homework does not have the desired effect as students fail to install the software that they have been provided with, while teachers have to struggle with plagiarism more and more often. Public workshops with such software are of little use. Each year, we have to simplify the GIS classes due to the plunging levels of knowledge and preparation of high school graduates. It is difficult to attract interest from a young person to the technology of a digital forest map and related vast advantages to economy, when numerous similar solutions are already implemented in a steadily growing field of smartphones. The quality of geomatics education is also impacted by the system of staff evaluation at the university. There will be no academic teachers really involved in teaching if the periodic evaluation fails to include their contribution to preparing new subjects, contents, materials, class description, textbooks, as well as the number of classes. These are time-consuming tasks that require not only being up-to-date with the latest solutions, but also huge amounts of technical work related to the preparation and testing of new curriculums.

Technological development which results in new things constantly emerging in the field of data processing is one of the external factors. Those trends also have to be reflected in forestry education. Carpenter and Snell (2013) predict that the next decade will bring a revolution in the field of the GIS – spatial data will be more and more accurate and collected at a lower cost, the importance of the GNSS will grow, and data will be used in a cloud. Users will be interested in 3D or 4D data available in real time (e.g. observation of dynamic phenomena using satellite systems with stereoscopic coverage and direct distribution to end users). Traditional photogrammetry will also significantly change, with IT specialists involved with computer vision having more and more to say (Przywara 2012). The boundary between photogrammetry, remote sensing and the GIS is blurring, with 3D modelling becoming an important field of geodata usage. The data will be obtained using laser scanning or unmanned aerial vehicles (UAV). Network technologies (web, cloud) currently have a large impact on the production, placement, distribution, and approval of cartographic products and data (ICA 2013). However, quantity is not always quality. We can say that the world, fortunately mainly the virtual one, is overloaded with not necessarily good maps. It seems that attracting the user is more important than constructing a useful and relevant product. Yet in 2013, almost 1 million pages used the functionality of Google Maps (Field and Cartwright 2013). Education in the field of spatial information sciences is helped by distance learning tools (e-learning), so-called open source software, but also by open standards and publicly available data (open data), creating a new quality of teaching. It is possible, that students will more and more often seek geomatics knowledge in the Internet-based education platforms that will emerge in projects similar to ELOGeo (Mitasova and Schweik 2013), which was aimed at creating a framework for transferring knowledge and conducting practical classes, exchanging and preparing teaching methodologies, tools, curriculums and materials.

Geomatics in foresters' professional work

We can get some idea of the importance of geomatics in foresters' work by looking at the results of research as a part of "Determining the university curriculum requirements that include the needs of forestry management in the 21st century", completed by the IUFRO Task Force – Education in Forest Sciences (Paschalis at al. 2014a). This research was related to the curriculums and their methods of execution, and was meant to determine the current and future trends in their development. In a study by Gruchała et al. (2014a), we will find that as far as professional knowledge is concerned, the State Forests' employees have indicated biggest gaps in their knowledge of silviculture, SILP (close to geomatics) and forest protection, such as 53.0%, 49.0% and 40.7%, respectively (answer "5" – I need it the most). In this context, the GIS and geomatics are not that bad (Tab. 7). The result may be interpreted in two ways: no deficiencies were indicated, as the respondents thought they were sufficiently educated or, more probably, they had no need to use geomatic knowledge and skills. The survey was conducted mainly among field employees.

Tab. 7. Deficiencies in geomatic and related expert knowledge according to State Forests employees – a selection (Gruchała et al. 2014a)

Scope of knowledge	I do not have any deficiencies [%]	Percentage of indications in the various levels of assessment [%]				
		1 – I need it at least	2	3	4	5 – I need it the most
SILP	5.7	2.8	5.7	15.3	27.2	49.0
GIS	7.9	10.0	12.4	21.8	25.7	30.1
geomatics	9.0	15.3	15.4	24.1	22.5	22.7

Source: Own calculations

Employees of the State Forests were also asked, in which areas of knowledge personal skills should be improved in order to increase their efficiency at work. Respondents indicated primarily (the answer 5 – I need it most) dedicated computer systems (36.9%) and silviculture (29%), while the GIS and geomatics scored 28.4% and 23.4%, respectively (Tab. 8).

Tab. 8. GIS and geomatics as areas of knowledge crucial to improving the efficiency of work, in which skills should be improved according to surveyed employees of State Forests (Gruchała et al 2014a)

Scope of knowledge	Percentage of indications in the various levels of assessment [%]				
	1 – I need it at least	2	3	4	5 – I need it the most
GIS	14.8	13.5	20.4	22.9	28.4
geomatics	19.7	15.2	20.7	21.1	23.3

Source: Own calculations

The answers to questions concerning the most and least useful knowledge learned at the university, including expert knowledge are also interesting (there were 43 areas to choose from). Respondents reluctantly indicated useless knowledge, arguing that "all knowledge a person gains influences development and we are not able to predict all circumstances that we can face in our profession." The forest surveying, geomatics and SILP were found to be more useful by a relatively large number of respondents – 47, 72 and 49 indications, respectively (out of 4275), overtaking the history of forestry (1), hydrology (1), non-commercial use of the forest (2), global forestry (3), phytosociology (4), environmental protection (6), meteorology (9), social communication and public relations (10), ergonomics (11), plant physiology (12), forest transport (15), construction (19), forest productivity (20), theory of machines (24), soil science (25), partition law (31), accounting (38), timber science (40), zoology (40), field survey (41). There were also 20 "I don't know" answers.

In every modern economic organisation there is a need for continuing education. The State Forests' employees were asked (Gruchała et al 2014b) whether and how their knowledge should be improved. Four possibilities were given and more than one could be selected. Most people pointed to courses and training (866), slightly fewer of them – to postgraduate studies (589), followed by university studies (136), and other (147) forms. Among the 48 areas of expertise geomatics, the GIS and forest digital map (in total) were listed relatively frequently, e.g. in the case of training courses and training sessions only computer science was more often indicated.

Summary

Issues related to forest measurement, data processing, visualisation and sharing have been included in forestry studies since the beginning of advanced education, of course as much as the then times permitted. From simple measurements, through forest surveying and photogrammetry, we have reached modern methods of processing remote sensing imagery, GNSS satellite positioning systems, GIS, ALS and TLS. All those technologies "in real time" enter our curriculums and, as a result, the professional practice of foresters. A dedicated group of experts, academic teachers, supported by the State Forests, takes care of it.

We are aware that we can and should change a lot in geomatics education. On the one hand, the development is forced by rapid technological changes, while on the other, we should remember about the circumstances we work in: insufficient preparation of our students to tackle geomatics, unsatisfactory number of teaching hours in our modules, decreasing interest from our students, lack of factors that would motivate the staff to really commit to teaching.

It should also pay attention to the consequences of the NQF (Korpetta and Olenderek 2014):

- new terminology is emerging (for describing curriculums).
- formalisation and precision in describing curriculums,
- various levels of detailing of the learning outcomes (adopted by individual universities),
- a good way to increase bureaucracy in advanced education,
- university decides whether or not to teach geomatics (it used to be mandatory),
- we continue to teach geomatics… exclusively in specialisations.

The GIS is or soon will be present in all fields of study related to the processing of spatial data (Bill 2013). Therefore we need to put a lot of effort to make the students aware of the fact that the ability to use digital maps is now a necessity, both when they start working for the State Forests and somewhere else, in sectors related to all kinds of spatial data analyses.

It is necessary to gradually transform classes dedicated to map editing towards utilitarian use of digital maps in forestry practice, taking into account realistic tasks performed in the State Forests. Our curriculums should include the use of spatial data services, field usage of digital maps in mobile devices in order to gain knowledge concerning the forest and, more widely, nature. We should also remember that geomatic data, including the GIS, not only educate students to the extent of software related to digital maps but is a perfect way to reinforce knowledge of computer technologies as a whole.

Challenges for future educators will include the already visible changes to geomatics technologies, the development of the Internet, mobile applications, universal access to various spatial data and software. Users are becoming creators of spatial information. Just as digital cameras have enabled almost everyone to take pictures and video, and the Internet has allowed for publishing and distributing one’s own writing, we will soon be creating and sharing spatial information en masse, which will be vastly supported by software and cloud computing.

To conclude, a slightly humorous take on geomatics in forestry – a short poem written by Łukasz Kwaśny in 2015:

A forester meets... – geomatics.
What is this strange technique?
Earth in the front, ticking in the back,
it even touches space technologies.
Surveying and remote sensing,
with DEM this is a party!
GPS in hand, tablet on your arm,
and the whole forest is in your GIS.
And when the forest is burning...
When stumps get bugs...
Do not take chances, send a drone.
Let it take pictures for you.
There are countless possibilities.
Use them, forester!

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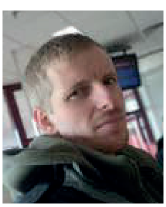

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Elżbieta Bielecka

BLENDED LEARNING AS AN ALTERNATIVE TO TRADITIONAL GIS TRAINING IN HIGHER EDUCATION

NAUCZANIE ZINTEGROWANE JAKO ALTERNATYWA DLA TRADYCYJNEGO NAUCZANIA GEOINFORMACJI NA STUDIACH WYŻSZYCH

Distance Learning

Distance learning (or d-learning) has been practised for over three hundred years. Initially, teaching materials were sent by post, and this method of education was called correspondence learning. Americans are precursors of the distance learning as the first correspondence course was created by them in 1700. In Poland the distance learning began in 1776 at the Jagiellonian University, with the occupational course for craftsmen. Three years later in Warsaw a distance learning course for physicists, modelled after the Cracow school, was launched (Karauda, 2001). A characteristic feature of the distance learning is the indirect and continuous stimulation and guidance of the students' work through various media that allow to

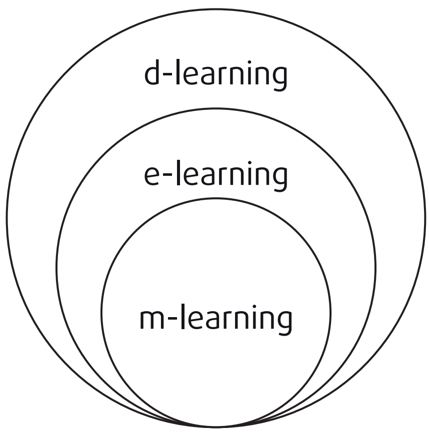

Fig. 1. The relationships between different forms of distance learning

minimise the distance. Universal access to telecommunication technologies, especially the high-speed and contextual Internet, caused the rapid development of the distance learning. Some variations of the d-learning include e-learning (electronic learning) which involves teaching through computer networks and the Internet and m-learning (mobile learning) that means learning that requires the mobile Internet access (fig.1).

Both e-learning and m-learning have a number of drawbacks, hence the search for new, cheaper and more effective teaching methods. Such methods include blended learning (or b-learning), also called hybrid, integrated or complementary learning. The blended learning combines traditional learning methods based on direct contact with the teacher with activities performed remotely using a computer. Graham et al. (2004) emphasise three characteristics of the blended learning, that involve the combination of:

1. Traditional forms of teaching (requiring direct participation of the teacher, known as the face-to-face learning) with on-line activities, primarily sing the Internet;
2. A variety of media and tools used in various learning environments;
3. Various teaching methods and approaches, regardless of the technology used.

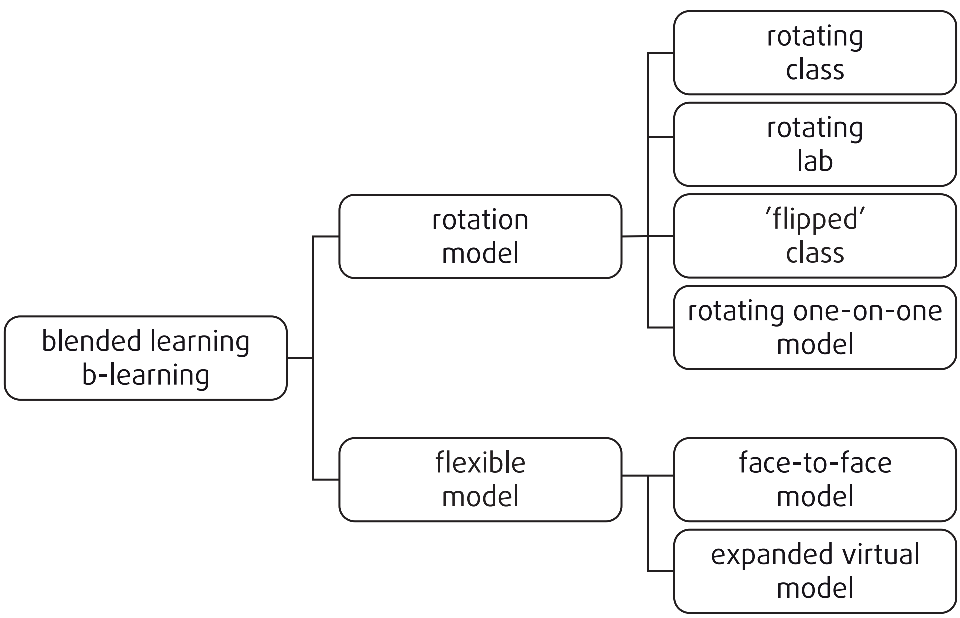

Fig. 2. Blended learning models

According to the website of the Polish Agency for Enterprise Development, the b-learning is very effective as it allows for flexible course building, that takes into account the goals, themes and specifics of the course as well as the skills and expectations of the participants (Vademecum…). Some important advantages of the b-learning include the ability to use both conventional and modern teaching methods and an opportunity for teachers and students to work together on-line. Free scheduling that fits the students' time constraints is also a big advantage. Zwirowicz-Rutkowska and Chojka (2015b) have pointed out that in times of pervasive computerisation, the Internet is often used in the distance learning as a "bank" of information resources.

For at least a decade, the b-learning has evolved from a new idea into widespread, practical and rational way of learning. In the US, the blended learning is gradually becoming the primary method used in advanced education. Amarowicz (2011) reports that in 2010 approx. 93% of American teachers used this form of education. This is because the blended learning allows for a much greater degree of personalisation of teaching, adjustment of curriculums and pace to the individual abilities of students, thus increasing students' motivation and engagement as well as their self-confidence. Research on complementary teaching shows that the b-learning not only saves time and is convenient for students but also ensures excellent academic performance supported by an increased number of course enrolments (Staker and Horn, 2012; Rouen, 2011; Korkmaz and Korkmaz, 2009).

The purpose of this chapter is to present the principles, models and tools for the blended learning, with particular emphasis on advanced education. In particular, the study shows legal aspects that for various reasons prefer this learning method.

Models of Blended Learning (b-learning)

The blended learning models most often fall into the category of rotation or flexible models, also referred to in Polish literature as interspersed models. In the rotation model, a student attends the courses (classes) conducted in the traditional manner, i.e. with the direct participation of the teacher, according to a schedule as well as courses taught in the distance learning mode. The proportions between the face-to-face and the remote modules are not preordained, and the e-learning may include lectures, exercises, laboratories, seminars, and consultations. The rotation model may be further broken down into:

Table 1. General characteristics of learning management systems (LMS). Based on: The Top 8 Free/Open Source LMSs, Published November 20th, 2013, to JP Medved; Summary of LMS and e-learning platforms www.e-learningtrends.pl

No	Name	LMS type	Mobile version	Advantages	Disadvantages	Users
1.	Moodle	Open source	yes	The most popular distance learning platform; numerous plugins to expand functionality; predefined courses; PayPal payments.	Unintuitive student interface. Difficult management of student groups.	Universities, schools, commercial companies
2.	Blackboard	The free version of commercial software	yes	The ability to login via Facebook and Gmail.	Lack of technical support, unintuitive interface. No full LMS platform functionality. User-created courses limited to 5.	Universities, public administration
3.	Sakai	Open source	yes	It integrates documents in Google Docs and Dropbox, includes Wiki-like tools.	Java-based, making functionality expansions more costly.	Universities, community
4.	Latitude Learning	Freemium	no	Available in 9 languages.	Costly expansions.	Large commercial companies

No	Name	LMS type	Mobile version	Advantages	Disadvantages	Users
5.	Dokeos	Open source	yes	Predefined quiz forms.	Difficult to adapt to specific needs. Difficult Powerpoint and OpenOffice file uploading.	Universities, schools
6.	eFront	Open source, paid version available	yes	Good technical support	Incomplete functionality, lack of integration with social media.	Universities, schools
7.	Schoology	Freemium	yes	Modern tools, works in the cloud	Incomplete functionality.	Universities, schools
8.	ILIASy	Open source	yes	High data security. A large group of active users (own conferences)	Mobile version requires the installation of plug-ins. 13 years old, with all its consequences.	Universities, schools, public administration, NATO in Europe
9.	n-educatio	Commercial	yes	Social learning module available.	No virtual classroom module nor station course management.	Universities, schools, companies, individuals
10.	CyfrowaSzkoła.pl	Commercial	yes	Social learning module available. The ability to review teaching materials. Partner settlement module.	Requires plugins, lack of blog and forums functionalities.	Universities, schools

1. The station rotation, in which students cycle through traditional lectures or seminars and e-learning activities; all conducted within the same classroom and in the presence of a teacher;
2. The lab rotation model differs from the station rotation model as the e-learning classes may take places at different locations at school;
3. The "flipped" classroom model, in which face-to-face classes are conducted at school, according to a given schedule, while e-learning classes are taken at home, after school;
4. The individual rotation model, in which the schedule may be adjusted to the needs and abilities of a student.

The flexible model usually takes the form of an individual or extended virtual model. In the individual model, a student selects an e-learning course in order to supplement a traditionally taught course. In relation to the GIS learning, these may be ESRI or SoftStat webinars or the Internet courses in sharing data over the Internet, database design, etc. The extended individual model is characterised by a predominance of e-learning courses whereas the face-to-face learning is only used to explain and expand the hardest parts of the curriculum and is often conducted as one-on-one consultation. Types of the blended learning models are presented in fig. 2.

Effective e-learning requires appropriate tools for both preparation of remote courses and management. Systems for preparation courses are called the LMCS (Learning Content Management System) and the ones for learning management – the LMS (Learning Management System). An LMS platform allows for embedding complete courses, managing students (enrolment, progress reporting, assessment, analysis of competences) as well as managing entire e-learning courses (access to training plans, access to and distribution of teaching materials). The offer of the LMS platforms is extensive and includes both commercial and open-source systems, so the choice of a solution can be hard. Several publications are available that might facilitate the decision on which LMS to choose (Szwarbach, 2012; Medved, 2013; Ramasubbu, 2015), and a lot of advice may be found in blogs and forums. First of all, the author emphasises the simplicity and ease of use, functionality, reusability of contents (of various courses), the ability to serve multiple students at once, the cost of purchase and maintenance. The basic functionality of the LMS includes the following modules:

1. Survey – tests, quizzes, surveys;
2. Chat – a tool for synchronous communication;
3. Forum – a tool for asynchronous communication;
4. Blackboard – any content designed in a LAMS editor;

5. Notebook – a student's notes;
6. Shared resources – any file (such as a spreadsheet), a link to a website or prepared and zipped website;
7. Question-answer – asking students questions;
8. Multiple choice – multiple choice questions with assigned weights;
9. "Send file" – submitting completed tasks (e.g.: text documents, presentations, spreadsheets) to the teacher.

A summary of the most popular LMS systems used in advanced education is presented in the Table 1. They include open source systems (5), proprietary systems (2) and the so-called freemium systems (2), that allow free access to a specific number of users, and one system that is a free version of proprietary software. Most of them have a mobile version, which means that they may be used smartphones or tablets. The most popular LMS platform is the Moodle (available free under the GPL licence) which is also the most widely used in Poland.

Conditions of B-learning at Universities in Poland

Formal and legal conditions In Poland, the rules for university education are governed by the law on advanced education (Journal of Laws from 2012, item 572, as amended), Article 164, Par. 3 states that "university classes may also be conducted using distance methods and techniques". The proportions between the activities carried out with the direct participation of teachers and using e-learning are defined in the Regulation of the Ministry of Science and Higher Education of 2 November 2011 amending the previous regulation on the conditions that must be met for university classes to be carried out using distance education methods and techniques (Journal of Laws from 2011 no 246, item 1470). Article 5, Paragraph 1 of the regulation provides that "the number of hours of classes during full-time and part-time studies carried out using the methods and techniques of distance education cannot be greater than 60% of the total number of hours of classes specified in curriculums for given majors and levels of education". On the other hand, Paragraph 2 of that Article adds: "Education in the acquisition of practical skills, including laboratory classes, ATVs and workshop should take place in real life, in the classroom teaching requires direct participation of teachers and students. Methods and techniques of distance learning, including virtual laboratories may only be used as support in this regard." These provisions are the most important formal and legal conditions of introduction of the blended learning, based on 40% of synchronous work with the direct participation of teachers and 60% of remote teaching using the Internet or e-learning. Additional conditions are imposed by resolutions enforced by university authorities, course regulations, education effects and curriculums that specify in detail the method and conditions for the conduct and assessment of individual subjects. When analysing the provisions of the regulation and the rules set out by university authorities, we may conclude that the only possible teaching method that includes the distance learning during full-time and part-time studies is the blended learning, with no more than 60% of lectures, recap seminars, homework assignments and supplementary education conducted through the e-learning.

The b-learning assumes that a teacher's and student's participation has to be an organised process, and so it differs from the self-learning. As Bronk et al. (2006) noted, the distance component of the blended learning does not only include e-mailing of teaching materials but also incidental use of technical means of communication (such as e-mail, etc.) for the teacher-student contact. It also has to be institutional. Thus, one of the conditions for its introduction in advanced education is the reorganisation of the curriculums and, in particular, the establishment of mechanisms for approval of activities carried out in the distance learning mode, including the settlement of teachers' workload in the new system, etc.

The above mentioned factors make the development of the university-level e-learning in Poland effectively inhibited by legal and formal factors, which was emphasised, among others, in the opinion issued by the Association of Academic E-learning submitted to the Ministry of Administration and Digitisation in 2013 (SE@, 2013).

Methodological conditions The blended learning requires a change in teaching theoretical knowledge, including different preparation of teaching materials for subjects taught using e-learning methods. The main task of the teacher is not only to provide and require knowledge but also, maybe most importantly, to motivate the student to learn and maintain interest in the subject.

Uploading extensive collections of materials as PDF files to the platform is not a satisfactory solution. Studying such materials is tedious and reduces students' interest in the subject. Efforts should be made to activate the student through interactive forms of communication, quizzes, simulation and strategy games. Information should by hierarchical and structured. Earlier information should be repeated and retained before progress is made to further parts of material. However, instead of a set of questions relating directly to the information, problem questions, that indirectly check the degree of material memorisation, should be used. As noted by Bronk et al. (2006), a teacher's intuition and experience are not sufficient in the b-learning. The ability to use modern means of ICT communication as well as finding new ways of preparing teaching materials is crucial.

It is also worth noting that there is a large variability regarding the scope of educational content that may be conveyed through the b-learning. Alammary et al. (2014) observed that many teachers in distance modality publish the same contents that they convey in lectures, while only a part of them prepare brand new courses tailor-made for the blended learning methods.

Students' attitude is also an important issue, especially in Poland. The blended learning assumes that the students are responsible, fair, and perform all e-learning assignments by themselves. The experience of every teacher shows us a different picture: the one, in which many students struggle with independence, promptness, proper scheduling. There are also examples of dishonesty. A solution, at least at the preliminary stage of introducing the blended learning, is to use traditional face-to-face methods in passing certain modules.

Technological conditions The blended learning requires the department and the university to invest in technical and IT infrastructure. Efficient execution of a course requires not only learning management systems (LMS) and learning content management systems (LCMS) but also the high-speed Internet connections and licences for specialised applications for both students and teachers. Electronic access to a library that would provide at least part of its resources in digital form is also necessary.

Research carried out by the Polish Open University in 2012 shows that almost three quarters of Polish students felt that state-run universities were not prepared to provide the top quality e-learning education. At the same time, almost a half of the respondents would choose this form education. The majority also predicted that in the future, the e-learning would replace traditional education. A sales manager of the e-learning solutions at Asseco Business Solutions S.A. noted that schools traditionally provided practical knowledge using the b-learning, while e-learning was used to repeat, retain and check that knowledge. He also stated that "we had gone one step backwards, retreating from total enthusiasm for the distance learning methods but, at the same time, we had made two steps forward by taking what was best and most effective in the combination of several learning modalities"[1].

E-learning and B-learning in Teaching GIS in Advanced Education in Poland

The GIS education at the majority of Polish universities is carried out traditionally, in the form of lectures and tutorials/labs although, at least in the last decade or so, we have been seeing a growing interest in the distance learning. Two leading universities, the Jagiellonian University and Warsaw University, can boast the greatest experience in this regard. The postgraduate UNIGIS studies have been conducted by the Department of Geographical Information Systems IGiGP at the JU in the e-learning form since 2004[2]. The Department of Geography and Regional Studies of the Warsaw University has been conducting classes in the blended learning form since 2005 (Kozak et al., 2009). Remote courses in the field of geoinformation have been available at the UMCS since 2014. This is a postgraduate course for teachers, financed by the European Union under the European Social Fund. Also is teaching the GIS in technical faculties more and more dependent on modern teaching methods. The Warsaw University of Technology has been working to create a remote education platform since the early years of this century (Gawas et al., 2002) but the first remote course in geoinformation, also co-financed by the European Social Fund, was launched by the Department of Geodesy and Cartography (Białousz et al., 2009). For several years, the e-learning GIS courses, land information systems, databases and geomatics have been available at the Higher School of Technology and Economics in Jarosław. The Faculty of Geoengineering, Mining and Geology at the Wrocław University of Technology offers a facultative course in "Maps in mining" (Głowacki, 2010). For several years, the Wrocław University of Technology has been offering an e-learning GIS basics course (Blachowski, Woźniak, 2007). In 2014/2015 the b-learning Spatial Information Infrastructure classes were also launched at the Department of Geodesy, Spatial Engineering and Construction at the University of Warmia and Mazury in Olsztyn.

1 http://www.pifs.org.pl/UserFiles/BlendedLearning2%282%29.pdf
2 http://krakow.unigis.net/UIA/UNIGIS-Krakow

Planned B-learning Classes in SIP Design Methodology at the Department of Civil Engineering and Geodesy at the Military University of Technology

So far the Military University of Technology has not offered any courses in the distance learning mode to students, and thus that University has no experience in this respect. The introduction of the distance learning will therefore require changes to the regulations and the creation of the e-learning infrastructure for the university. The university authorities will support the project of modernisation of teaching methods, provided that the related interest is shown by teachers and students. Such interest seems to be shown by the Department of Civil Engineering and Geodesy. A survey conducted among freshmen of Master's studies (56 people) shows that a half of them prefer remote learning at home, during their leisure time, most often in the evening or in the morning. GIS teachers are willing to prepare teaching aids and the e-learning module using open-source tools. One of the subjects chosen for a pilot implementation of the b-learning is the SIP Design Methodology (MpS).

The MpS is the specialist subject taught for 60 hours (30 hours of lectures, including 10 hours in English, and 30 hours of project work) and 5 ECTS credits. 5 ECTS credits mean that in order to pass the subject the student has to work/learn for 150 hours, so the student has to submit unattended work that is assessed to be the equivalent to 90-hours. The course covers selected issues of the GIS/spatial system design with particular emphasis on the theoretical basis and practical skills in the development of a conceptual, logical and physical models, as well as the knowledge of language and notation used to store application schema. The unattended work hours include: preparation for the project, documentation of consecutive stages of the project and final documentation, preparation for the discussion and subject credit. All classes are carried out with direct participation of the teacher, the lecture presents the theoretical bases and examples of existing solutions, and the project has the students (in groups of 4) design a spatial information system for a chosen topic, progressing from the user's needs analysis through conceptual and logical models to test implementation.

According to the Regulation governing the conditions of the introduction of the distance learning (Journal of Laws 2011 no 246, item 1470), only a part of the lectures (exactly 60%) may be delivered through the e-learning, which amounts to 18 hours in the case of the MpS. Recaps and modules that support the project may also be organised at the university and in the presence of the teacher, according to the curriculum. It has been decided that the course will start traditionally, at the university, with the direct teacher participation. After 10 hours of lectures, the students will study a chosen issue in the e-learning mode. Consultations and recap classes will also be delivered via the distance learning. Another session of 10 hours of lectures, the project and final credit will be delivered traditionally (fig. 3).

The following aspects will be taught through the e-learning:

1. Methodology of designing information systems – an introduction.
2. Introduction to the UML.
3. UML – class diagrams, packages. Examples of the surveying and cartographic law, and/or the INSPIRE data specifications.
4. Conceptual and application framework, applicable standards. The integration of conceptual frameworks.
5. XML and GML – introduction.
6. Spatial information system and spatial information infrastructure.

The reason for choosing this topic was the availability of numerous online courses that may be treated as good practice at least at the initial phase of creation of the e-learning module. There are plans to include willing students and PhD students in the preparation of this course. Their main task would be to assess the proposed solutions and the difficulty of the contents. Basic materials made available as interactive "lessons" in Polish will be expanded using articles and various materials in Polish and English. Modules supporting the implementation of the project as well as recap classes will be implemented at the second stage, in the subsequent year. Depending on the interest of students in the b-learning, there are plans for the e-learning SIP application and topographic database classes.

Conclusions

1. The blended-learning uses both synchronous teaching (where knowledge is transmitted and received at the same time) and asynchronous teaching (various times of knowledge transfer and receipt). The idea behind this method of education is to combine lectures, project, seminars, exercises, laboratories, consultations, tests, etc., when some of them are implemented in the distance learning mode.

2. The GIS teaching based on advanced techniques of data and information transfer is perfectly suited to distance learning. This is evidenced by numerous implementations of the e-learning courses in this field at var-

ious universities and technical universities. Many studies show that the interest in this form of education is also growing among Polish students. We should hope that the changing law that governs university-level education will make the distance classes and laboratories possible.

3. The Military University of Technology does not currently offer the distance learning courses. There are ongoing pilot programmes on such classes, and their success will determine the method and pace of introduction of the e-learning at the WAT to some extent.

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THE PROJECT METHOD IN EDUCATION OF GEOINFORMATION SPECIALISTS

METODA PROJEKTU W NAUCZANIU SPECJALISTÓW W GEOINFORMACJI

Introduction

One of the main tasks of any university is to provide students with comprehensive and interdisciplinary education at a general academic level. At the same time, the university should create conditions for students to be able to use their knowledge in wider practical context.

Interdisciplinarity and implementing practical applications are of particular importance in the process of training specialists in the field of geoinformation. Studies in this major are designed to allow for acquisition of expertise in such fields as the theoretical basis of Geographic Information Systems, and develop skills to create and manage such systems, perform spatial analyses and administer spatial data. Moreover, the students' personal skills are developed, allowing them to independently and reliably perform their cognitive and practical tasks, work in a team, communicate effectively or become aware of the need to constantly improve their knowledge. This task requires implementation of a number of subjects as well as the use of appropriate educational strategies (Cichoń, Piotrowska 2012; Jażdżewska, Cybula 2012).

One of them is the project method, in which students have to exhibit high degree of independence in performing their tasks. On the other hand, the academic teacher is tasked primarily with creating appropriate working conditions, motivating the students and participating in the cognitive process.

The aim of the study is to present the possibilities of using the project method in educating geoinformation specialists, as illustrated by the project "Geographic Information Systems in Tourism" in the course of geoinformation training within the framework of the Bachelor's degree studies at the University of Łódź.

Project Method

The project method was developed in the 19th century in the United States by pedagogist John Dewey and has been used at various levels of education until today. Out of the numerous available definitions of the method (J. Dewey, W.H. Kilpartick, C.R. Richards, W.W. Charters, J.A. Stevenson, J. Fowler and R.Walker, M.S. Szymański), we may choose one main feature, namely independent learning by performing practical activities in order to achieve a previously set goal (working on a topic). Depending on the variant used, the goal may be specified by the teacher or a project team, which is described as preferred in literature as it gives more independence to the project team but also makes the execution much more dependent on the creative potential of its members. But the most important feature is linking the specified goal with the surrounding. We should point out the interdisciplinary nature of any endeavours, that allows for capturing the relationships between various scientific disciplines as well as for their practical applicability (Suchodolski 1963; Szymański 1999; Szymański 2000; Zając 2015).

The implementation of the project method may be divided into three phases. The preparation phase primarily involves the determination of the subject matter to be worked on, an introduction to the subject but also: selecting groups, gathering preliminary information, scheduling the project execution and developing evaluation criteria. If the students encounter this method for the first time, they should be additionally primed for this way of working. The project execution phase mainly involves independent work and students taking actions toward reaching the goal but also regular consultations to support students activities. In this phase, results are prepared and presented to the group. The last phase, i.e. evaluation, includes evaluation of the project by the teacher but also self-evaluation by the students as well as social evaluation, i.e. evaluation of each student by the rest of the group. This assessment should serve as feedback for the project participants regarding their strengths and weaknesses, and allow them to use it in the future (Szymański 2000; Zając 2015).

This method, despite being based on students' independent work, does not diminish the role of academic teachers as it only changes their role from an expert in a given field into a person providing the students with the best possible work conditions. It is important that the teachers do not impose their points of view nor suggest solutions but just discreetly control and support the actions of their group (Szymański 2000; Zając 2015).

We must reiterate that the process of evaluation is different from standard classes. In this case, it is not conducted by the teacher either but it is left to the participants of the project and is a part of it. Evaluation may be based on criteria specified at the beginning. It covers not only the effects but mainly the activities that have lead to them. It may also be carried out during the project, e.g. to correct certain actions undertaken by the project group members (Szymański 2000; Zając 2015).

Practical Exemplification of the Project Method

One example of this method used in the process of education of geoinformation specialists may be the training session conducted within the framework of the "Geographic Information Systems in Tourism" as a part of the Bachelor's degree studies of geoinformation at the Faculty of Geographic Sciences in co-operation with the Faculty of Mathematics and Computer Science of the University of Łódź. The subject was first introduced in 2014/2015 offering 52 teaching hours (6 ECTS points) to 18 students participating.

The vague name of the subject gives the teacher a wide range of the detailed project topics to choose from. In this case, the topic was chosen by prof. Iwona Jażdżewska, associate professor at the University of Łódź, who proposed the development of a[1] tourist geoportal related to murals present in the urban space of Łódź.

Murals

Murals constitute a form of visual art (street art) derived from graffiti. The name comes from the Spanish word for decorative wall painting. Murals are characteristic since they are present in public space and their artistic and aesthetic values are high. Their aim is to transmit the view of the creator and shape the surrounding, which distinguishes them from graffiti which is only meant to mark the author's presence. In Łódź, the first murals were created back during the Communist times as large-format

1 Geoportal means the Internet website or an equivalent providing access through electronic means to such spatial data services as: searching, browsing, downloading and processing. Spatial data relates directly or indirectly to a specific location or geographic area (EU Directive 2007).

“advertisements” of companies operating at that time. They mostly covered gable walls uncovered after adjacent buildings got demolished. As such, they served a practical purpose of masking unsightly facades. We should, however, remember that have significant artistic value as those are the works of renowned artists that at that time referred to the then current artistic trends. Not all of them have survived, some have disappeared, some – painted over in the 1990s – have been preserved under a layer of paint until deteriorating facades have uncovered them again (Mokras-Grabowska 2014).

Interest in murals grew after 2008, when ms^2 art museum was created to promote modern art, including street art. In 2009 the Urban Forms Foundation was formed, the goal of which has been to promote urban art. Its operations include the creation of the Urban Forms Gallery consisting of large-format artistic painting on the wall of tenement houses and blocks of flats in Łódź. Currently it consists of more than 30 wall paintings. The collection constitutes a new tourist space for the city. According to the surveys, the collection is popular among local people who are thus prompted to learn about their city, and it serves the purpose of revitalisation and revival for urban spaces (Matulewski, Święściak, Makohonienko 2015; Mokras-Grabowska 2014).

The accumulation of art forms in the city as well as mapping the routes for seeing them have resulted in an influx of individual tourists and organised groups. This means, that they have become another downtown attraction. At the same time, they have contributed to improvement of the tourist attractiveness of areas that have so far been overlooked by tourists (Mokras-Grabowska 2014).

Preparation phase

Preparation of the project from the educational point of view is the teachers’ responsibility. In this case it heas mean the commitment of the authors of this paper as well as computer science and geodesy specialists.

The main task has involved the inclusion of teaching outcomes[2] assigned to the module, the subject of which is in the curriculum. The outcomes will be achieved during the course based on the students’ present knowledge of geoinformation, programming and the GIS web applications.

2 http://infogeolog.uni.lodz.pl/wp-content/uploads/2013/06/infogeolog-geoinformacja.pdf

Tab. 1. Activities performed by the academic staff and students in the first phase of the project (source: own study, from B. Zając (2015))

Teacher activities	Student activities
Selection of the project topic	
Determination of spatial scope of works	
Preparing students for working with the pro-ject method	Getting to know the project method
Introducing the students to the subject matter of the project	Getting to know the topic of the project
Providing possible sources of information	Evaluation of available sources of information and finding new ones
Motivating for action	Collecting and processing information on the basis of available sources
Determining the overall work schedule (field and lab work)	Analysis of the work schedule
The choice of the number of project groups and people in each team	Division into groups
Presentation of the standard of the final result of the project	Evaluating the feasibility of the project
	Creating a project outline
Approval of the detailed work schedule	Establishing a detailed work schedule, taking into account the general schedule
Establishing evaluation criteria	Establishing evaluation criteria

The aim of the project has been to create a geographic information system related to tourism and linked to the presence of murals in Łódź. It was decided that the project needed to include two parts: I. the part devoted to collection of spatial data in the field of tourism and II. the part, during which the GIS system would be designed to allow for presentation of this information. After determining the subject and scope of field work, preparation works and the initial phase of the project were started. In this phase, project leaders were doing most of the work (Table 1).

Since the class group had never participated in such projects, students had to be prepared for the work using the project method. First of all, they had to be made aware that they were responsible for organising and performing the task as well as for working in a team. Then they were introduced to the subject matter of the project. Issues that were discussed included tourism, tourist traffic, murals as forms of visual art and their relation to the city. Other topics included geoportals, their creation and operational principles as well as spatial information and Java development. Possible sources of information concerning the project were also provided. At this stage, the timeframe (deadlines) and division of work in the project into field and lab work were also introduced. The project started with the field work due to the weather condition that is usually better at the beginning of the winter semester (October – November) as well as the need to collect spatial information concerning the objects – murals that were to be presented in the geoportal created during the lab work. The lab work that mainly included data preparation, design and development, was planned for the second part of the semester (December – January).

The next step involved determining the number of project teams and the number of people in each of them. This parameter was set by the leaders as the students lacked experience in working with this method. It also allowed for even division of the city during the field work, so that no single group ended up overloaded with work.

Six three-person groups were established to have each of them survey one district of the city (Bałuty, Widzew, Górna, Polesie, Centrum). Two teams were assigned to survey the downtown area as the murals were more numerous there. Participants were allowed to choose their teammates, while the leaders just approved their division.

The next step involved the teachers determining the standard project results, namely a basic geoportal containing information about murals found in Łódź.

The project group had some time to familiarise themselves with the subject matter, gather information, and evaluate the feasibility of the project. This allowed students to create a project outline containing, among others, the main goals, activities, and expected time of completion. After that, a work schedule was set, taking into consideration the divisions instituted earlier and the dates for the field and lab work.

The last stage of this phase involved the determination of evaluation criteria. It was agreed that the leaders would evaluate: the quality of collected spatial data (completeness, quantity, precision, aesthetics), promptness of task completion (according to the schedule), proper Java implementation of data entry modules for the geoportal as well as data edition and display, and the end result of the project (presentation of the geoportal by the project team). The project also involved self-evaluation of each team as well as peer-review of each team by the other members of the project.

Execution Phase

In this part of the project, the division into the field and lab work is the most prominent. The role of the teachers changes. They are now providing the group with as much independence as possible, assuming the roles of observers and advisors (tab. 2).

The field work was preceded by a query concerning murals in Łódź conducted by the project teams. Printed sources, such as scientific papers, guidebooks, etc., as well as online sources were taken into account. Based on information gathered in regard to the murals located in assigned areas, each team used the GIS ArcMap 10.2 and data from the Web Map Service (WMS) to plot routes to collect spatial data. Field data was gathered using mobile multimedia devices and applications that measure GPS coordinates. Each project team completed the previously plotted route and documented the murals found along it. The collected information included:

- photographs of murals,
- coordinates (the coordinate system PUWG 1992) of their locations,
- address of the building where the mural is located,
- assessment of the mural condition (good/bad).

Each group entered their data into a table which was specified in the outline and facilitated later merging. In addition, each mural was further described using data from previously found sources, such as the date of creation, authors and a brief note (fig. 1).

The progress of the field work was discussed at weekly meetings (during classes). Each group presented the data they collected, which was then evaluated by the remaining participants.

Most comments were related to the photographic documentation of murals. Other participants often expressed reservations concerning the qual-

Tab. 2. Activities performed by the academic staff and students in the second phase of the project (source: own study, from B. Zając (2015))

Teacher activities	**Student activities**
Consultation meetings with students during classes	Participation in consultation meetings with teachers
Supporting students' activities	Implementation of tasks according to the agreed schedule
Observing students' activities	Gathering information on murals from various sources
Assistance in gathering means needed to collect spatial data, present the project	Planning of the field work
Monitoring the progress of the project	Acquisition of spatial data concerning data in the field: measuring the coordinates of a mural, photo-graphic documentation, assessment of murals' condi-tion
Verification of sources and information regarding murals	Expanding information on murals based on other sources
Observation and support for decisions concerning the selection and evaluation of data quality.	Selection and analysis of collected data in order to assess the related quality (photographic documenta-tion) or possible use in the project (additional de-scriptions of murals)
Preparing the project database	Developing a module for entering data into the pro-ject database
Interventions and assistance only in difficult and crisis situations	Developing a module for entering data into the pro-ject database
Interventions and assistance only in difficult and crisis situations	Entering system data into the project
Providing assistance from outside experts in the field of computer science (programming)	Developing a module allowing for the display of entered data as icons on a map
	Developing a module allowing for the display of de-tailed data concerning each object – the mural
	Developing a module allowing for changing the mu-ral-related data
	Developing a module allowing for the display of col-lective summary of the geoportal data
The organisation of summary classes	Presentation of the project

Fig. 1. Examples of photographs of murals taken by one of the project teams (from the left: the Holy Warrior, ul. 28 Pułku Strzelców Kaniowskich 48, the author: Inti; The Priest and the Devil, ul. Srebrzyńska 2, the author unknown, the Urban Forms Gallery al. Politechniki 16, authors: ETAM CREW)

ity of photographs, that were meant to show the painting in their entirety and in good lighting, according to the project description

The progress of the field work was discussed at weekly meetings (during classes). Each group presented the data they collected, which was then evaluated by the remaining participants.

Most comments were related to the photographic documentation of murals. Other participants often expressed reservations concerning the quality of photographs, that were meant to show the painting in their entirety and in good lighting, according to the project description. Not all images complied with the above requirements and some buildings required repeated photographing. One of the problems encountered by the team was the selection of collected data. There was a dispute concerning the inclusion of murals in very bad condition or completely invisible but present in the source data. This phase resulted in spatial data concerning 149 murals, 61 out of which were created after 2000, including the Urban Forms Gallery, and 21 created before 1999. Their condition was determined as very good and good. The condition of the remaining 67 ones is bad, they are painted over, covered or cannot be found. There is no data on the date of their creation, either.

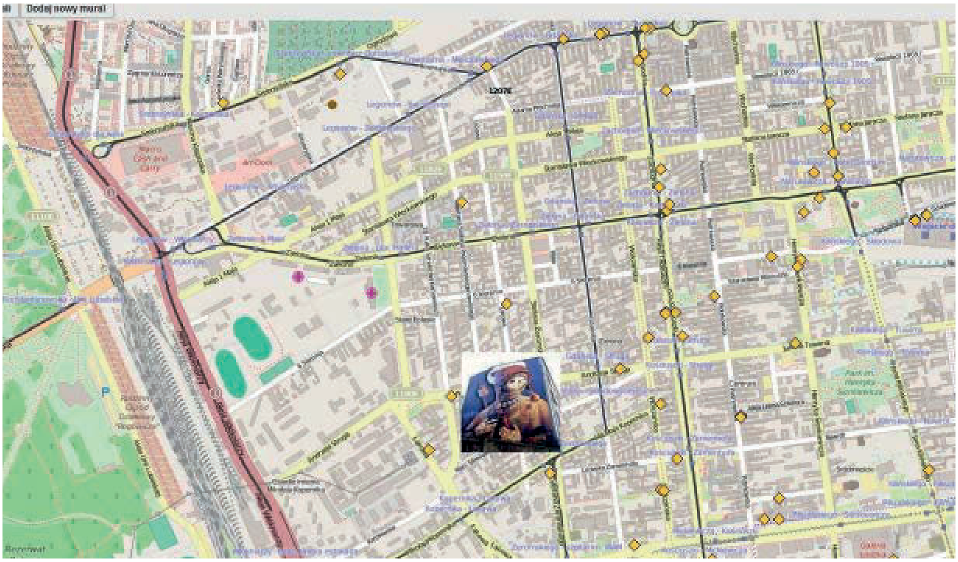

Fig. 2. The main window of the geoportal

Project Implementation Phase

In this phase, students implemented individual modules of the geoportal. The project included the following modules:

Fig. 3. Geoportal pop-up menu

Fig. 4. Geoportal window displaying mural details

- a module for adding data to the geoportal database,
- a module for displaying murals as icons on the OpenStreetMap maps,
- a module for obtaining all data concerning individual murals, including photographs,
- a module for editing the data of individual murals,
- a module for displaying aggregated data on murals.

Java was chosen for the implementation of the geoportal as it allows for quick creation of complex computer systems as well as access to systems for the management of a relational and object databases from multiple providers using the JDBC programming interface. In addition, Java has a built-in exception handling, which allows for uniform handling of user data entry errors as well as when adding and acquiring data from a database. The selection of Java as the programming language used in the project implementation has also allowed for the use of the application programming interface (API) of the OpenStreetMap. It is a set of classes that display various geographic objects on a map as icons. The OpenStreetMap API has structures, in which coordinates are entered for objects, so they are displayed in their real locations.

Tab. 3: Geoportal window showing aggregated data on murals

ID	Nazwa	Adres	Autor	Wykonanie	Rok powstania	Stan	Opis
216	Baloon	Uniwersytecka 3	Mateusz Gapski	Etam Crem	2012	bardzo dobry	kolorowo ubran...
217	Łódzkie Przeds...	ul. Piotrkowska...	J. Oplustil, M. B...	brak danych	1956	budynek rozebr...	Reklama domu...
218	brak danych	ul. Północna 13	brak danych	brak danych	brak danych	zły	Widnieją na ni...
219	brak danych	Jaracza 59	Grzegorz Gonsi...	Grzegorz Gonsi...	2010	dobry	biała postać z k...
221	brak danych	ul. Północna 19	brak danych	brak danych	brak danych	zły	Reklama znisz...
228	Zakłady Włókie...	Piłsudskiego 75	Jerzy Jankowski	brak danych	brak danych	nieistniejący	brak danych
230	Fotograficzna S...	ul. Zachodnia 34	Jerzy Jankowski	Ryszard Macha...	brak danych	budynek rozebr...	Reklama sieci ...
231	Państwowa Ag...	ul. Struga 21	Zdzisław Bek	Antoni Adamkie...	brak danych	zabudowany	Reklama Państ...
233	Kwiaty	Rzgowska_77	brak danych	brak danych	brak danych	zamalowany	Na jego kompo...
235	Biblioteki Śród...	ul. Zachodnia 7...	Jerzy Jankowski	Ryszard Macha...	brak danych	budynek rozebr...	Mural przedsta...
236	„SPOŁEM" - Do...	Tuwima 100	brak danych	brak danych	brak danych	nieistniejący	brak danych
238	Przedsiębiorst...	ul. Kościuszki 2...	Zbigniew Wład...	Ryszard Macha...	brak danych	zamalowany	Reklama nawi...
244	Powszechna S...	ul. Jaracza 33/3...	brak danych	brak danych	lata 70	zamalowany	Reklama Pawil...
248	„POLDROB"	ul. Pomorska 30	Jerzy Jankowski	Ryszard Macha...	brak danych	skuty z tynkiem	Reklama prze...
249	Robotnicza Sp...	ul. Zamenhofa ...	Ryszard Macha...	Ryszard Macha...	brak danych	zamalowany	Reklama Ruchu
252	Przedsiębiorst...	ul. Legionów 7	Zbigniew Łopat...	brak danych	brak danych	zamalowany	Reklama przed...
254	Restauracja Ka...	ul. POW 44	brak danych	brak danych	brak danych	zamalowany	Reklama resta...
258	brak danych	ul. Więckowski...	MORIK	MORIK	2014	bardzo dobry	brak danych
261	brak danych	al. Kościuszki 32	Kenora (Hiszpa...	Kenora (Hiszpa...	2011	bardzo dobry	Abstrakcyjno-g...
281	brak danych	ul. Zachodnia 61	Sepe i Chazme...	Sepe i Chazme...	2011	bardzo dobry	Geometryczne, ...
285	Przedsiębiorst...	Zachodnia 84	Jerzy Jankowski	Ryszard Macha...	brak danych	nieistniejący	Reklama Otexu...
286	Galeria Urban ...	Politechniki 16	Aryz	Aryz	2012	bardzo dobry	Gnijące kwiaty ...
288	Więzień z oboz...	ul. Wojska Pols...	Piotr Saul	Piotr Saul	2012	dobry	Mural z I edycji "...
289	Zakład przemy...	al. Politechniki ...	Jerzy Jankowski	R. Macharowsk...	lata 70	zły	Na murze przyl...
291	brak danych	ul. Zachodnia 52	Gregora (Grzeg...	Gregora (Grzeg...	2009	bardzo dobry	Maszyna do szy...

Zamknij

The main window of the geoportal (fig. 2) shows two buttons "Show mural data" and "Add new mural" that allow, respectively, for viewing aggregated data on murals and adding a new mural. Moreover, the window shows icons for individual murals entered into the system as well as a thumbnail of a mural which is shown in the geoportal window after the mouse is hovered over the icon.

Right-clicking on the thumbnail displays a context menu with the following choices: "Delete" and "Show data" (fig. 3).

Choosing "Delete" removes the mural from the database, while choosing "Show data" displays detailed data for the selected mural (fig. 4).

Clicking "Change data" allows the user to edit data for the selected mural. Clicking "Show mural data" in the main window shows aggregated data on murals (tab. 3).

The implementation phase of the project ended with the presentation of the finished geoportal.

Evaluation Phase

The evaluation phase was conducted as a group discussion following the presentation of the geoportal at the last planned consultation meeting. In accordance with the criteria adopted in the first phase of the project,

Tab. 4. Activities performed by the academic staff and students in the third phase of the project (source: own study, from B. Zając (2015))

Teacher activities	**Student activities**
data quality evaluation	self-evaluation according to criteria
evaluation of timeliness of task completion, according to the schedule	peer-review at team level
evaluation of correct implementation of individual mod-ules	
evaluation of the accuracy of data entered into the sys-tem	
evaluation of the final result	

evaluation applied to the timeliness of the project execution according to schedule, the quality of spatial data, correct implementation of individual geoportal modules, as well as the final product, namely the geoportal and related functioning (tab. 4).

Each participant performed a self-evaluation (on a scale of 2-5), taking into account such criteria as: involvement in the project, timeliness of completing tasks they were entrusted with, creativity, team work skills, the end result. Additionally, the team-level peer review was performed. Each team used a scorecard to evaluate the other groups on a scale of 2 to 5, taking into account such criteria as: involvement in the project, timeliness of completing task they were entrusted with, work effort, creativity, co-operation. It should be emphasised that the peer review of individual teams was also performed at the consultation meeting during the project, e.g. when individual teams presented their data.

Summary

The application of the project method to implement the Geographic Information Systems in tourism had very good effects. First and foremost, the main goal, namely the geoportal for murals in Łódź, was achieved. The project allowed students to expand their knowledge, acquire and improve the skills useful in the labour market, such as communication, team work, using information, problem solving or decision making.

One great advantage of such classes is their interdisciplinarity which is key in the process of educating geoinformation specialists. Moreover, its practicable nature pushes the students to use their knowledge and skills in computer science, surveying and social sciences. One pre-condition for the success of such classes is the involvement of academic teachers as this kind of work demands greater flexibility and quick reactions to students' needs, which often involves the need to expand their own knowledge and skills.

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GIS IN POLISH HIGHER EDUCATION – A DISCUSSION

GIS W POLSKIEJ EDUKCAJI WYŻSZEJ – DYSKUSJA

For more than 20 years attempts have been made to implement the general Geographic Information Systems (GIS) into the system of higher education in Poland. Initially, these were isolated subjects – mainly in the case fields of geography, surveying, military studies, natural sciences, and later spatial management studies, and humanities. They attracted growing interest of students. In the next stage, specializations emerged to offer more teaching hours dedicated to the GIS – the state of geoinformation education in the first decade of the 21st century was presented in the Annals of Geomatics (Gaździcki, 2009). At that time, their authors used various names for the new specializations, such as geoinformation, geoinformatics or geomatics. The students received titles appropriate for the major they graduated, e.g. a master's degree in geography with a specialisation in geographic information systems at the Jagiellonian University, geoinformatics and remote sensing or cartography at the University of Warsaw (UW), geoinformation at the Adam Mickiewicz University in Poznan (Kozak, Werner, Zwoliński 2009), geomatics at the Academy of Mining and Metallurgy (AGH) in Krakow (Eckes 2009), geoinformation and mobile technologies at the University of Gdansk (UG) (Stępnowski, Moszyński 2009), geoinformatics at the Technical University of Wroclaw (Blachowski, Woźniak 2009). The development process of education in this regard could be seen in most state universities in Poland, both at universities and technical colleges. Each sought its own path of development. After some time, the first original curricula were created, though they were not always accepted and launched right away, as was the case with prof. A. Stateczny's project at the Maritime University in Szczecin (Stateczny 2009). Educators involved in geoinformation discussed the need for a new major at conferences and in literature (Gaździcki 2009). Sometimes, as in the case of geographical courses in Polish universities, a circle of enthusiasts from various schools: the Adam Mickiewicz University of Poznan, the Jagiellonian University (UJ) in Krakow, the Gdansk University, the University of Lodz, the Warsaw University, the University of Nicolaus Copernicus in Torun, the Maria Sklodowska-Curie University (UMCS) in Lublin met several times in 2009 to lobby for the creation of a new training course.

There was no real wider acceptance from the scientific community and authorities for this kind of action. The main fear was competition in an ever-shrinking students' market. The first enrolment process for first degree studies in the field directly related to the GIS was launched in 2012. New courses had various names: geoinformation at the University of Lodz and the Adam Mickiewicz University (UAM) in Poznan, environmental geoinformation at the University of Nicolaus Copernicus, geoinformatics at the Warsaw Technical University and the Maria Sklodowska-Curie University in Lublin. In 2015, admissions for second degree studies were launched in the field of geoinformation at the University of Lodz (UL), while other universities started numerous specializations in the course of master's degree studies related to the GIS.

The time has come to gather a wider group to discuss the current state of geoinformation education in Poland, to share experience, doubts, and plan our future actions. The tasks of organising the conference entitled the GIS in Education were undertaken by a team from the Department of Geoinformation of the Faculty of Geographical Sciences at the University of Lodz, which acquired the Norwegian FSS funds for the implementation of a graduate course and the meeting of educators included in that project[1]. We were invited to the Department of Geoinformation of the Institute of Geoecology and Geoinformation at the UAM. The conference was held on 3-4 June 2015 in the hospitable halls of the Department of Geography and Geology at the Adam Mickiewicz University in Poznan. Representatives from state universities who tought geoinformation-related courses were invited. It was organised under the patronage of the legend of Polish geoinformation, the chairman of the Polish Association for Spatial Information, prof. Jerzy Gaździcki. 70 participants represented most state universities in Poland that had launched geoinformation training courses and hada lasting impact on the development of that discipline.

1 Geographic Information Systems (GIS) – integration of environmental and climatic aspects as an important factor in economic development and the quality of life – innovative MA studies as co-funded by the Norwegian EEA funds coming from Iceland, Liechtenstein and Norway as well as national funds.

They included (in an alphabetical order, including the abbreviation of the names of universities): prof. Krzysztof Będkowski Warsaw University of Life Sciences (SGGW), prof. Stanisław Białousz Warsaw University of Technology (PW), prof. Elżbieta Bielecka Military University of Technology in Warsaw (WAT), prof. Konrad Eckes University of Science and Technology (AGH), dr Leszek Gawrysiak Maria Curie-Skłodowska University in Lublin (UMCS), prof. Iwona Jażdżewska University of Łódź (UŁ), prof. Andrzej Kostrzewski Adam Mickiewicz University in Poznań (UAM), Prof. Grzegorz Kowalewski (UAM), prof. Jacek Kozak Jagiellonian University (UJ), prof. Elżbieta Lewandowicz University of Warmia and Mazury in Olsztyn (UWM), prof. Katarzyna Osińska-Skotak Warsaw University of Technology (PW), prof. Iwona Piotrowska (UAM), prof. A. Stateczny Maritime University of Szczecin (AM), prof. Bogumił Szady Catholic University of Lublin (KUL), dr inż. Przemysław Tymków University of Life Sciences in Wroclaw, prof. Piotr Wężyk University of Agriculture in Kraków (UP), prof. Jacek Urbański University of Gdańsk (UG), prof. Piotr Werner University of Warsaw (UW), prof. Zbigniew Zwoliński (UAM). Eight papers and 40 posters were presented during the meeting. A lot of time was devoted to the discussion, during which participants had the opportunity to exchange experience, comments, and ask questions. Statements referred togeneral issues such as various points of view in respect of the GIS, represented by the participants in the conference and the information society, especially the new generation which easily uses modern information methods and technologies, including the GIS.

The participant still found relevance in the question posed in 1997 by Wright D.J., Goodchild M.F., Proctor J.D. if geoinformation was a separate field of the GIS Science, with its own methodological and methodical foundations, and if so, which group of sciences it might be incorporated into – geographical, computer or others?

Special attention was paid to the aspects of teaching geoinformation at various types of universities and during training courses in Poland. The market of universities that offersthe GIS is growing. The difference between education at universities and technical colleges as well as the differences between the GIS training courses, such as geography, surveying, spatial management, history, and geoinformation, geoinformatics or geomatics, were pointed out. The number of people admitted to universities is steadily decreasing (due to the demographic decline 20 years ago). That has resulted in the fierce competition for students among universities. The meeting of such a large group of academic teachers involved in teaching geoinformation in Poland may start co-operation efforts among universities at various levels.

Students participating in the discussion presented their expectations and professional competences they may gain from the geoinformation studies. Do curricula match up with the standards of professional competence and the job market, can we consider these qualifications recognisable internationally? The need to define the typical levels of the GIS-related jobs was expressed (they are present in the US), so that students may seek employment abroad.

The labour market for the geoinformation graduates is diverse, so notes and examples of institutions/employers we educate our students for were exchanged. Participants discussed the needs of the labour market not only in Poland but also in Europe and in other continents. There was a proposal for tracking the professional careers of the geoinformation graduates in Poland and abroad.

The meeting of the geoinformation enthusiasts also resulted in other numerous proposals that the education process could benefit from. Many proposals concerning the future were presented in relation to:

- the need for developing the teaching staff;
- the need for more textbooks and the need to share not only the scientific but also educational achievements;
- the proposal for creating an association of universities teaching the geoinformation;
- providing opportunities for foreign students, e.g. a common course, a common GIS e-learning;
- linking the educational process with the implementation of the geoinformation projects in the region;
- development of the geoinformation with the such issues as the Building Information Modelling (BIM) systems;
- pressure from various scientific communities to recognise textbooks as a part of scientific achievements;
- spreading the discussion to such institutions as the National Science Centre, relevant departments of the Ministry of Science and Higher Education;
- promotion of the GIS among the general public;
- the inclusion of secondary school teachers in the discussion;
- cyclic GIS Education conference.

The discussion was extremely lively and touched both the current problems faced by the debaters and the tasks awaiting them in the future. For this reason, it is worth quoting – chronologically.

E. Bielecka – problems of teaching the GIS in the field of geography and creating opportunities for students to find interesting jobs, as raised by prof. Werner, also apply to surveyors. Both disciplines have many graduates, with not all of them working in their learned profession. The knowledge on the GIS undoubtedly gives them this opportunity. However, I disagree with prof. Werner that algorithmisation and programming should be taught in the field of surveying or geography. I think that it should be tackled by IT specialists because we (i.e. surveyors and geographers) use ready-made tools, programs and applications. We should realise, however, how much the GIS needs IT.

P. Werner – ad vocem I want to explain – how scientific research is conducted in the field of geography – I propose a certain methodology of solving a given spatial problem. It may involve a combination of two known methods that have not been combined before. When I send a paper to a renowned international journal, I receive a completely negative review, saying this or that is not correct. And what is that? This is creating an algorithm, I de facto translate this algorithm into a tool system in the Geographic Information System, e.g. as a macro. This is my algorithm. Even the disclosure of steps of known methods and creating a macro out of it is an algorithm.

Geographers may also use their knowledge to design algorithms and tools for the geoinformatics. One example of this would be the innovative choice of certain methods that when combined form a sequence of the GIS software that functions as a subprogram (application, such as the Model Builder ARCGIS). That is the way, in which new functionalities and new algorithms are created. This makes a sequence of actions forming a macro in a scripting language becoming an algorithm.

E. Bielecka – In this perspective, I agree with you.

J. Urbanski – I absolutely do not agree with the Professor as the practice shows that most of the tools that we use, those various routines, models, plug-ins have not been created by programmers – with their help at the most – they have been developed by geologists, climatologists, not in Poland, but that's a fact. The programmer is very useful and may turn a given algorithm into a much more efficient program that may run faster but the core of that problem is in a given field and specialisation of science.

J. Gaździcki – which means that we operate in an interdisciplinary field, in which experts from various fields co-operate.

P. Tymków – I am a trained surveyor and computer scientist. After hearing the presentations and discussions I have a few thoughts: firstly, I feel that the GIS and geoinformatics are treated equally. Secondly, I cannot agree with the prof. Zbigniew Zwoliński that the geoinformation belongs to geographic sciences, the social and economic ones, without mentioning technical sciences. For me as a surveyor and computer scientist this centre of gravity shifts towards technical sciences. In addition, the GIS – as considered in the world – is a science in itself. Finally, let me add one more thing about the specializations that combine various fields. I have heard a hurtful opinion from employers – "Who is a geoinformatics specialist? He's like a guinea pig – neither a pig, nor from Guinea." We can discuss this sentence – it may be a computer scientist or a geographer with programming skills, or a surveyor.

J. Urbański – I'd like to cite someone else's opinion, the essenceof an article published in Nature in 2004, which described the new dynamically growing field called geotechnology by means of a simple sentence stating that geotechnology "is the GIS plus the Remote Sensing plus the GPS". For me as a scientist, an article appearing in such an important journal is something, on which I can basically refer to.

B. Szady – as a historian, I would like to appeal to the classical understanding of science, which requires the formulation of the object, aspect, purpose and method – I find it very difficult to define clearly what is studied in the geoinformation.

S. Białousz – there are about 50-150 definitions of the GIS, the problem is that the translation of the English term into the Polish language, the word by word as the Geographic Information Systems, is fundamentally erroneous. What does this error in the GIS involve? At the first lecture, I explain to my students that the word Geographic in the definition of the GIS should not be associated with the discipline of geography but with all data and information located in the geographical space. And all those who deal with anything in the geographic space use these tools and are in this area. I think it has been very wrong that the GIS has been translated so literally, the word for word.

Zb. Zwoliński – in my opinion, in order for the geoinformation to be recognised as a scientific discipline, it must meet three conditions: have its own object of study, its own research workshop and concrete practical applications. When it comes to the object of its study, the answer is very simple: the globe, all issues that concern the world that surrounds us, when it comes to the research workshop these are geographic information systems as tools and the application – in this group no one questions the applicability of the geoinformation.

J. Gaździcki – we should bear in mind who it is that we want to teach, users of the geoinformation, creators of information or the managers of these resources that comprise spatial information. We should say it clearly, when we start our teaching.

J. Gaździcki – after hearing the presentations from prof. E. Bielecka and prof. A. Stateczny, I would like to highlight a few important conclusions of these immensely interesting presentations. First – the need, even the necessity, pointed out by prof. E. Bielecka to improve the teaching personnel as the progress is so huge and the GIS technologies are changing so quickly that if the personnel "oversleep", this teaching will be at risk. Second – the interrelation between the teaching process and the implementation of big-ticket geoinformation projects in the region, mentioned by prof. A. Stateczny of the Maritime University of Szczecin. n addition, it is important to adapt the curriculum to the standards of professional competence and the job market for graduates. If they acquire qualifications that authorise them to perform certain professional activities, their position in the labour market will improve accordingly.

I. Jażdżewska – we should pay attention to the need to develop a larger number of textbooks as well as the need to not only share our scientific but also teaching experience (with respect to copyrights, of course). Preparing a training course at a high level, with Polish examples, is time-consuming and we should use the experience of other educators, such as the good examples of prof. J. Urbański and prof. S. Białousz. Some GIS subjects have the same scope and we should not waste any time "walking in place". Educational co-operation will be beneficial for both academic staff and students.

K. Osińska-Skotak – in my opinion there is no significant difference between education in universities of different types, e.g. universities and technical colleges. The basics are always the same, only the emphasis on certain elements is different. For example, prof. K. Eckes of AGH talked about the level of detailing, accuracy and precision that guides surveyors, and there are also standardisation, formalisms, to which surveyors attach great importance but the teaching process is similar. It is commonly claimed, too, that geodesy only involves data acquisition and surveyors do not analyse or process any data. Professor, let me disagree with that opinion, surveyors also have to process and analyse data as it is the case at universities, they just focus on the technological aspects. The second thing that was highlighted in the discussion was the competition among universities – the thinking that we have to teach geoinformatics/geoinformation, unless others take that from us. If we keep thinking that way, every educator will have to start learning certain things from scratch – things that are already done and well-known. If a variety of teams fail to co-operate, we will not quickly gain this foreground knowledge.

J. Kozak – we are aware that we should co-operate and exchange experience but we are also rivals when it comes to students, especially at a time when their numbers in Poland are significantly reduced. All the more deserving is the praise for the initiator of that meeting. I think the fact that we have met, we are talking and exchanging our experience, and opening to new ideas is of great value. Recall what prof. J. Gaździcki said about there being a difference between producing data and using it. I do not fully agree with the previous speaker, that both (universities, universities of natural sciences and technical universities) do the same thing. There is, however, a division between technical colleges that acquire and create data and the universities that try to use the data in various fields. It seems to me that this division is essential but also differentiating. Of course, we also learn data acquisition at the universities but the main emphasis is put on using the data for various environmental analyses that interest us as scientists. This is the issue that the "GIS in science", that has just been organised for the fourth time in Poland, is devoted to. As a voice in the debate, I would like to add that I see a difference and that there are certain spheres of influence that we somehow share among ourselves in order not to step on one another's toes. The division may not be strictly defined but it seems to me that it is nevertheless present.

K. Osińska-Skotak – I do not entirely agree with this statement, although as far as surveying and cartography are concerned I agree but there are also other training courses in technical universities, such as those related to environmental protection or transport, where data is not only acquired but also processed, modelled and analysed. I am therefore convinced, that the division is more related to the discipline we are involved in. Indeed, surveying and cartography is primarily tasked with collecting data but the emphasis in other training courses is put on processing and application.

J. Gaździcki – we should not overemphasise the differences between technical and non-technical universities. These are really secondary divisions. What is important is that we co-operate when we see two markets that we are dealing with. Prof. J. Kozak spoke about the market of students and those who are educating. Of course, we also have the labour market where our graduates end up. It seems to me that we have so far focused on the first one of those, we have been talking and exchanging ideas about how to teach. However, we lack information about what happens to our graduates, the discussion about the labour market. Allow me to appeal to all debaters to consider the problems of the labour market.

P. Werner – I am very interested in the plans presented by prof. Eckes in the scale of 1:500 scale, especially the related extent of detailing and precision. I have been co-operating for some time, as a part of the spatial management training course at the University of Warsaw, with architects who teach spatial thinking and imagination, trying to tie it with landscaping. I have been talking with them about something that has been developing for a decade all over the world, namely the Building Information Modelling (BIM). This is exactly what the professor said, the difference being that they speak about the concept and standards in architecture that start at the building design stage and last for the whole period of its life – the whole lifespan of the building. I believe that its development will be as dynamic as the one of the GIS, and we should take interest as a part of our spatial management and surveying studies.

G. Kowalewski – I'm happy with this conference, as there are so many various points of view concerning the GIS, not only the geographic one. It seems to me, however, that there is a fundamental difference between technical colleges and universities, and it mainly involves the scale of their studies. Prof. Eckes talked about large-scale maps, and geographers usually deal with a slightly bigger area. Regarding the discussion about employment for the geoinformation students, I would like to point out the need for their presence in institutions of education. Most teachers are graduates from universities that had not been teaching the GIS yet, and they have to deal with a digital generation that was discussed by prof. I. Piotrowska. We are far behind in teaching them to use the GPS, Google Earth, etc. I can see a gigantic role for geographic centres at universities. We need post-graduate training for teachers and future teachers in order to introduce children into this digital world that is entering their world anyway.

J. Urbański – I would like to point out that we educate future employees not only for Poland but also the European Union. It seems to me that many of our graduates will be working outside of Poland. Those skilled in the field of the geotechnology will find employment abroad as there is greater demand for them there. I think that the problem arises from a very large diversity of names of specialists we educate. Perhaps it would be a good idea to define the typical levels of professions related to the GIS, that are dubbed in many countries, such as the United States as a GIS technician or a GIS analyst. Should we succeed in determining in a very general, informal, way, what for example a GIS analyst should be able to do, we would make it far more transparent for foreign employers. Let me also call for writing geotechnology textbooks as there are authors of several textbooks in this room but their number in relation to the number of students is scarily low.

J. Gaździcki – I would like to concur with prof. Kowalewski, that we should not be confined exclusively to academic teaching. First of all, we should consider promoting the knowledge and skills to the extent of spatial information. Ladies and gentlemen, this applies to almost the whole society, so this is a gigantic task we have to perform. We have to start with teaching people how to use navigation and find geographic information in the Internet. We need appropriate methodology, materials, and curriculums.

I. Piotrowska – I would like to inform you that the Didactics and Environmental Education Lab UAM is responsible for the implementation of the Educational Module for preparing students to become teachers of geography and nature. It includes subjects called Multimedia in geography and nature education, including the GIS, that were introduced many years ago. The students' task is to design classes for elementary, secondary and high school students held in computer labs using a variety of the GIS software, including free software, available regardless of the financial condition of the school. Should our graduates start teaching after such studies, they will be appropriately prepared to include the GIS and to educate the young, digital generation, whose natural interest in communication and information technologies should be used in the educational process. The civilisation leap is so huge that we should include subjects that emphasise the GIS in the curriculums of other training courses that prepare students to be teachers.

P. Tymków – I have an analogy: as far as I am concerned, geoinformation/geoinformatics is like a country set for partition, eyed by a number of powers such as geography, surveying and computer science. Each one introduces its own "green guys" into it in order to take more on one's own. This has to result in a crisis. I would call for independence.

L. Gawrysiak – referring to the discussion on education and the labour market, I would like to point out that as I am analysing the curriculums presented by representatives of other universities, I have the impression – excuse me – that they were written not for the labour marketbut to find employment for the employees of the university. We have taken a different approach, despite the authorities pressuring us to analyse the labour market not only in Poland as it is pretty stagnant but also in the US and Canada where there is a lot of jobs. We need to instil this in young people. They have to study with an attitude that there is work – not for PLN 1600 (EUR 400), and if need be, they will have to pack up and leave for Ontario or Melbourne.

P. Wężyk – all in all, I do not know if we are university or technical college as we teach very technical things at the Faculty of Forestry at the University of Agriculture in Krakow. We – in the field of forestry and nature – use the term "Geomatics". I am glad that there are such interesting voices in the discussion but I would like to tackle a different issue: "what to do to allow students/graduates to migrate among our schools?", "how do we recognise curriculums, minimums at various universities?". The labour market – and I have just the opportunity every day to look at it – is changing very rapidly. The current projects assume that we are prepared for everything and have a team of universal people. So let's give students a chance to be able to change their courses of study. If they need to, let's say, switch from forestry to geography after two years, let's make it possible. Let's not leave them in our splendid aquariums. Moving within study levels in our universities does not solve it. Maybe we should start – as proposed earlier by prof. J. Urbański – to talk about the levels of recognition for our qualifications but in an international context. Let's provide students from abroad with opportunities to study with us en masse. Let's create a common training course – a common GIS e-learning. Let's form an association of universities teaching the GIS, so that we can offer various field of the geoinformation. This is already happening in the world – for example in Sweden one can defend a doctorate in the field of the geoinformation using the Moodle system. This is what the Taiwanese and the Chinese, who come to Sweden to study and still study on-line, do. We should be talking about such matters, so we can beautifully differ in our geodiversity.

E. Lewandowicz – a reference to the discussion about the labor market. We have information that our surveying and cartography graduates as well as the postgraduates pursue their surveying careers, start their own companies and work in administration. The profession also welcomes geographers. My praise to you, teachers in the field of geographic training courses, that you educate the students so well that they find employment in surveying companies. They sometimes are better in navigating the GIS software than the surveyors. The Director of the Department of Surveying and Cartography of the Marshal's Office in Gdansk wanted to hire surveyors to work in the Regional Surveying and Cartogprahic Documentation Centre, in the Land Information Systems Lab but he hired graduates of geography instead. They had demonstrated a greater ability to work with the GIS applications, they had been better. Geographers also work in county surveying offices, working on the base map. They learn surveying quickly but they have problems with their careers, they have to improve their educational background in order to gain documents and professional qualifications. Our surveying and cartography graduates as well as geography graduates work together in various companies, such as TomTom which creates navigation applications. We are teachers from a variety of universities and our graduates meet at work and work together.

S. Białousz – I would like to share with you the experience of teaching in the field of the land management and administration. At the Cardinal St. Wyszynski University a new e-government specialization was opened. I was invited there to lecture the geoinformation for 15 hours and conduct the same number of classes. What can be taught in such a short time, especially without access to a lab? Lectures were conducted in the traditional manner. I also presented to the students, by changing some classes into the lecture, an overview of maps, from a 1:250,000 NATO operations map to the 1:500 base map, an overview of aerial and satellite images useful for the administration as well as a review of thematic maps important in administration. As a part of the classes, following some work on aerial images and chosen maps, I asked the students to visit their municipalities' websites and see how their municipalities are presented there. Is there a map next to the mayor's portrait? Then, they were to find the "planning" tab and locate the document called the study of conditions and directions in spatial development, the so-called municipal study. They had to search for the resolution of the City Council approving the study, along with attachments: descriptions and graphics. The text attachment is usually quite long but I told them -read it in its entirety as you live in the municipality and do not know anything about it. Print only what interests you. But print the whole graphical attachment to the study and see what the municipality proposes for the surrounding of your house. The next task for the students was similar. They had to go to the Local Development Plan website and find the fragments of documents related to the vicinity of their houses and see the designation of the area. Incidentally, we discussed the subsequent steps of the planning process, the role that spatial data plays and the opportunities for citizen participation in the planning process. The next class involved working with a geoportal. I told the students: go to the geoportal.gov.pl, open ortho layers of the land registry, zoom in until you can see your plot with a number and print it. Then open the Topo tab where the BDOT is located, not the topographic map. Zoom in on the map until the number of your house appears. Print this image, go out into the street and check if the numbers are correct. The students were very interested in this form of classes, they brought beautiful prints. They got closer to the municipality they lived in. It turned out that they did not know that such documents were readily available to the residents and useful for the administration. Therefore I encourage those of you who have smaller numbers of classes to conduct them in this way.

K. Będkowski – allow me to refer to the natural curiosity of children and youths, their strive to learn about the world. This example comes from India where a large monitor, a computer and a mouse was installed in a town that had not learned about computers yet. A few months later results were checked. And what happened? Local children got to know the operation of the computer. When asked if there was something they needed help with, they answered that the computer could use a better mouse and a faster CPU. It was a prelude to my thought. It seems to me that we – the teachers – will fall behind the technological progress but the youths are far quicker in adopting all the latest technological developments which may result in some trouble on our part. I therefore think that we should pursue this direction when teaching: provide students with certain skills and tools, then provide them with some ideas, a problem to solve, so their natural curiosity and the ability of young people to immediately use technical novelties is aimed at solving these problems.

Zb. Zwoliński – I think that call for independence of the geoinformation is not necessary because if it was not independent, we would not be here in such numbers. I am convinced that we should focus on complementing each other. When I start an analysis, I don't think about taking a theodolite or a laser scanner and going out in the field. I wonder what the databases look like, what precision and resolution the data has and if none of these databases meet my expectations, then I think how to acquire the data myself. This artificial division thus stems from the so-called technical and university approach. I would add that one of the UAM geoinformation graduates worked in a VW car factory where he had the task of managing large surfaces inside the buildings for both production and storage. He has been recently promoted and works at the headquarters in Germany where he is doing the same job.

S. Białousz – after our discussion, I have a reflection. We have a very large collection of information on the projects currently being implemented, about education systems, curriculums, etc. In all this variety and institutions responsible for implementing them, there should be one core. We are all situated around it. Whatever we do, all our reflections start with spatial objects and phenomena. If we want to explore something new, we must first define the object, determine the accuracy, with which we want to locate it. This is what we should do first. Determine what the database should be. If we are using an existing database, we have to assess it from the point of view of the accuracy of positioning objects and their attributes. This looks good, I'm taking this database. This does not work for me, I have to fill in the data or increase precision. This is a very important step in any activities, namely defining the object or phenomena accurately as well as positioning accuracy. Later, these objects and phenomena are described using spatial data. The first part is location, through coordinates or other locators, then comes the semantic description. We have hundreds of millions of pieces of spatial data that we collect in spatial data sets for later use and sharing. These sets include the base map sheet, topographic map sheet, orthopohotomap, land registry sampling, geological map, etc. I estimate that just for the city of Poznań this means several thousands of spatial data sets. There are several hundreds of land registry precincts in the city. These collections constitute spatial information. I do not agree with what the specialists from Brussels have written. According to them, there is hardly any difference between data and spatial information. I consider spatial information to be all (the data sets) that describes our space. In order to move around in all this, we have the spatial information infrastructure. In order to use it, we all use computer technologies. This is our common core, around which we are all moving, whether we tackle surveying, geography or planning. Let me remind you that prof. J. Gaździcki said that we could not omit the infrastructure of spatial information in our teaching. We teach it, we have this common core, which informs spatial information, the philosophy of education at different levels. Different for policy-makers, office workers, and different for analysts who will be responsible for important decisions. In this area, we can really shine, everyone will fit, as this cake is very big. Good competition is inspiring. If there is something good in Kraków, they will want to do the same in Warsaw. If we exchange information, we will all progress, so let's support one another.

I. Jażdżewska – to sum up our presentations and discussions, I would like to emphasise that owing to the presence of representatives from such diverse fields as forestry, surveying, geography, history, as well as representatives from military and maritime academies, we have had the opportunity to learn how the GIS is taught, even though the name means something different in technical colleges and universities of various types. Currently there is a number of educational offers that include the GIS for university candidates in Poland. These are simply additional subjects within the framework of training courses, or specialisations integrated into a course, or brand new majors like geoinformation or geoinformatics, that have been launched in the last few years. We should therefore remember that in our discussions and clarify if we mean a separate course or a specialisation within a course. There were suggestions to write more textbooks for students as well as to support one another in teaching. I agree, ideas coming from our curriculums are worth sharing. During the lecture by prof. B. Szady I had a reflection that we should also share materials created by us and our students. It has reminded me of how we were pursuing the administrative division of Poland back in the 1950s. And maybe it is already done, having been stored on someone's hard drive, and we will be creating it again. We should not waste our time repeating such activities. Our students also create interesting data which is usually no longer used. Of course, such exchange should be in accordance with standards such as metadata and copyright. We have a lot of fields for co-operation. We must remember that some of us are more advanced in the geoinformation and others are less advanced, some are more focussed on certain issues, such as the use of LIDAR data. Only through friendly co-operation will we be able to develop.

A. Kostrzewski – the question of whether the geoinformation is indeed a science with its own subject of research, methodological and methodical foundations is of utmost importance. The fact that this topic is being discussed is encouraging as this applies to every field of science, even the more advanced ones. The issues that have to be determined first are the questions of transdisciplinarity, interdisciplinarity and monodisciplinarity. Where is the geoinformation in this system? In my opinion every scientific discipline has its roots, that is exclusively its own, and the fact that it has something to offer to other disciplines is only a measure of its worth. I am convinced that in this case the geoinformation is of particular importance. The issue of individualisation of the geoinformation against other fields of science and the issue of transdisciplinarity and interdisciplinarity is this value of the geoinformation. In my opinion cartography has largely remained a tool as it has not succeeded in developing its own unique subject of research. The geoinformation is now at a very important moment in time, deciding to inidividualise its subject of research. The fact that the geoinformation as a sub-discipline is classified into different scientific disciplines is good.

Zb. Zwoliński – as I was summarising the speeches and discussions, I noted a few issues worth mentioning. We should:

- teach the geoinformation at all levels of education, not only at an academic level;
- pay attention to the potential of geographic information systems;
- collect and analyse data at different spatial scales, from a micromap to continents at a global scale;
- collaborate among teams;
- have the core of geographic information systems for each discipline to develop in its own direction;
- improve our staff, ourselves as teachers;
- have less technique and more analyses in the curriculum;
- highlight the role and knowledge of the spatial information infrastructure;
- link teaching to projects, so there is a connection between theory and what awaits our graduates in their professional lives;
- adapt the studies to professional competences;
- define the role of textbooks as our literature is still too modest;
- transition from editing to analytic classes;
- data sources, time and space, also in the historical dimension;
- create interdisciplinary training courses.

L. Chudziak – a teacher at a secondary and high school – I would like to add, that the GIS and other technologies have already entered schools. They have forced the teachers to get training. I would like to share my experience with you. I conduct field classes with kids. One of the exercises is determining north using your watch. Once I wanted the students to perform that task, it turned out that hardly anyone had a watch with hands. Only one out of 30 students had one. Finally, we determined the direction, we succeeded. Then, one of the kids said ‚now we will show you how to find north'. They switched the GPS on in a smartphone, and I was brought down, I understood – to quote a sentence that was already used today – that we could not use old methods to teach modern kids. My second comment: you presented your educational offer for your students, and I feel bad that I am the only teacher in this group. I think this offer should be intended for a wider range of teachers. My high school graduates often asked me about choosing a training course, "Sir, I find geography interesting but what am I supposed to do to find a job later?". After this conference, I will be able to tell them about the main training courses that will help them find a job in this technological world. Allow me to ask you to include a wider group of high school teachers among the participants. They are the ones preparing your students. My third comment relates back to one of the slides presented by prof. K. Będkowski showing that "the level of education should be adjusted to the level of students". I strongly disagree with that, on the contrary, I think that students should adapt to the high standard of education.

B. Szady – I fully and wholeheartedly support the inclusion of high school teachers in our discussion. This is very important. In reference to comments made by prof. Jażdżewska, I think that sharing processed data is very important. In may presentations at this conference as well as at "GIS in science", we have been able to learn the results from the research done by participants. They are often shown as web-GIS applications, often interactive. From what I can observe in my own field, the power of development involves integration of data, cross-analysing, finding dependencies, relations, etc. The more data resources we have in various formats, such as gml, shp, etc., the better our research will develop. The idea is not to confine ourselves to visual presentation but instead to open to the possibility of data exchange and downloading. Let me further develop prof. Jażdżewska's appeal – let's share not only our publications, not only research conclusions, but also the data itself.

J. Kozak – Ladies and Gentlemen, once again I would like to emphasise that today's conference has been very interesting and we have been able to learn a lot. There have been in fact so many interesting topics that it is difficult to form conclusions or focus on anything in particular. There are many interesting things happening in various places, with our colleagues at the AGH in Kraków presented an ice-age reconstruction of the Tatra mountains using various geotechnological possibilities. Many interesting problems also appeared onthe GIS Day, we started co-operating with artists at that meeting, those involved with video games, as well as artists in general. This is another trend, which – as it turns out – integrates the GIS to a large extent. During the panel discussion we heard interesting insights from prof. Wężyk, prof. Pyka about the interesting synergies occurring in this field. Perhaps this community is also missing here. There is a number of things that have been discussed here but there is also a lot of them that have not been addressed.

Let me refer back to our discussion about our involvement in teaching, "how do we benefit as scientists?": maybe satisfaction should be enough? As far as our teaching publications are concerned, they are not scored or scored low. We have heard an opinion that there is a lack of textbooks. After that, as prof. Będkowski said, and as we all know, there are no scores for textbooks, as far as categorisations are concerned. I think that there are surprisingly many textbooks. That means there are a lot of people among us who are thinking about improving the teaching side of things and making it more efficient. I think that the GIS in Science conference is developing so nicely that we should think about making the GIS in Education cyclical, for us to be able to continue our conversations on these topics.

K. Osińska-Skotak – We have mentioned numerous times that we should promote the GIS knowledge. However, I sometimes feel that the more we promote it, the less popular it becomes. There are still many areas where people do not know what it is used for, they do not even know that spatial data exists. Thus, there is a need for continuing promotion of knowledge about the GIS. I will talk about our experience at the Warsaw University of Technology. Our faculty provides classes for primary and secondary schools as a part of the Festival of Science in Warsaw. While at the beginning there was some resistance from our employees, as time passed many people started to feel satisfaction with the classes and we have had new people joining the project. They watch how thirsty for knowledge the kids are, especially in primary schools and the first year of secondary schools, and they are more and more eager to participate in the festival each year. When we announce enrolment to the classes, they are fully booked in minutes. That's how much interest there is in it. We also have classes as a part of the PW JUNIOR project for children, and we are surprised how well the smaller children are dealing with challenges. Our students are often taught to think schematically, and young people who see a satellite picture for the first time, when asked "where is a forest?", just show it. They do not mind that it is red or some other unnatural colour. I therefore think, that this promotion of science is important and there is a demand for it among young people. Kids of today are different, the first question they ask is "Why are we learning this?", "How can I use it?" If we fail to show them the purpose, they will not learn.

P. Wężyk – I would like to thank you for the idea of the conference. I see that we have to meet many times to catch up, so that we start speaking the same language. Let me return to my dreams. I would like to meet you periodically, and such integration, apart from the ideas listed here (professor Jażdżewska is very experienced in this regard) would be supported a lot by the grant and the creation of a platform for Polish GIS campus, so that each one of us would contribute something to its construction. So that our students could, as a part of their electives, choose a training course for some specified ECTS points. So that we can create geodiversity and an opportunity for learning without necessarily changing our schools (this is not easy, especially considering that we also compete). Let's create this opportunity so that our students are better prepared than we were at the beginning of our careers, let's give them a chance to understand various issues, e.g. as a couple of hours of a training course, lecture, some practical issues, analyses and possible solutions. Should any of you decide to accept such a challenge, I am speaking to geographers now, who have geoeducation subjects, and each of us would chip in from our fields, we would create a great Polish geo-campus, which I strongly encourage you to do.

P. Werner – initially, when professor Wężyk proposed the idea of a "GIS campus", I thought we were doing harm to our universities – by creating competition we limit the influx of students to our schools. But when I looked wider, I saw a consortium of universities, a joined effort that would free of charge transmit certain materials to a common e-learning platform created by several universities that signed an agreement. Such solutions are already in place at the best universities in the world. This is what MOOC is (Massive Open Online Courses) – a platform supported by big names, full-time training courses, lectures. In this context, I can imagine it. We are not very experienced at our faculty, but we have been using blended learning on the moodle platform for more than 10 years. Students have their own accounts and participate in training courses that supplement curriculum classes. In principle we no longer use paper. Each year new employees join the programme with their classes. In this context, the project works well for both students and the staff.

Zb. Zwoliński – today's conference would not have happened if the geographers were not in an informal consortium already. In 2009-2010 we- geographers met several times among, which resulted in the creation of the geoinformation training courses in Poznań, Lublin, Łódź, Toruń and other cities. We discussed the naming, the subjects to be taught. Universities were not left to prepare on their own, we co-operated. Please note that the name of the training course, the geoinformation, only exists in universities, not technical colleges. And in 2009, we also had an intense discussion with professor Stateczny, in the same group, we wanted to include a geoinformation training course. I think such meetings are really necessary and the creation of a wider consortium of the universities that are already involved with geographic information systems should be treated as a trunk with the branches related to respective universities spreading further and developing variousgeoinformation training courses.

A. Kostrzewski – I have a proposal for the organisers. Unfortunately, our scientific community, and this applies to all scientific disciplines, is insufficiently outgoing. During the meeting, you have come to many interesting conclusions that should be disseminated. Suitable applications should be submitted to such institutions as the National Science Centre and relevant departments of the Ministry of Science. One of the most important issues is to locate the geoinformation in the Central Commission for Degrees. There should be pressure from various scientific communities for the recognition and inclusion of textbooks in scientific achievements as they are often scientific works.

I. Jażdżewska – Ladies and Gentlemen, I would like to conclude by thanking you for this discussion, for the kind words for the initiators and organisers of this conference. You have suggested that we could organise another such a meeting. We will certainly think about it. A few years ago, in 2012, we at the University of Łódź initiated jointly with the University of Gdańsk the conference named the GIS in Science, which was subsequently organised in Lublin (2013), Gdańsk (2014), Poznań (2015) and Warsaw (2016). They enjoy increasing popularity, this year there have been around 150 participants. After the interest that the GIS in Educationhas sparked, I see the need for it to continue in a year or two. I am very glad that we have got to know one another better, we have integrated, we have had various points of view that have led to a single conclusion that this diversity is our strength.

Summary

The experience of Polish scientists and educators in the GIS has not been as long as mentioned by Michael F. Goodchild who jointly with Ross Newkirk (Goodchild 2006) started the first GIS training course at the University of Western Ontario in Canada in 1975. Discussions on the scope of knowledge included in the GIS have continued at most universities that have offered such classes. In 1988/89, owing to the National Centre for

Geographic Information and Analysis (NCGIA), the 3-volume document of over 1000 pages was put together to include curriculums, student materials and other teaching aids. We have good models and we can use them. Meetings and discussions about the GIS education have been and still are regularly held all over the world (Forer P., Unwin D. 1999). When employees of Polish universities were starting to learn the GIS software and possibilities, Morgan J. M., Fleury B., Becker R. A. (1996) had already identified over 800 higher education institutions all over the world that had offered at least one GIS course. The rapid development of new technologies, methods, the creation of new labour markets has arisen discussions on the contents GIS training in various centres of higher education, e.g. in the Netherlands, the US, and those have been similar to the ones presented in this article (Toppen F. J. 1992) and some issues needed to be resolved in court (DiBiase, D. 2008).

You can see how important these meetings of educators are for exchanging opinions and experience. They have allowed to meed people representing various fields involved in the geoinformation, which may result in co-operation and new educational initiatives, and sometimes, competition.

Finally, we should agree with prof. J. Gaździcki (2009 p. 12) that "It is obvious that the success of any measures to modernise education in the area under consideration depends on the interest of academic communities, involvement of research and academic staff in these endeavours, their will, ambition and willingness to co-operate"

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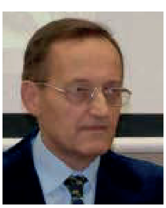

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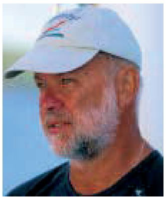

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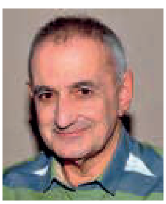

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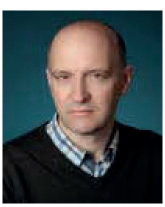

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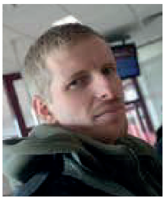

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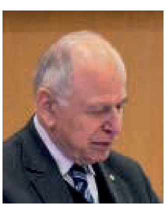

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