STUDY OF COMPETENCES

LIFESCIENCE

FINAL RESEARCH REPORT

Center for Evaluation and Analysis of Public Policies

Interdisciplinary Centre for Organizational Research and Development

Jagiellonian University

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SUMMARY

The report presents effects of research works carried out under the project: "Balance of competences" in the lifescience sector in Kraków. With regard to social, economic and promotional aspects of the sector, its development should be one of the most important components of the city development strategy.

For the purpose of the present report, **life science sector is understood as comprising entities engaging in activities in the area of technological processes and healthcare. These are mainly pharmaceutical companies (developing, manufacturing, and distributing medicines), biotechnological companies as well as enterprises conducting clinical trials and performing quality audits in pharmaceutical and biotechnological companies.**

Within the framework of research works, and based on the analysis of job offers and in-depth interviews with opinion leaders and representatives of businesses, we identified more than 80 competences which – to a different degree – are important for the sector, these include *specialist knowledge (16 competences), specialist skills (16 competences), business knowledge and skills (14 competences), soft skills (16 competences) and foreign languages and other requirements (21 competences).* At the next stages of research work, quantitative analysis related to the demand for competences (9 sector companies employing almost 1000 employees in total), was compared with results related to the supply of competences (13 fields, almost 20 specialisations of studies, and 1000 students). The research method was considerably modified as compared to that used in 2012 and suits better the specific entities operating in the lifescience sector.

The demand analysis shows information related to the most important competences sought by employers, including **operation of office software packets**, **being concerned about quality**, **integrity**, **analytical skills and knowledge about clinical trials**, as well as competences that will be demanded in a five-year perspective, including: **experimental method**, **HPLC analysis**, **technical English language**, along with the assessment of difficulties in acquiring these competences from the labour market. **We also present key information related to the dynamics of employment in the sector, which – in case of the lifescience sector – shows a decreasing tendency.** Most graduates now and in the five-year perspective will be offered employment on the basis of civil law contracts or self-employment. The report also contains information related to jobs/positions that are most frequently offered in recruitment processes .

The supply analysis shows information related to fields of studies the curricula of which, according to employers, offer the profile of education best fitting the needs of the sector. The analysis also presents the assessment of educational effects as seen by employers (the definitions of the competences were "translated" into educational effects). Competences important for employers, are, inter alia, **operation of MS Office, OpenOffice and Google Docs**, **ability to use equipment, adaptation, focus on development (or development orientation) and information science**.

Co-operation between universities and the representatives of businesses in the selected segments of the lifescience sector is gaining its momentum, although the co-operation, except in

computer games area, may be said to be potential and informal rather than to have any systemic dimension.

Difficulties in acquiring skills are juxtaposed in the study with the achieved educational results. As regards majority of competences important for the life science sector, both companies and universities agree on their presence in syllabuses of university courses intended to prepare graduates to work in this specific sector.

The strongest disagreement between business entities and universities concerning competences needed in the life science sector is observed around **validation**, **integrity**, **ability to prepare expert opinions**, and knowledge of **GMP principles**. Employers are of the view that these features are hard to find in graduates, while universities claim that they are being developed in the course of studying. There is much more agreement as regards the competences related to **being concerned about quality**, **initiative** and focus on customer (or customer orientation) – these skills are hard to find, both in graduates and in syllabuses of university courses teaching students in areas needed in the life science sector.

Business and universities agree as to the place of the majority of the selected competences (**analytical skills**, **ability to analyse**, **operating apparatuses**, **information science**, **ability to use office applications**, **being concerned about quality**, **validation**, **knowledge about hazardous substances**) in syllabuses of university courses preparing graduates for this sector.

The final part of the report presents conclusions derived from analyses along with proposed actions aimed at the development of universities and sector companies.

CONTENTS

BACKGROUND

In September 2012 the Study of Competences in BPO/SSC and ITO/IT in Kraków was published. In subsequent reports, while continuing our work and focus on the analysis of demand and supply in sectors of vital importance for the development of the city of Kraków, we are pleased to present the results of research work in the four sectors:

1. Passive houses and low-energy building sector

2. Power sector

3. Selected segments of the creative sector

4. Life science sector.

In reports focusing on each of the aforementioned sectors, we present the most important conclusions related to the demand of Kraków's companies for certain competences and the supply of such competences by Kraków's universities. The principal tasks that were assigned to the research team have not changed and are focused on a reply to key questions: what competences should possess graduates of Kraków's universities now and in the future, and to what extend the competences are taught at the universities. The reports also help to find an answer to the question: how businesses and universities perceive the role of the latter in teaching selected groups of competences and what consequences may have differences (if any) between those two perspectives. In the reports, interested Readers will also find information related to the state and development perspectives of and challenges faced by the sectors, as well as barriers related to cooperation between research institutions and businesses.

A large number of assumptions and guidelines related to the outcome presented herein are a result of research work carried out within the framework of the first edition of the study dedicated to the balance of competences. Accordingly, whenever it is possible or advisable, we will refer to materials previously developed and published. However, considering specific features of the sectors which are analysed in this year's reports an the necessity of adapting research methods, substantial changes have been made to the methods, and described in details.

Conclusions presented in the reports were formulated on the basis of research questionnaires and several dozen interviews with sector experts and with the representatives of companies and universities. The subject matter of research was also a set of job offers and, to a lesser degree, documents related to university curricula of selected fields of university studies.

The project was commissioned by the Kraków City Hall and carried out in cooperation with the Centre for Evaluation and Analysis of Public Policies and the Interdisciplinary Centre for Organizational Research and Development at the Institute of Psychology of the Jagiellonian University. The execution of the project would not have been possible without the courtesy and professional assistance from the representatives of the Kraków City Hall, businesses and Kraków's universities. We would like to express our thanks to them, and declare that we, as the research teem, feel responsible for shortages and/or imperfections (if any) of the reports. Particular thanks are addressed to the following (in alphabetic order):

- Sector experts and persons who enabled us to understand the core of the operation of the said sectors in a broader context and submitted, often very critical remarks, which helped to improve the quality of tools and definitions applied by us: Adam Biernat (Regional Labour Office), Paweł Błachno (Jagiellonian Innovation Centre), Zuzanna Drożdzak (Centre for Evaluation and Analysis of Public Policies of the Jagiellonian University), Joanna Homa (Department of Evolutionary Immunology of the Jagiellonian University), Paweł Jastrzębski (Małopolska Energy and Environment Agency), Stanisław Just (11 bit studios), Paweł Kołodziej (xtech.pl sector Internet service), Dawid Kurdziel, Maria Leńczuk (Regional Labour Office), Kazimierz Murzyn (Lifescience Cluster), Rafał Orlicki (Kraków Festival Office), Tomasz Pyszczek (Passive Architecture, Polish Institute of Passive and Low-Energy Building), Barbara Siorek (Career Office of the Academy of Fine Arts), Anna Szczucka (Centre for Evaluation and Analysis of Public Policies of the Jagiellonian University), Dariusz Szklarczyk (Centre for Evaluation and Analysis of Public Policies of the Jagiellonian University), Paweł Szlachta (INRET – Cluster of the Culture and Free Time Industries), Paweł Węgrzyn (Department of Games Technology of the Jagiellonian University), Michał Wojtulewicz (ASTOR), Ewelina Woźniak-Łyp (Creative Kraków Foundation), Katarzyna Wysocka (Kraków City Hall);

- representatives of companies[1]: BioTe21 Adam Master, BioCentrum, F1 Pharma, MicroBioLan, Przedsiębiorstwo Pszczelarsko Farmaceutyczne Apipol Farma, Selvita, Teva Operations Poland, Zakład Farmaceutyczny Amara,

- representatives of universities connected with the sector: AGH University of Science and Technology (Faculty of Management, of Materials Science and Ceramics, Faculty of Electrical Engineering, Automatics, Computer Science and Biomedical Engineering), Jagiellonian University (Faculty of Medicine, of Pharmacy, of Health Sciences, of Chemistry, of Biochemistry, Biophysics, and Biotechnology, of Physics, Astronomy and Applied Computer Science, of Biology and Earth Sciences).

We intended to develop the reports in such manner that – on the one hand – each report could be used independently from the other reports by employers, universities, public authorities, students or graduates, and – on the other hand – could help to create a tool for effective communication platform between the aforementioned groups. As it was shown by the discussion on the results of our previous research works, such a project, commissioned by the Kraków City Hall and unique in the country scale, may easily fulfil the aforementioned tasks.

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[1] The list contains the names of companies which agreed to their names being mentioned in the report. Both, in the case of companies and universities, the list accounts for all institutions that have filled out, in whole or in part, the survey questionnaire or participated in in-depth interviews.

RESEARCH TEAM

Leading experts:

Prof. Jarosław Górniak, PhD., [prof. dr hab.], dean of the Faculty of Philosophy of the Jagiellonian University, director of Centre for Evaluation and Analysis of Public Policies, director of Department of the Sociology of Economy, Education and Research Methods at Institute of Sociology of the Jagiellonian University. A sociologist and an economist, an expert in social research methods and data analysis, evaluation methodology and analysis of public policies as well as the sociology of economy and organisation. Scientific patron of the systemic research project "Study of Human Capital in Poland" (BKL) and previously – director of multiple research projects and author of studies on the labour market and public policies. A member of the Consulting Council at the Presidium of Kraków.

Prof. Małgorzata Kossowska, PhD, [prof. dr hab.], deputy dean for educational issues at the Faculty of Philosophy of the Jagiellonian University, director of the Social Psychology Unit, president of the Polish Society of Social Psychology (2008-2011 and 2011-2013), President of the Management of the Interdisciplinary Centre for Organizational Research and Development at the Institute of Psychology of the Jagiellonian University (ICBRO). She conducts research connected with issues such as: individual differences, political approaches and beliefs, conditions for political beliefs, cognitive rigidity. Holder of multiple prestigious prizes and distinctions. Author of numerous books and articles.

Team members

Piotr Prokopowicz, holder of PhD title in liberal arts and sciences, graduate of sociology and psychology at the Jagiellonian University. Assistant of deputy dean for development at the Jagiellonian University, associate researcher at the Center for Evaluation and Analysis of Public Policies at the Jagiellonian University. Co-worker and lecturer at Cologne Business School and Jagiellonian University, Visiting Fellow at Saint Mary's University in Halifax. Specialist in organisation of research and data analysis. When working as a consultant for Great Place to Work Institute Europe in Copenhagen, he took part in preparing the list of 100 best employers in Europe and South America. Author and editor of many studies, books and articles about sociology and psychology of management.

Grzegorz Żmuda, psychologist and sociologist, Managing director, ICBRO, manager of a specialization path in organisational psychology at the Institute of Psychology of the Jagiellonian University. He specializes in psychology of management and organisation, in particular in psychological organisational diagnostics, participatory management and psychology of personnel. He is also working on creating innovative tools for organisational development. He is working on his PhD thesis concerning the preferences of management styles among the young entrepreneurs, he is the author of multiple publications and presentations about organisational psychology.

Katarzyna Jaśko, holder of a PhD title in liberal arts and sciences, a psychologist. She specializes in social and political psychology. She is working on the conditionality of beliefs about justice, in particular in the context of inter-group relations. She is also interested in psychology of purposes and motivation as well as in creativity. Author of multiple articles about motivation through compensation.

Joanna Pyrkosz, psychologist, managing director, ICBRO, manager of a specialization path in organisational psychology at the Institute of Psychology of the Jagiellonian University. She specializes in psychology of management and organisation, in particular in psychology of entrepreneurship and project management. Author and coordinator of many development projects for the University, with the support of the European Funds. She is working on her PhD thesis concerning the impact of motivation factors of young entrepreneurs on their professional success. She holds a British certificate NVQ 3 issued to vocational counsellors.

Karolina Dukała, psychologist, PhD student at Social Psychology Unit of the Institute of Psychology at the Jagiellonian University. She specializes in psychology of hearing and lies. Certified trainer in group training; leads training sessions mainly in personal development and application of soft skills in business, with particular focus on negotiations. President of the Jagiellonian University Society of PhD Students, engaged in the promotion of science and arts and involved in the development of a platform for co-operation between businessmen and Jagiellonian University scholars.

Bartłomiej Baryła, sociologist. He specializes in social psychology and behavioural economics, paying particular attention to the areas at the junction of psychology, sociology and economics. A scholarship holder of Central European University in Hungary and Antioch College in USA.

Maciej Taraday, psychologist, PhD student at the Experimental Psychology Unit of the Jagiellonian University. He participates in the PhD research project on educational measurement. Fields of interest: relationship between working memory and human intelligence, cognitive control, methodology of research and statistics. He is a holder of many awards and fellowships. He specialises in statistical analysis using R, SPSS, STATISTICA and AMOS programming environment.

Marianna Król, psychologist, PhD student at Social Psychology Unit of the Institute of Psychology at the Jagiellonian University. As a coach and a trainer she specializes in holding development programmes for companies and organisations, which include trainings in soft skills necessary for effective acting in a complex business environment and individual coaching sessions focused on increasing efficiency and motivation among the employees.

KEY UNDERLYING ASSUMPTIONS

Adapting the educational offer to the needs of the labour market continues to be one of the main topics of discussions concerning university education development directions, technology transfer and mutual relations between business and educational institutions. As the topic gets more and more exposed, the risk that the problem will be oversimplified or generalised gets increasing, which obstructs cooperation instead of making it easier. One of the main goals of research works carried out within the framework of the balance of competences is to demythologise the problem of intellectual capital transfer from universities to business. Another goal is to create an objective description of expectations and perspectives adopted in the perception of the process of educating students.

The starting point for the study of competences are the needs of Kraków's businesses. It does not mean that the needs should be the only one factor defining the quality and nature of educational programmes. In this context, we want to emphasise clearly what we wrote in the previous report, i.e. that our views are far from sharing quite a common belief that universities must adapt their educational offer to the labour market regardless of what the market looks like. A view that problems related to cooperation between universities and business arise only from employers not being ready or being unable to use the potential offered by universities, in our opinion, cannot be upheld, either. Our goal is to present a perspective that will enable the main stakeholders – students, universities, employers and public authorities – to get to know better the relationships between demand for and supply of certain competences, and to develop solutions which will serve each of the interested milieus.

One of the already diagnosed problems related to cooperation between universities and businesses lies in that there is no common language and notions suitable for the description of human resources. There are several factors indicating that the said barrier will diminish when the guidelines provided by the National Qualification Framework (Krajowe Ramy Kwalifikacji) are implemented more efficiently by the universities and the educational effects are used in a more professional manner. A detailed discussion of the problem is presented in last year's study[2], while this time we present only key information related to the meaning of core definitions.

In this report, as in that of the previous year, we define "competence" as: "a set of behaviours belonging to a common category, enabling effective realization of the purposes in an organisation and the tasks at the given position, determined by various psychological factors."

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[2]   Balance of competences in BPO and ITO in Kraków. http://www.krakow.pl/zalacznik/1165 Chapter: The premises behind the study of competences

In this understanding, competences constitute sets of behaviours connected with characteristics expected at the given position. The following list includes the categories of factors, identified in the demand analysis:

- Knowledge – information acquired during learning process (e.g. knowledge related to heat circulation in buildings, graphic composition, etc.)

- Skills – learnt actions within a given area (e.g. operation of MS Office, a foreign language, but also communication and social skills, etc.)

- Abilities – inborn predispositions within a given area (e.g. analytic abilities)

- Other – the qualities that cannot be attributed to the aforementioned categories (e.g. mobility, integrity, etc.)

In order to make the discourse clearer and simple, further in this study, the term "competence" will be used collectively to denote their behavioural manifestations in the aforementioned categories. This approach is compliant with both: the Polish research tradition and the commonly accepted international convention.

Competences, which constitute one of the key notions in businesses, find their counterpart at the universities in the notion of educational effects. Kraśniewski[3] says that the essence of educational effect may be found simply in "a statement (–) what the learner should know, understand and be able to do after a certain period (process) of education." In Poland,. educational effects are often classified in three categories: **knowledge, skills and social competences**. However, these categories often overlap. Within the framework of our study we made a simplifying translation of expectations related to competences into the code of educational effects. As in the previous study, we decided to use a general catalogue of effects so that they may be easily specified in details and adapted to specific fields of study.

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[3] Cf: : A. Kraśniewski (2011). Jak przygotować programy kształcenia zgodnie z wymaganiami Krajowych Ram Kwalifikacji dla Szkolnictwa Wyższego. [How to prepare curricula in compliance with the requirements of the National Qualification Framework for Universities.]   Warszawa: MNiSW; E. Chmielecka (2010). Autonomia programowa uczelni. [Curriculum autonomy of universities] Ramy kwalifikacji dla szkolnictwa wyższego. [Qualification framework for universities] Warszawa: MNiSW; Rozporządzenie Ministra Nauki i Szkolnictwa Wyższego z dn. 02.11.2011 w sprawie Krajowych Ram Kwalifikacji dla Szkolnictwa Wyższego [On the National Qualification Framework for Universities]

RESEARCH METHOD

The research method applied for the purpose of this report has been considerably modified as compared to research related to BPO/SSC and ITO/IT sectors. The factors which made the modifications necessary, provide, as such, important information related to the analysed sectors and deserve to be briefly described here.

The first important factor is related to the technique of defining a sector. In case of four sectors analysed in this year's study, there occurred more substantial differences in opinions as to the criteria for the classification of a business to a given sector . In order to meet the challenge, in-depth additional interviews with persons related to each sector were also incorporated into the preparatory phase of the study. The interviews allowed, inter alia, to additionally precise definitions previously adopted and to identify companies and specialisations of university studies of vital importance for the sector. Exceptionally important remarks were provided by the Regional Labour Office. Another challenge that we faced was related to the defragmentation of the sectors analysed in this year's study, as compared to the BPO/SSC or ITO/IT sectors. Of course, there are large companies in each sector, but most businesses may be classified into small and medium enterprises (SME). This fact made it impossible to cover the whole population of the representatives of the analysed sectors.

With view to the budget of and the number of personnel engaged in the project, the whole set of companies employing more than 9 employees, engaged in activities selected according to the Polish Classification of Economic Activities (PKD) was included into the survey pool, except the sectors of passive and low-energy building and some PKD segments of the other sectors where PKD does not provide sufficient information on the profile of activities and its application appears impracticable. The pool was extended by a target sample from micro-enterprises , following recommendations of experts from a given sector and based on activities in the business space (participation in fairs and sector events, high recognition of the company). Although such approach directly implies that the overall assessment of the size of employment in a given sector (no random sample available) is impossible, it helped to improve the evaluation of market trends and anticipated dynamics of the demand for competences.

The previous report was criticised for the importance of specialist "hard" competences having been underestimated in it, whilst soft competences were given too much focus. As it occurred later, such distribution of results was, to a considerable degree, caused by the specific features of outsourcing sectors and by the employers focusing mostly on the importance of competences missing in their sectors. In the event of all the sectors analysed in this year's study, exactly the same relationship was observed at the initial stage of research, save that the phenomenon was manifested to a smaller degree in the life science and in the passive and low-energy building sectors. The representatives of companies and experts attached the highest weight to soft competences and ability to use acquired knowledge in practice. In regard of the foregoing, the subject of the analysis was extended by job offers from the whole country, combined with the classification and categorisation of information on specialist knowledge and skills specific for the sector and/or jobs offered to university graduates (with maximum 1 year of experience).

The extension of the initial list of competences required that the research tools had to be modified so that their use would be less time-consuming. The time needed by the participants to take part in the project had to be reduced also with view to the relatively low interest of companies in the participation in the project, which fact was identified at the initial stage of the project. While the last year's research scheme provided that the supply questionnaire required 1.5h to 2h to be filled in, depending on the profile of the company, the time needed to fill-in this year's questionnaire required 30 minutes or 1 h, although the number of assessed competences was greater.

Within the framework of the research work, we decided that the analysis of demand for competences should be carried out at a more general level (in abstraction from specific jobs/positions). There were three reasons for such decision. Interviews with experts and employers indicated that the development of the Strategic Human Resource Management (SHRM) considerably varies from one company to another. We also noted a trend that there were no schemes for the creation of jobs/positions (defined as employment under labour contracts) and that the cooperation under another legal scheme (under civil law contracts, for instance) appeared more important and prevailing, which phenomena occurred quite common (particularly in the creative sector and in the passive and low-energy sector) and depends on the nature of actually performed projects. Entities subject to the study quite often indicated that their seeking of employees and collaborators depended on the winning (or failing to win) a certain project. With regard to the foregoing, the companies, although being capable of indicating clearly what competences are now important for them and will be such in the future , cannot or are reluctant to give a reply to the question how many employees and at which positions they will employ in a longer perspective of time.

All modifications adopted in our approach were also reflected in the tools applied for the purpose of the analysis of supply from Kraków's universities. The tools are presented in the appendix to this report. To summarise the foregoing, the research work consisted of the following steps:

1.   Initial phase

a.   In-depth interviews with experts and persons related to a given sector and consultations with the Kraków City Hall and the Regional Labour Office, Kraków, purported to define more precisely the notion of a sector, as well as to recognise the context in which a given sector operates and, identify key players (on the part of businesses and universities). At the initial phase ca. 10 interviews and consultations were carried out in regard of each sector.

b.   The desk research of the sector and the analysis of job offers, purported mainly to identify key challenges faced by the sector, and to develop an initial list of competences sought by employers.

2.   Analysis of the demand for competences

a.   In-depth interviews with the representatives of selected companies, which gave insight into the sector experience related to recruitment procedures, selection and development

of employees, as well as the assessment and completion of the list of competences sought (competence demand questionnaire).

b.   The development and testing of the competence demand questionnaire as a research tool.

c.   The development of the pool of companies, based on PKD items related to the lifescience sector, desk research analysis as well as guidelines provided by experts and companies. The initial list of companies invited to the research work counted 93 entities. After the list had been reviewed, in the course of which certain entities were removed from the list where they no longer existed, had moved their activities to other towns, or no longer carried out activities related to a given sector, or where they had declared that in the next five years they would not employ university graduates, the base survey sample counted 60 items.

d.   Survey of sector companies with the use of questionnaires, which allowed to collect quantitative data on current and projected market requirements concerning the most important competences of the graduates of Kraków's universities, and to assess difficulties in acquiring such competences along with opinions on the responsibilities of universities for teaching the said competences. In addition, we collected information related to employment schemes (for 2014 and 2019), as well as information on competences required of graduates in order to get promoted in their companies, fields and specialisations of university studies the profiles of which, in the opinion of companies, fitted best the profile of their businesses (in the lifescience sector, the survey covered 9 companies in total, employing – under various legal forms – almost 1000 employees, which makes 17% of the survey sample realization; as many as 50% of companies definitely refused to participate in the survey, whilst others declared their being ready to participated, but eventually failed to fill-in the questionnaires).

3.   Analysis of the supply of competences

a.   The development and testing of the competence supply questionnaire as a research tool.

b.   The development of a survey sample for research of the fields and specialisations of university study (based – in the lifescience sector – on information provided by desk research analysis, guidelines provided by experts and companies, the initial list of field study invited to participate in the research work – total: 40)

c.   Structured interviews combined with filling in the supply questionnaire, purported to obtain quantitative data on currently achieved educational effects and projections of the number of future graduates, as well as to get insight into the context in which the field of study exists, challenges related to cooperation with businesses and expectations from companies and the Kraków City Hall.

d.   Questionnaire on-line survey of the representatives of universities responsible for the profiles of the curricula of studies. The main purpose was to collect quantitative information on currently achieved educational effects and on projections of the number

of future graduates. In addition, we collected information on additional educational effects that may be of significance to the sector and that are achieved at a given field of study. For the purpose of the lifescience business sector survey, the questionnaire was filled up by the representatives of 13 fields of studies (out of less than 20, including post-graduate studies), currently attended by more than 1000 students of full-time courses and other forms of studying, which makes 33% of the sample realisation.

SECTOR DEFINITION

Life science sector is made up of enterprises and scientific institutions engaging in examining and using live organisms (proteins, cells and tissues, plants and animals) in scientific research as well as deploying the outcomes of the research in technological processes. This definition encompasses pharmacy, biology as well as biotechnology[4] or genetics. Life science sector is a key domain for agriculture, pharmacy, medicine, or industrial manufacture of food.

Based on the Polish Classification of Activities (PKD)[5], the entities belonging to this sector include: 72.11.Z Research and experimental development on biotechnology, 72.19.Z Other research and experimental development on natural sciences and engineering, 21.10.Z Manufacture of basic pharmaceutical products, 21.20.Z manufacture of pharmaceutical preparations, 46.46.Z Wholesale of pharmaceutical and medical goods.

The definition of the life science sector adopted for the purpose of the present report is narrower and covers, first of all, **entities active in the area of technological processes and healthcare**. These are mainly **pharmaceutical companies (developing, manufacturing, and distributing medicines), biotechnological companies as well as enterprises conducting clinical trials and performing quality audits in pharmaceutical and biotechnological companies.**

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[4] Biotechnology can be divided into: while biotechnology (industrial biotechnology, based, *inter alia*, on biocatalysis), red biotechnology (concerned with discovery of new solutions in the area of healthcare) and green (connected with agriculture).

[5] In some cases, PKD codes do not enable adequate identification of entities belonging to a given sector, as the list of codes is not exhaustive and companies operating in a given area may report other activities as their core business. In such cases, identification of companies belonging to the sector was based on opinions of experts, other companies operating in the sector, and desk research of sector-related web portals and sites.

BASIC INFORMATION ABOUT THE SECTOR[6]

Kraków is justifiably considered the Małopolska's innovation centre[7]. In order to retain this status and enhance its potential, the city has to be ready for investments in selected sectors and for promotion in areas where the city's intellectual capital is deployed. This is the only way to get international attention, attract investors and capital, and ensure inflow and development of state-of-the-art technologies. The result may be economic growth of the city and better quality of life of its residents.

The analysis entitled "2020 Kraków-Małopolska Technological Perspective"[8] identifies 10 technologies with the greatest growth potential for Kraków. Two of them belong to the life science sector and two other to bio information technology which, according to many experts, can be considered a life science domain.

One of the Poland's most innovative companies in life science – Selvita – is located in Kraków. It fully utilises the scientific potential of the city and employs trainees and scientists from Kraków universities, providing biotechnological and bio IT solutions to other entities. It is also one of very few enterprises conducting own research and development works. Pioneering character of Selvita's solutions has been noticed and the company has received numerous awards, including 2011 Małopolska Innovator and honourable mention in GRAND PRIX EXPOCHEM or in Innowator 2012 competition organised by Wprost weekly[9]. This flourishing company quoted on New Connect market is unfortunately an exception in Kraków.

The situation is not better in the pharmaceutical industry. This sector is dominated in Poland by foreign companies and Kraków is practically not present in the list of locations of the largest Polish pharmaceutical companies[10]. Only one of the thirty largest enterprises (Teva/Pliva) has its manufacturing plant in Kraków, producing mainly generic drugs[11]. A medium company that can boast its own R&D work is Instytut Biotechnologii Surowic i Szczepionek Biomed. Biomed's

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[6] This chapter is based on desk research of documents and publications concerning the sector and on the information obtained from interviews with experts and with representatives of business entities and universities.

[7] Nadolny, M., Krok-Baściuk, I., Puzio-Literska, A., Bachórz, A., Kwiatkowski, T., (2012). Ocena transferu wiedzy i powiązań sfery B+R oraz instytucji otoczenia biznesu z przedsiębiorstwami w województwie Małopolskim w 2012 roku. [Assessment of Transfer of Knowledge and links between R&B work and business environment institutions with business enterprises in Małopolska in 2012].

[8] Bendyk, E., Kisieliński, S. (red.)(2010). Perspektywa technologiczna Kraków – Małopolska 2020. Wyzwania rozwojowe ["2020 Kraków-Małopolska Technological Perspective. Developmental Challenges"].

[9] http://www.selvita.com/pl/o-firmie/nagrody-i-wyroznienia

[10] PwC (2011). Wkład innowacyjnego przemysłu farmaceutycznego w rozwój polskiej gospodarki, Raport. [Report on Impact of Innovative Pharmaceutical Industry on the Growth of Polish Economy.]

[11] http://www.teva.pl/u235/navi/33165

core activity is the manufacture of probiotics, dietary supplements, and vaccines[12]. The scale of operation of other companies is much smaller and they do not generate demand for university graduates of life sciences or for technological implementations tested by Kraków universities. Smaller companies standing out against their competitors are: Wytwórnia Euceryny Laboratorium Farmaceutyczne COEL[13], Amara[14] or Farmina[15]. They manufacture simple pharmaceuticals, such as eye and ear drops, syrups, hydrogen peroxide, or bases for ointments and creams. The majority of Kraków's pharmaceutical companies are characterised by low level of innovation and are hardly recognisable abroad . They manufacture mainly generic drugs and do not conduct R&D works which would result in launching new drugs. They usually focus on tests of dietary supplements, with much simpler clinical procedures, which are not innovative and whose allegedly beneficial influence on health is often contested by medical circles[16].

The situation looks better when it comes to public institutions and organisations supporting life science sector. Kraków is the seat of the Institute of Pharmacology and of Physiology of Plants of the Polish Academy of Sciences (PAN) as well as Faculty of Biochemistry, Biophysics, and Biotechnology of the Jagiellonian University, which is a leading Polish research entity in the area of life science[17]. There are also two life science clusters in Kraków: Life Science and Centrum Transferu Technologii Medycznych [Medical Technology Transfer Centre].

Centrum Transferu Technologii Medycznych[18] is an enterprise formed by Krakowski Szpital Specjalistyczny im. Jana Pawła II [Kraków Specialist Hospital] with a view to supporting the collaboration between scientific units and R&D centres with private entities, managing patents, and supporting implementation of technologies. Another entity is Life Science Cluster[19] established in 2006. The authors of the project emphasise that it is the first such project in the Central and Eastern Europe. The cluster's infrastructure is managed by Jagiellońskie Centrum Innowacji [Jagiellonian Innovation Centre] (JCI). JCI is also represented in the cluster's executive bodies and invests in new enterprises from life science sector via a seed fund – JCI Venture. Cluster members are three representatives of local administration, six education entities, six research and development institutes, 15 hospitals and other entities related to healthcare, 19 entities from business environment, and 21 manufacturers. Presently, there are no data available, describing benefits from the presence in clusters or giving a cross-sectional picture of the condition of the cluster members. Enterprises-members of the clusters do not have any particular achievements in the form of new patents (except for a few notable exceptions) or new innovative solutions implemented in life science sector. Undoubtedly, clusters deserve credit for

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[12] http://www.biomed.pl/en/Company/About_company
[13] http://www.coel.krakow.pl/onaszejfirmie
[14] http://www.amara.pl
[15] http://www.farmina.pl/
[16] http://health.usnews.com/health-news/articles/2012/05/10/vitamins-and-supplements-do-they-work-2
[17] http://www.aktualnosci.pan.pl/images/stories/pliki/2013/Wiadomo%C5%9Bci_biez/A.pdf
[18] http://www.ctt.krakow.pl/
[19] http://lifescience.pl/o-klastrze-lifescience

organisation of a platform for sharing knowledge and views , where regular meetings and seminars take place. It is hard to capture in statistics the actual value of informal meetings and contacts that can be made on such occasions, but in the long run they may translate into new projects and joint initiatives.

In 2013, a joint initiative of the Jagiellonian University and Agricultural University resulted in the establishment of Małopolskie Centrum Biotechnologii [Małopolska Biotechnology Centre][20]. The role of the centre is to coordinate collaboration between science and business and scientific research in the area of biotechnology, food safety, nutrigenomics, and in other related domains. The centre is not yet fully operating; hence, it is difficult to assess the impact it may have on the life science sector in Kraków.

Another initiative is the Life Science Park[21] established in the Jagiellonian University campus, which is a complex of buildings of the total area of 20 thousand m^2 to be leased out to newly established enterprises. The buildings house numerous laboratories divided into small modules, which are intended to facilitate commercialisation of research outcomes of young scientists. The laboratories meet high standards, thus allowing for the conduct of chemical and biological tests. Location within the UJ campus ensures proximity of faculties, inter alia, of biotechnology, chemistry, biochemistry and others dealing with life science. The project may trigger off development of small and medium enterprises, but since it is in its early stage, it is hard to conclusively assess its potential impact on the life science sector.

According to the surveyed experts, the life science sector in Kraków has enormous, but not yet fully utilised, potential. Experts emphasise the large number of research centres specialising in biotechnology, the extensive and diverse scientific milieu responsible for the innovative character of the conducted research, and the existence of LifeScience Cluster[22]which, by organising sector meetings and conferences, integrates and supports enterprises and the world of science.

BUSINESS AND SCIENCE
The greatest advantage of the life science sector in Kraków is, according to experts, the huge scientific potential of Kraków universities. This covers both the scientists who are the foundation for the development of the sector as well as numerous highly-qualified university graduates who may become the driving force of new initiatives. Kraków attracts many talented students from south-eastern Poland and its universities usually occupy top position in university rankings concerning studying quality. Translating this potential into actual economic value is a challenge faced by local authorities and enterprises operating on the local market.

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[20] http://www.mcb.uj.edu.pl/pl/index.php
[21] http://www.jagiellonskiecentruminnowacji.pl/pl,articles,lsp,life_science_park,12.html
[22] http://lifescience.pl/o-klastrze-lifescience

Experts are of the view that Kraków is an internationally recognisable city; hence, attracting investors, entrepreneurs, and – most importantly – scientists is easier than in the case of other Polish cities. This is the case with organising conferences, symposiums, and meetings as well as with the ability to find prominent scientists willing to come here to conduct research and teach.

Despite considerable scientific potential, experts emphasise that Kraków lacks specialists in domains of key importance for the sector, such as epidemiology or biostatistics and experts capable of designing clinical trials. They also point to the fact that universities do not develop soft skills which may be decisive for the success of a given project. To be able to address the challenges faced, enterprises from the life science sector need employees who are able to collaborate and to work independently, which is often a problem for many graduates. Graduates often do not meet employers' requirements in terms of knowledge they possess, too. This is partly due to fast advancement observed in this sector. In many cases university syllabuses do not account for the latest scientific developments, thus making the process of employment and introduction of graduates to their job tasks more expensive and longer.

Another issue mentioned by experts is the dispersion of interests and research areas in Kraków research centres, which results in little synergy and inability to take advantage of the effects of scale. Lack of coordination also leads to duplication of projects and ineffective allocation of resources. There is no cooperation between the city (which could play the role of a coordinator) and the research centres and enterprises. The majority of public initiatives concerning life science is not undertaken by the city, but by the region, in particular by the region's Governor's Office. Collaboration of the city and the region could result in increased concentration of financial resources and could improve coordination of the undertaken initiatives, which might result in better performance and more innovation.

Experts mention that Polish research in the area of bioengineering and biotechnology is currently financed mainly from public resources. Small life science companies need significant capital expenditures which may not be recovered, and this sector is particularly capital-intensive due to its specific character and potential threats related to genetic manipulations. With relatively small own funds of Polish life science enterprises and high capital intensity of the sector, funds must be obtained from external sources and coordination of financing provided by the city, region, EU and private investors needs improvement. This will help to finance a greater number of research projects and to implement greater number of scientific discoveries. The effect of scale is also important for the promotion of entrepreneurship. Concentration of promotional effort may expand their reach and translate into increased interest among investors from outside the region. Better coordination of financing, interest among foreign investors and focus on selected niche domains may turn the region into an important player on the international market. If local, regional, and central authorities of various levels speak with one voice, the impact of their actions will be much stronger.

According to experts, another major obstacle hampering the development of the sector in Kraków – apart from financial issues – is lack of coordination among the authorities, science, and business. Leaving aside the existing clusters, there are more areas where the establishment of coordinating entities could significantly contribute to the growth of economic activeness. The establishment of tissue engineering cluster[23] and of Małopolski Ośrodek Medycyny Translacyjnej [Małopolska Translational Medicine Centre][24] could serve as a bridge facilitating the introduction of primary research in the medical market and may help to increase coordination and development of niche domains which could become "Polish specialities".

City authorities may promote Kraków on the international arena as a life science friendly city. The success of promotional campaigns of Kraków as an outsourcing-friendly city may be repeated in other sectors. The city and the region can tighten their collaboration with leading sector's centres[25]. This collaboration may lead to better coordination of international activities and to acceleration of scientific development, due to faster flow of knowledge, capital, and human resources. The city may engage in international cooperation as part of national projects, such as „Welcome to Bio-Poland" conference[26] organised in the USA by the Trade & Investment Section of the Polish Embassy, but also through undertaking individual initiatives utilising the promotional potential and recognisable brand of Kraków.

SECTOR DEVELOPMENT OUTLOOK

Life science is the fastest developing branch of science in the world and the sector with the largest spending on research and development[27]. New research methods and technologies further accelerate the process of discovering innovative drugs and previously unknown biological mechanisms. This knowledge spreads very fast due to disappearing trade barriers and to the global presence of the largest pharmaceutical companies. This, combined with high market access barriers and high costs of clinical trials, causes extensive marginalisation of the global leaders. Therefore, Kraków should seek its opportunity by focusing on market niches which, by their very nature, are rather risky ventures. Only extensive support of primary research from the state and regional authorities as well as financial assistance in new investment projects can mitigate the risk faced by private investors and increase the sector's dynamics in Kraków. Kraków has enormous research potential[28] which does not translate into

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[23] Bendyk, E., Kisieliński, S. (red.)(2010). Perspektywa technologiczna Kraków – Małopolska 2020. Wyzwania rozwojowe ["2020 Kraków-Małopolska Technological Perspective. Developmental Challenges"].

[24] http://www.spin.malopolska.pl/images/Wariant%20obszarowy_CMUJ_MT.pdf

[25] Małopolska is already closely collaborating with Illinois which is an important US centre in life science sector.

[26] http://www.ncbir.pl/en/news/art,1385,welcome-to-bio-poland-explore-our-potential.html

[27] PwC (2011). Wkład innowacyjnego przemysłu farmaceutycznego w rozwój polskiej gospodarki, Raport. [Report on the Impact of Innovative Pharmaceutical Industry the Growth of Polish Economy.]

[28] Bendyk, E., Kisieliński, S. (red.)(2010). Perspektywa technologiczna Kraków – Małopolska 2020. Wyzwania rozwojowe ["2020 Kraków-Małopolska Technological Perspective. Developmental Challenges"].

implementation of new discoveries or formation of new companies; nonetheless, if all recent initiatives operate in coordinated manner, the sector may start developing very fast in Kraków.

Experts think that the number of university graduates and students willing to work in the life science sector is much larger than the employment potential of the enterprises currently operating here. Local market is not able to absorb all interested in working in the sector, therefore many of them go abroad. Those who stay often find jobs that do not utilise their potential and skills or that have nothing to do with their specialisation. Many entities employ persons with a doctor's degree to perform easy laboratory jobs, which is an example of ineffective allocation of human capital and wasting public money spent on education. On the other hand, oversupply of life science graduates may also spark off the establishment of new enterprises in the sector, thus increasing the competitiveness and stimulating innovation. In order to stop the outflow of graduates abroad and encourage them to set up new companies in Kraków, it is necessary to reduce market access barriers. The encouragement may have a form of assistance in registering a new businesses or offering reduced office/laboratory space rental rates.

As any branch of knowledge related to human body, life science sector is particularly likely to be affected by legal regulations aimed at limiting excessive interference in the life of an individual, which may hamper research and necessitate changes in the applied technologies. Many legislative initiatives have regulated issues connected with harvesting, examining, and storing stem cells, causing outflow of funds and, subsequently, of researchers to research centres in countries where no such regulations have been enacted[29]. Enactment of restrictive laws concerning biotechnology in Poland may reduce interest in the sector and cause existing research teams to leave for foreign research centres.

Summing up, the life science sector in Kraków is made up of strong public institutions enjoying political support and engaging in subsequent investments and projects and of relatively weak and small private enterprises, to a considerable degree lacking innovation. In order to be able fully utilise the region's potential in this sector, it is necessary to enhance coordination among key market actors and ensure adequate promotion of the region as an attractive place for investing in life science sector.

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[29] http://www.scmp.com/article/984886/lighter-regulation-lures-stem-cell-scientist-china

PESTER AND SWOT ANALYSES

Presented below are key conclusions from the analysis of the environment surrounding the life science sector. PESTER analysis provides an overview of opportunities and threats originating from the current political, economic, social, technological, environmental, and regulatory situation.

a)   Political and Legal Environment

Excessive legal regulations concerning research and tests on biological material limit the scope of research and the range of research methods used by scientists. This will slow down the scientific development and – what is even a more serious threat – cause the outflow of researchers to places where they can enjoy greater freedom in conducting their scientific work.

A big issue hampering the development of the sector is the scale of patent protection in pharmacy and biotechnology. If the protection is extended over too long periods of time, this will slow down the dispersion of knowledge, reduce the availability of break-through medicines and therapies, and increase the market access barriers. Yet, if the protection periods are too short, it may reduce the availability of capital which is a driving force of the scientific development in this sector.

b)   Business Environment

Economic crisis make many people who cannot find a satisfying job go abroad. It also leads to re-allocation of public funds which are the main source of financing of primary research to other areas, thus slowing down the scientific development.

Małopolska has to compete with other countries, or even other Polish regions, to attract public investment projects and the best human resources. However, the neighbouring regions may become an advantage of Małopolska. The proximity of Śląskie region, with its huge population and strong historical ties with Małopolska, may be very beneficial. The region with relatively well-developed transport network has bigger population potential than Małopolska, and a considerable economic potential.

c)   Social and Cultural Environment

Reluctance towards biotechnology manifests itself most strongly in the case of GMO. Growing aversion and distrust towards pharmaceutical companies accompanied by concurrent growing popularity of "organic" and "natural" products may cause decrease in the sale of medicines and, consequently, financial problems of smaller manufacturers.

Demographic changes connected with the aging of the societies will necessitate fast development of medical technologies in the area of, inter alia, stem cells and gene therapy.

d)   Technological Environment

The pace of development in biotechnology and other segments of life science sector depends on the technological advancement. The discovery of certain technologies enabled the emergence of

genomics and blazed a trail for manipulation with individual genes in order to obtain expected results. Further technological advancement will speed up the development of the sector.

e)   Natural Environment

Natural environment does not have direct impact on the situation in the sector; however, it may have an indirect effect – as a result of global warming, climatic zones may shit, thus causing spreading of diseases which are untypical for a given area. This may increase the demand for pharmaceutical products. Similarly, the growing energy crisis may lead to intensification of search for alternatives to fossil fuels, where biotechnology may be of help.

f)   Regulatory Environment

Although they conduct advanced research and test, Kraków scientists do not patent their solutions. If no mechanism is developed encouraging scientists to ensure protection of their **intellectual property rights**, this may lead to a situation where, despite a technological breakthrough, the fruits of their labour will not be commercialised and profits will be earned by companies which have not incurred any considerable expenditures. One of the areas where innovative solutions are not adequately protected by law is tissue engineering. More attention should be paid in the process of teaching to educate students as regards protection of created intellectual property.

The SWOT analysis that follows is a summary of strengths and weaknesses of the sector as well as opportunities and threats in the surrounding environment.

Strengths of the life science sector in the region:

- Strong public institutions

- Numerous projects aimed at coordinating activities between science and business and at supporting the transfer of knowledge

- Political support for the development of the sector

Weaknesses of the life science sector in the region:

- No innovative enterprises

- Low expenditures on research and development

Opportunities of the life science sector in the region:

- Growing spending of Poles on drugs and dietary supplements

Threats to the life science business sector in the region:

- No investment capital

- Competition from foreign companies

DEMAND ANALYSIS
SECTOR DEMAND FOR COMPETENCES

An overview of findings as regards the demand for competences in the sector begins with a presentation of a list of jobs/positions that are most frequently offered in recruitment processes – the list below is based both on questionnaires as well as interviews with employers from the Kraków life science sector.

Job offers for graduates in the sector, as stated by companies active in the sector
Biologist
Biotechnologist
Production engineer / production process engineer
Operator of machinery and equipment
Sales representative
Analysis specialist
Process improvement specialist
Quality control specialist
Marketing specialist
Drug registration specialist
Synthesis specialist
Technician, laboratory technician

Table 1. List of jobs offered to graduates in the life science sector.

The above list of jobs offered by Kraków representatives of the life science sector suggests that – although homogenous – the sector needs relatively wide range of various jobs to pursue their business goals, from sales representatives, technicians and lab technicians, through research process specialists to marketing specialist.

Quite interesting is the dynamics of employment of graduates in the life science sector in the years 2014 and 2019 (Table 2). It turns out that, as stated by employers in in-depth interviews, any increase in the dynamics of growth of employment in the next five years in Kraków is unlikely. Kraków companies from the life science sector will recruit new employees; however, in 2019, they anticipate rather moderate level of employment.

Graduates employed in 2014	Graduates employed in 2019
8.7%[*)]	5.6%[*)]
Decrease in the dynamics of employment of graduates	

Table 2. Dynamics of employment of graduates in the life science sector.

[*)] graduates to be employed in 2014 and in 2019 as a percentage of current employment level (accounting for all legal forms of employment)

95% of the employees of companies that participated in the research is employed under contracts of employment and only 5% – under civil-law contracts (Fig. 1).
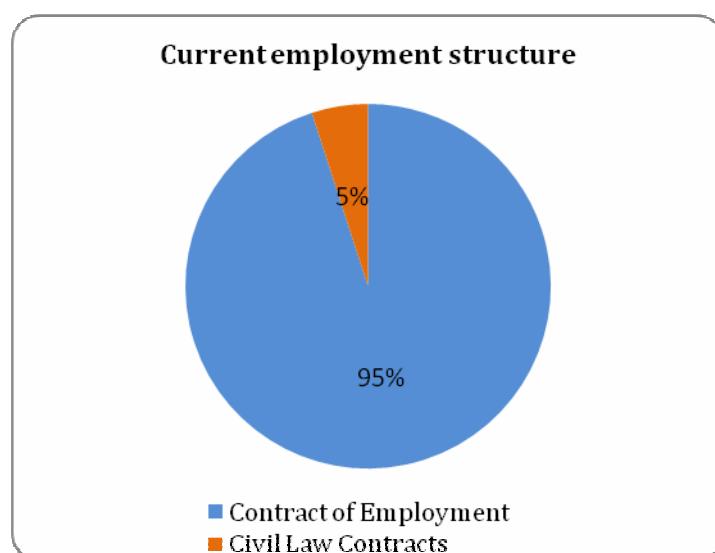

Fig.1. Structure of employment in the life science sector by contract type

A different situation – which is understandable – is observed in the case of planned employment among graduates (Fig. 2). In 2014, as many as 70% of all recruited graduates will be employed under civil-law contracts, while in 2019, this value is expected to fall to 50%. It suggests that, on the one hand, at the beginning of their collaboration with graduates they prefer flexible forms of employment, but on the other, they expect certain stabilisation in the sector over the next five years.
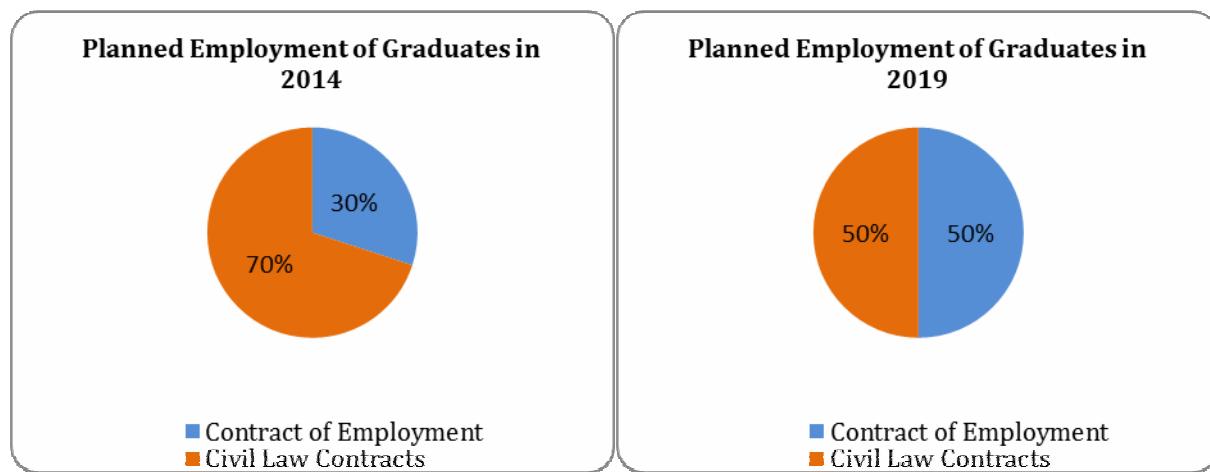
Fig. 2. Structure of planned employment of university graduates in the life science sector by contract type in 2014 and 2019.

THE COMPETENCES OF TODAY AND THE COMPETENCES OF TOMORROW

Before we present results of research works related the importance of given competences for the lifescience sector, it is necessary to make certain reservations.

The competences, subject to analysis, were identified on the basis of the interviews with opinion leaders, companies and the analysis of job offers. For better clarity of the report, the competences were broken down into 5 groups: specialist (professional) knowledge, specialist (professional) skills, business knowledge and skills, soft skills, foreign languages and other requirements. **As extensive as the list of competences is, it is not necessarily exhaustive**. Of course, there may be many companies that operate on the market and that need other competences – often very specific or exceptional.

Within the framework of preparatory works, we attempted to set all sought competences at the same level of generality. Not always was it possible or desirable, though. That is why **competences will vary as to their level of precision**, which fact, to a certain degree, reflects the specific characteristics of the sector.

The companies participating in the survey replied to questions related, inter alia, to the importance of each competence today and in the future. Although the sector is rather homogenous, naturally there are considerable differences as regards the importance of individual competences, depending on the profile and specialisation of a given entity. In practice, this means that regardless of the current employment level, **answers of firms planning to employ a larger number of graduates in 2014 and 2019 are assigned greater weights.**

It should be noted that **presented data reflect opinions of persons who are responsible for human resources policies or the management of companies operating in the sector.** Hence, **the said data have not a prescriptive nature**. In other words, we present the views of persons who manage companies, and we refrain from judging whether such views are correct, or not, and whether strategies based on these views are good.

The presentation of detailed results for each category is preceded by two tables containing the lists of 20 competences to be required from graduates in the nearest and more distant future, perceived by companies as the most important.

Table 3 contains a list of 20 most important competences (requirements) in 2014 and 2019 estimates. The most important – from the perspective of the labour market in the life science sector – are the following competences: **ability to use office applications**, **being concerned about quality**, **integrity**, **analytical skills**, **knowledge concerning clinical trials**[30]. The five competences that will become the most important in more distant future are: being concerned about quality, integrity, knowledge concerning clinical trials, analytical skills, and collaboration. Green fields in the table presenting "competences of the future" denote those competences which recorded the biggest growth in importance among the top twenty – they include: knowledge concerning clinical trials, collaboration, English, experimental method, and HPLC analysis.

20 most important competences (requirements) today	Importance 2014		20 most important competences (requirements) in the future	Importance 2019
Ability to use MS Office, OpenOffice or Google Docs	4.88		Being concerned about quality	4.83
Being concerned about quality	4.83		Integrity	4.83
Integrity	4.83		Clinical trials	4.78
Analytical skills	4.83		Analytical skills	4.67
Clinical trials	4.67		Collaboration	4.67
Commitment	4.60		Ability to use MS Office, OpenOffice or Google Docs	4.63
Learning	4.60		Commitment	4.60
Development orientation	4.60		**Adaptive skills**	4.60
Adaptive skills	4.60		English	4.57
Validation	4.57		Focus on customer	4.50

[30] Precise definitions of these and other skills are provided in the Glossary in Appendix No.1.

20 most important competences (requirements) today	Importance 2014		20 most important competences (requirements) in the future	Importance 2019
Technical English	4.50		Experimental method	4.50
Focus on customer	4.50		HPLC analysis	4.50
Organisation of own work	4.50		Validation	4.43
GMP principles	4.50		Technical English	4.43
Initiative	4.50		Learning	4.40
English	4.50		Focus on development	4.40
Coping with stress	4.50		**GMP principles**	4.33
Analysis	4.50		Initiative	4.33
Hazardous substances	4.43		Organisation of own work	4.33
Operation of apparatuses	4.43		Coping with stress	4.33

Table 3. Competences of today (perceived as important in 2014) and competences of tomorrow (perceived as important in 2019). Orange fields denote competences that within five years will no longer be included in top 20. Green fields denote competences which within five years will enter top 20.

Particularly interesting is that among the first 10 competences which are the most important for the life science sector employers, only two (clinical trials and validation) are related directly to knowledge and skills specific to this sector – the remaining ones are either soft skills or transferable skills (that can be used in various working environments). **This coincides with the opinions of experts who, although they notice the important role of specialist skills possessed by job applicants, point to the significance in professional career of competences such as ability to work in a team, commitment, and being concerned about quality.**

Experts mention also quality audits as a competence which will become particularly important in future. They also pointed to the knowledge of research methodology and the necessity to be up to date with the latest discoveries in the sector as particularly important competences. **What's important, as regards the gaps in the labour market, the weakness of graduates often mentioned by employers was knowledge of the English language, which is particularly important in the sector so much internationalised as the life science.** Yet again, the research findings dispel a myth concerning the knowledge of English among university graduates – although the majority of graduates has basic communication skills, hardly ever are they able to use technical English fluently.

GROUPS OF COMPETENCES

The charts below present detailed results concerning the importance of competences in individual groups discussed in the report (specialist knowledge, specialist skills, business knowledge and skills, languages and other requirements).

In the case of specialist knowledge, the importance of individual competences in the coming years, as declared by employers, should remain more or less the same – the skills considered the most important in this area are and will be: **knowledge concerning clinical trials**, **validation**, **GMP and GLP principles**, **hazardous substances**. Worth mentioning is the expected growth in importance of areas such as: **experimental method**ology, **intellectual property rights**, **statistics**, **international safety standards**, **ethics and bioethics**.
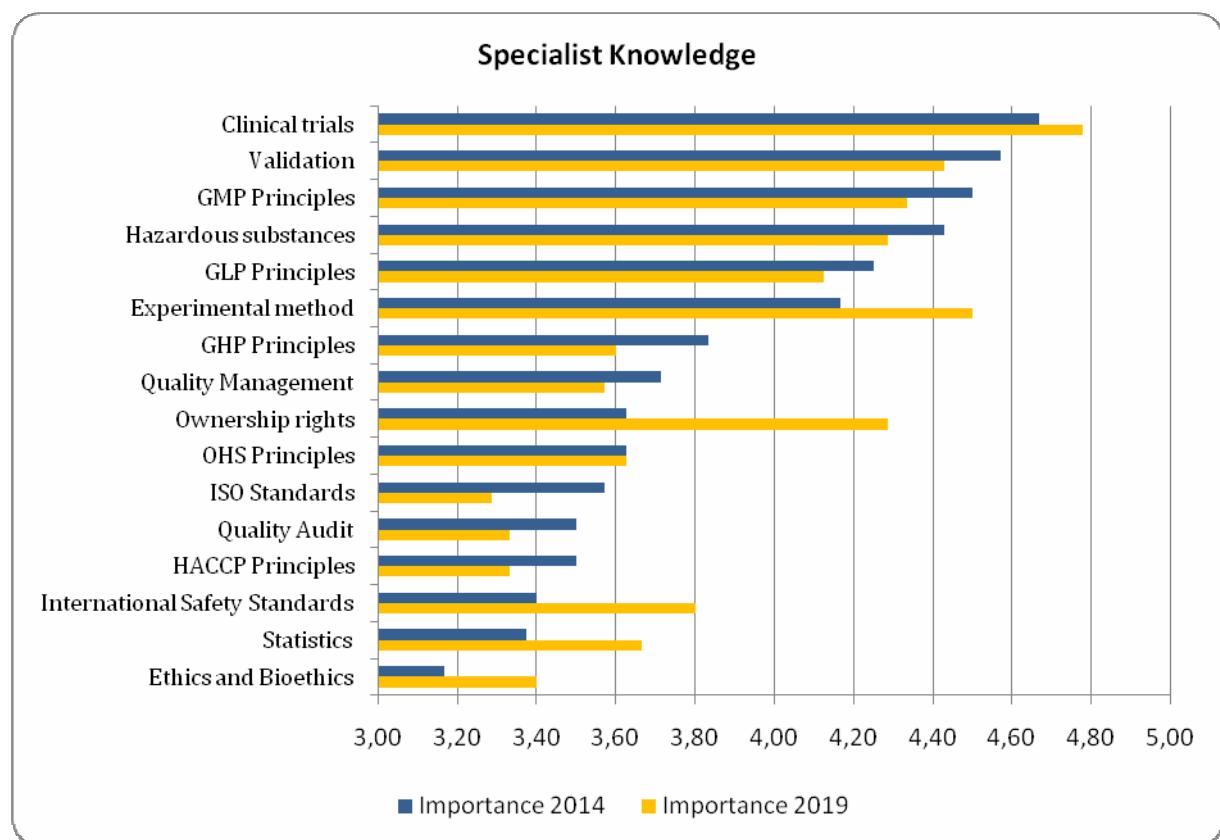

Fig. 3. Expected importance of individual competences in the area of "Specialist Knowledge" as perceived by employers in 2014 and 2019.

Rather moderate changes in the importance of competences expected from university graduates will be observed in the area of specialist skills. The following competences will grow in importance: **HPLC analyses**, **technological supervision**, **ability to use computer designing software** and **information management software**, **clinical projects management**. Specialist skills which are and will be in the next five years the most important include: **analysis**, **operation of apparatuses**, **ability to prepare expert opinions**, **knowledge of information science**, and **reporting**.
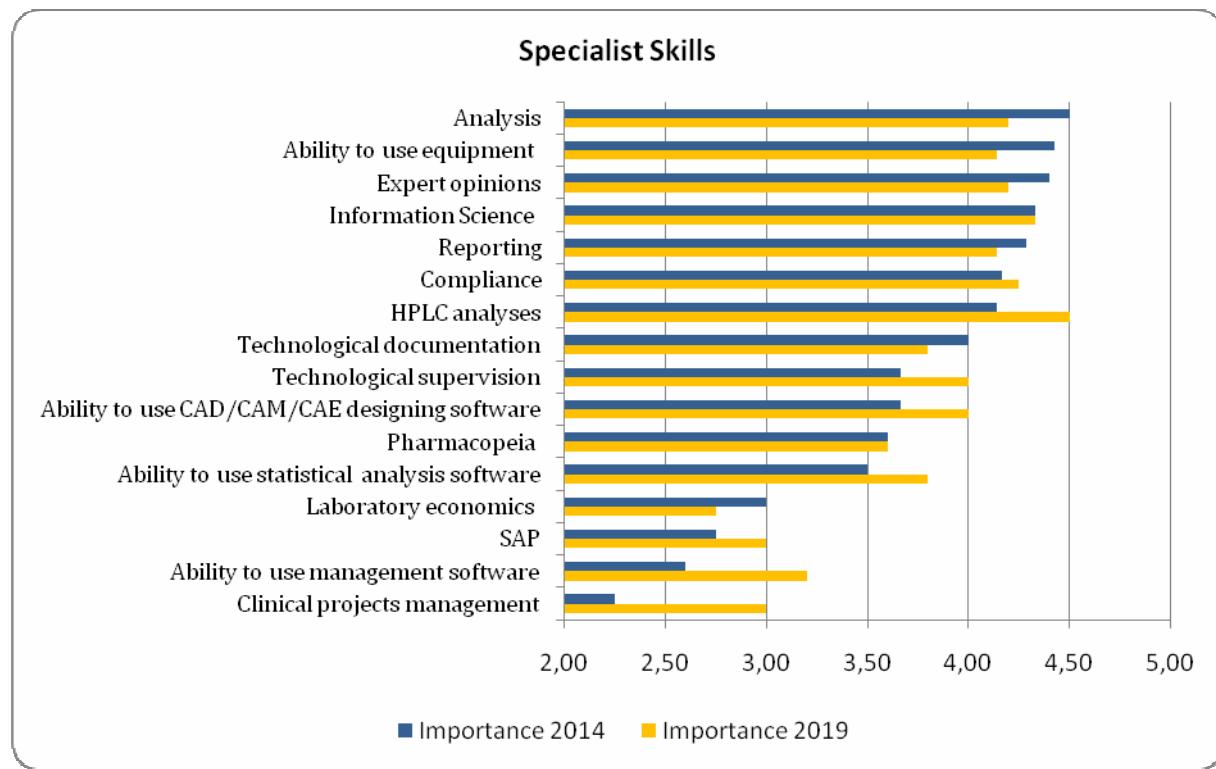
Fig. 4. Expected importance of individual competences in the area of "Specialist Skills" as perceived by employers in 2014 and 2019.

Based on the opinions of employers participating in the research, it can be concluded that in the recruitment process business skills are less important than specialist knowledge and skills. Business representatives pointed to the following competences: **knowledge of new trends in life science**, **project management skills, knowledge of laws governing the sector, business etiquette, and marketing**. Interestingly enough, life science sector employers anticipate relatively big growth in importance of **knowledge of AGILE methodology in project management**; in their opinion, the demand for other competences should remain stable.
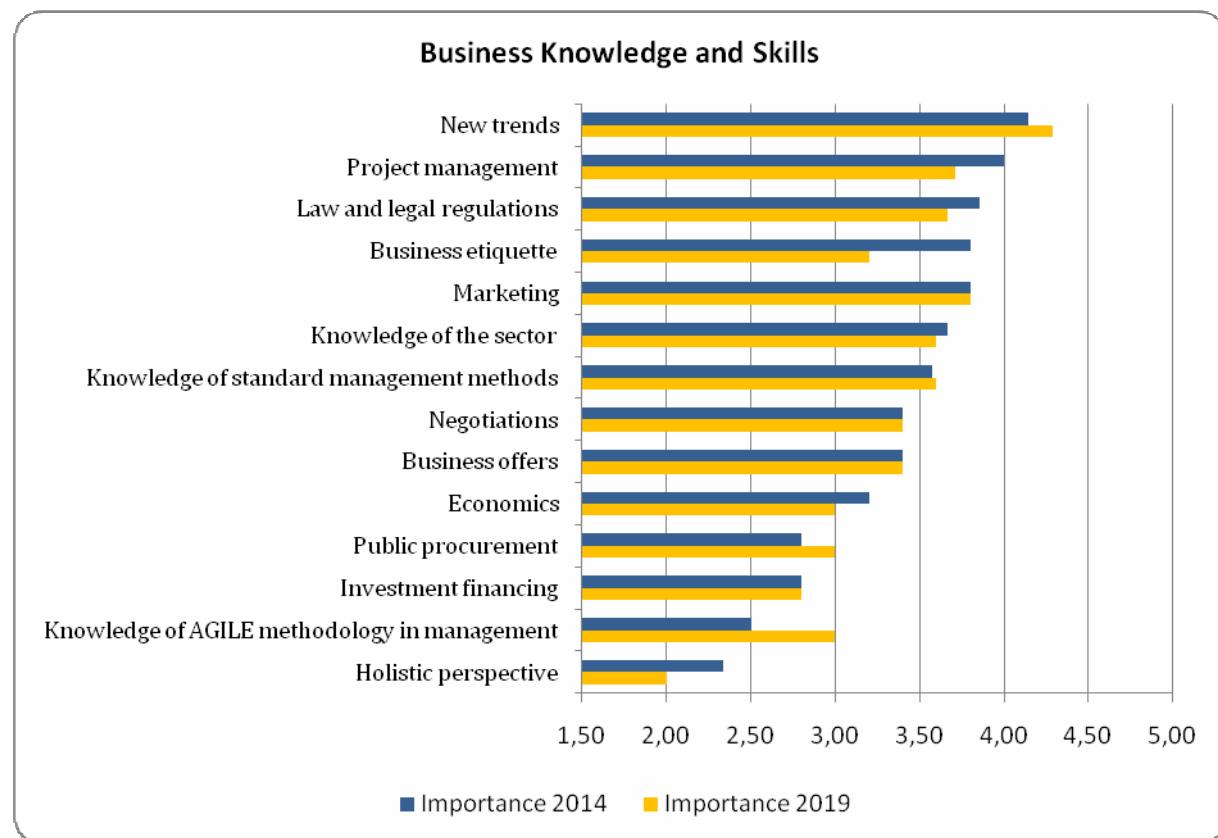
Fig. 5. Expected importance of individual competences in the area of "Business Knowledge and Skills" as perceived by employers in 2014 and 2019.

As already pointed out, employers in the life science sector often consider soft skills as the most important ones. The soft skills which are presently the most desired by business representatives in the life science sector are: **analytical skills**, **being concerned about quality**, **adaptive skills**, **learning and commitment** – their importance should remain high in the next five years. Quite noticeable is low importance assigned by survey participants to the communication skills (both oral and written) for the performance of tasks typical for the sector. This may result from specificity of jobs offered in the sector. Rather worrying are low expectations expressed in the interviews by employers towards graduates as regards innovation – **R&D centres in the life science sector are still located mainly abroad; therefore, the work in the life science sector to a very limited degree consists in developing and implementing new solutions**. Yet, employers expect the growth of importance of written communication and, subsequently, of **collaboration**, **focus on targets (or target orientation)**, and **ability to influence others** in the next five years.
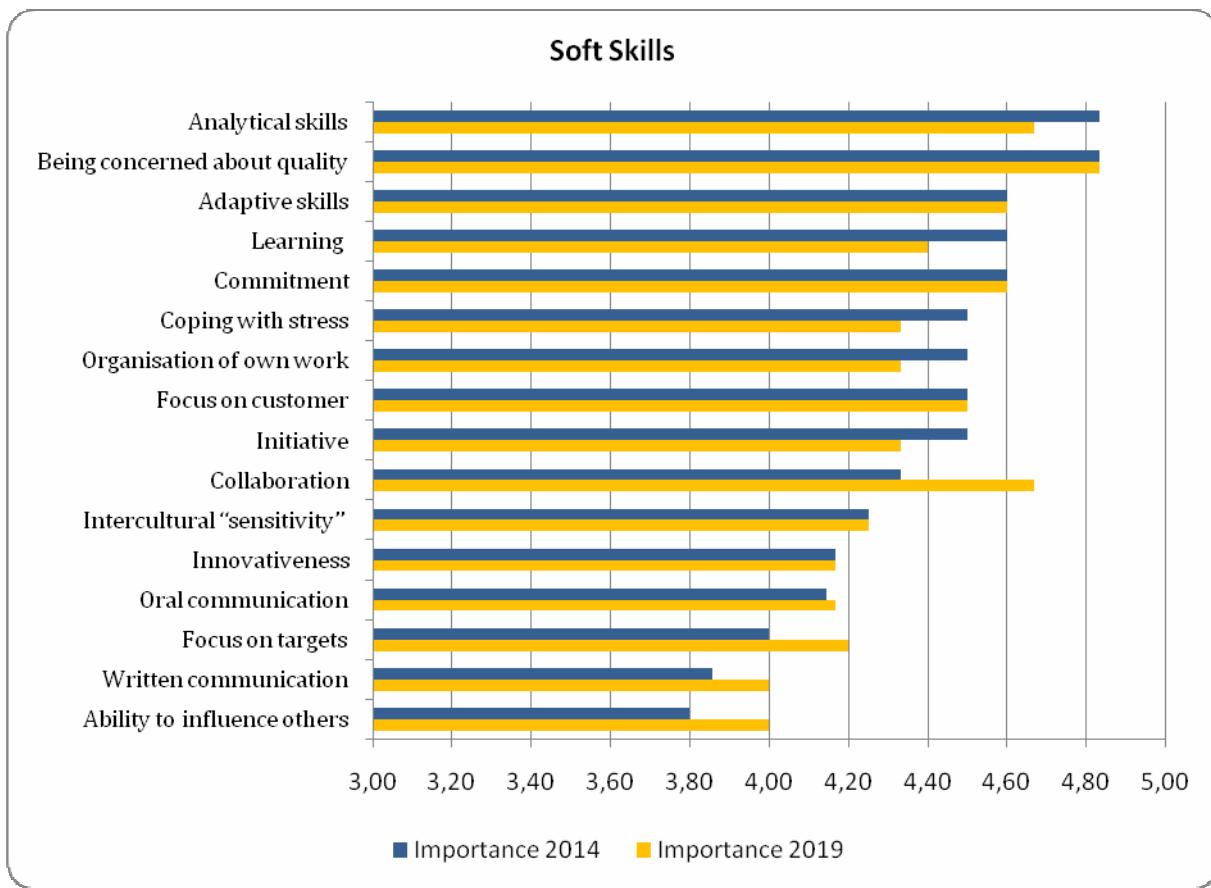
Fig. 6. Expected importance of individual competences in the area of "Soft Skills" as perceived by employers in 2014 and 2019.

As for foreign languages, the most important for the life science sector – presently and in future – is definitely **English, both spoken and technical**. Based on the results and materials gathered during interviews with experts, it can be concluded that university graduates in Kraków should be aware of very high expectations among employers in this respect. Employers anticipate growing importance of **Chinese and technical German**.

As regards other expectations which cannot be classified either as knowledge or as skills, the most important for the life science sector employers are: **integrity**, **ability to use basic office applications**, and **focus on development**. In the coming years, growth in importance will be observed with respect to already very important **mobility**.
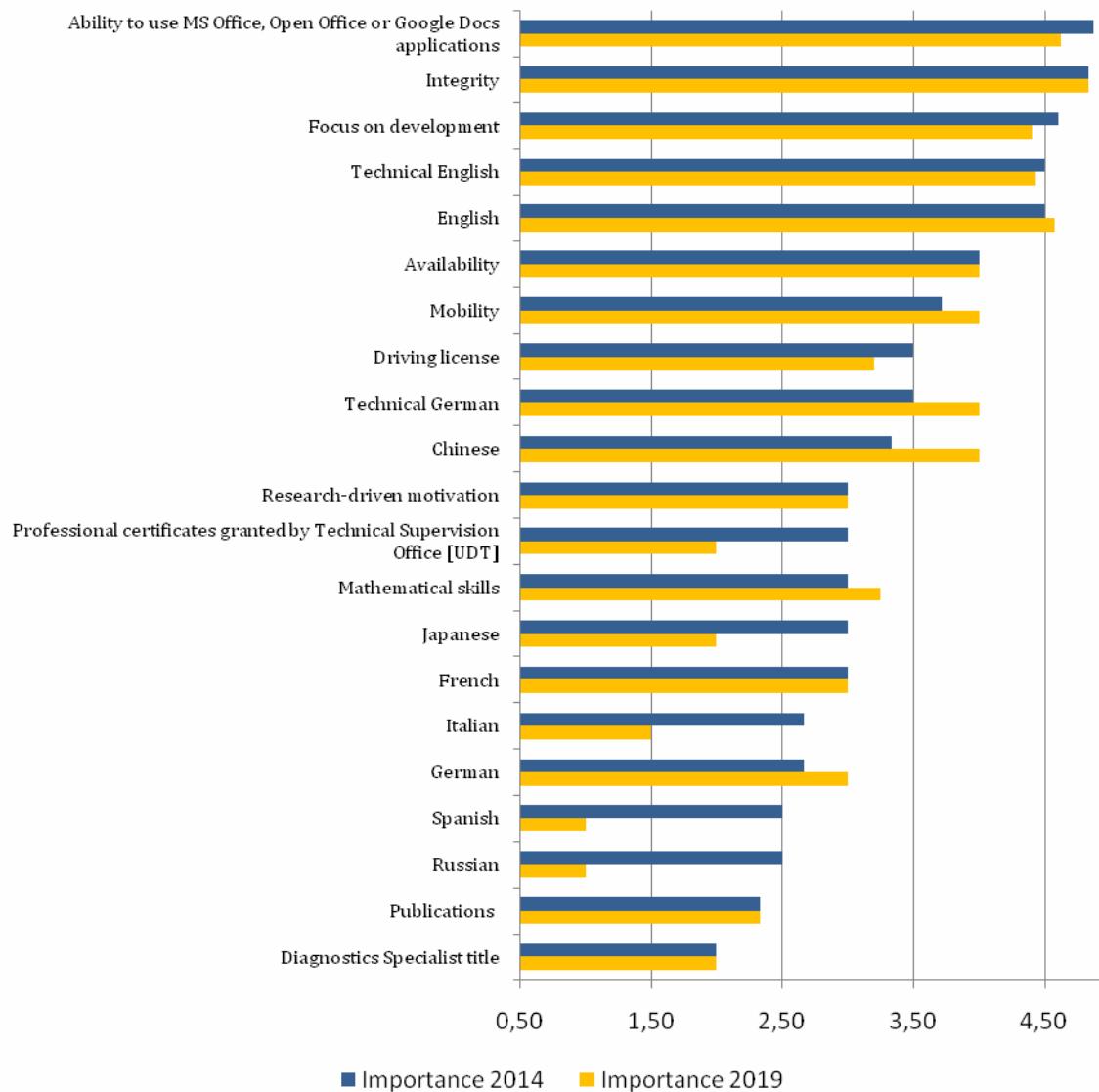
Fig. 7. Expected importance of individual competences in the area of "Foreign Languages and Other Requirements" as perceived by employers in 2014 and 2019.

We asked employers to indicate competences which are of key importance in the context of professional promotion. The list of these competences is presented in table below.

List of competences / requirements of key importance in the context of promotion at work
Experience in chemical analyses
Managerial skills
Specialist competences

List of competences / requirements of key importance in the context of promotion at work
Marketing
Focus on development
Practical knowledge of GMP / GLP
Business understanding
Respect for others
Integrity
Analytical skills
Validation of analytical methods
Collaboration
Commitment
Knowledge of quality management systems

Table 4. List of competences of key importance for graduates in the context of promotion at work

Interestingly enough, the competences mentioned in this context by employers are, to a great extent, soft skills. **This means that although specialist skills are necessary to get a job in the sector, further professional development may depend – apart from business skills – on competences such as integrity, focus on development, or commitment.**

COMPETENCES OF KEY IMPORTANCE FOR THE SECTOR

One of the most important indicator of the perception of the education market from the employers' point of view is the comparison of the importance of certain competences with the difficulty in acquiring them. Data in Table 5 show that amongst 20 most important competences there are those that may be easily acquired (marked in green colour) as well as those that are difficult to acquire (marked in red colour) from the market. Following this line of thinking, competences that from the demand and supply point of view may be considered to be those competences that the representatives of the sector consider important, but hard to acquire like a painfully missing and particularly hardly-available good. Therefore, on the basis of Table 5, one may find that the core competences are as follows: **being concerned about quality**, **validation**, **technical English**, **GMP principles** and **initiative**.

20 most important competences (requirements) today	Importance 2014	Difficulties in acquiring
Ability to use MS Office, OpenOffice or Google Docs	4.88	2.33
Being concerned about quality	4.83	4.00
Integrity	4.83	3.67
Analytical skills	4.83	3.25
Specialist knowledge – clinical trials	4.67	3.33
Commitment	4.60	3.33
Learning	4.60	3.00
Focus on development	4.60	3.33
Adaptive skills	4.60	3.33
Validation	4.57	4.14
Technical English	4.50	3.80
Focus on customer	4.50	3.67
Organisation of own work	4.50	3.33
GMP principles	4.50	4.40
Initiative	4.50	4.00
English	4.50	3.00
Coping with stress	4.50	3.50
Analysis	4.50	3.50
Hazardous substances	4.43	3.50
Operation of apparatuses	4.43	3.50

Table 5. Top 20 competences in the life science sector and difficulties in acquiring them.

In the charts below we present the importance and difficulties in acquiring each competence in 5 major groups (specialist knowledge, specialist skills, business knowledge and skills, soft skills, foreign languages and other requirements).
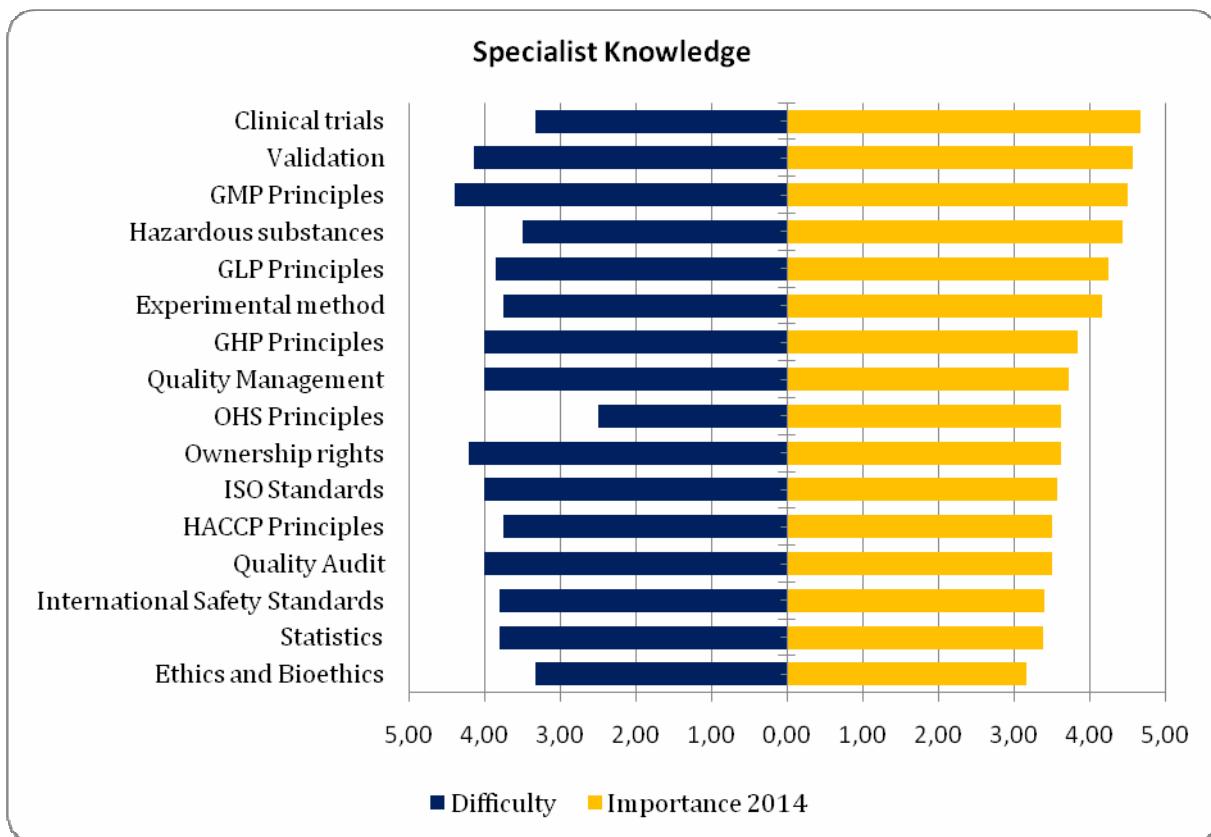
Fig. 8. Importance of and difficulty in acquiring individual competences in the area of "Specialist Knowledge" as perceived by employers.

According to the life science sector employers participating in the research, individual fields of specialist knowledge differ considerably in terms of difficulties with finding graduates who possess them. **Validation**, **GMP, GLP and GHP principles** are considered very important and – at the same time – difficult to acquire, while **specialist knowledge concerning hazardous substances and OHS principles** is perceived as commonly present on the labour market
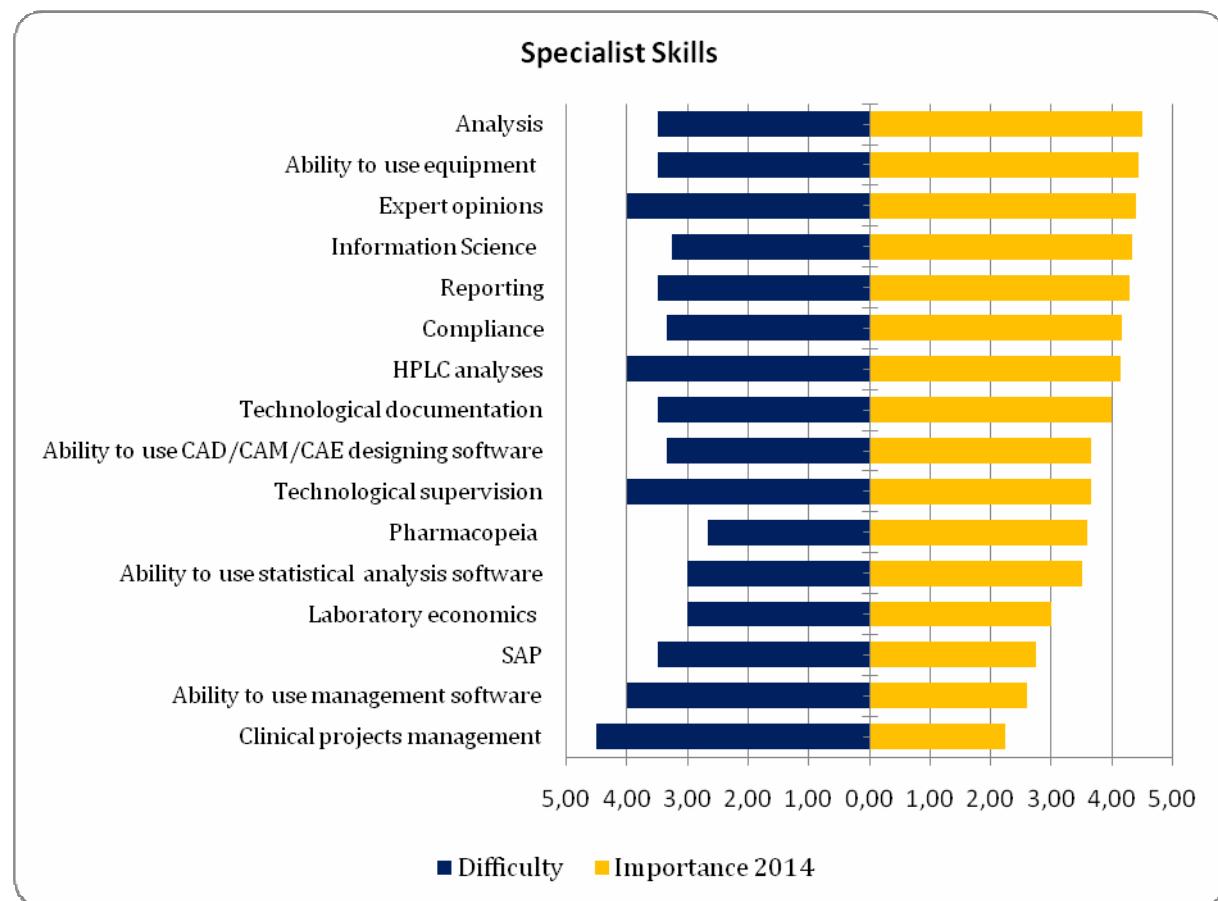
Fig. 9. Importance of and difficulty in acquiring individual competences in the area of "Specialist Skills" as perceived by employers.

As regards specialist skills, the surveyed employers from the life science sector mentioned **ability to prepare expert opinions** and to conduct **HPLC analyses** as important and at the same time difficult to acquire. **Ability to effectively use scientific information and to act in compliance with legal provisions** – although important – are the competences perceived by employers as much easier to find on the labour market.

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Business Knowledge and Skills

New trends
Project management
Law and legal regulations
Marketing
Business etiquette
Knowledge of the sector
Knowledge of standard management methods
Business offers
Negotiations
Economics
Investment financing
Public procurement
Knowledge of AGILE methodology in management
Holistic perspective

5,00 4,00 3,00 2,00 1,00 0,00 1,00 2,00 3,00 4,00 5,00

■ Difficulty ■ Importance 2014

Fig. 10. Importance of and difficulty in acquiring individual competences in the area of "Business Knowledge and Skills" as perceived by employers. The data on difficulty in acquiring competences as regards "Holistic perspective" are unavailable.

As regards the group of competences referred to in the report as "business knowledge and skills", employers mention **knowledge of new trends** in the sector and **project management as key competences** – that is the competences which are important and difficult to acquire. What's interesting, important and relatively easy to acquire is – in their opinion – **knowledge of business etiquette**.
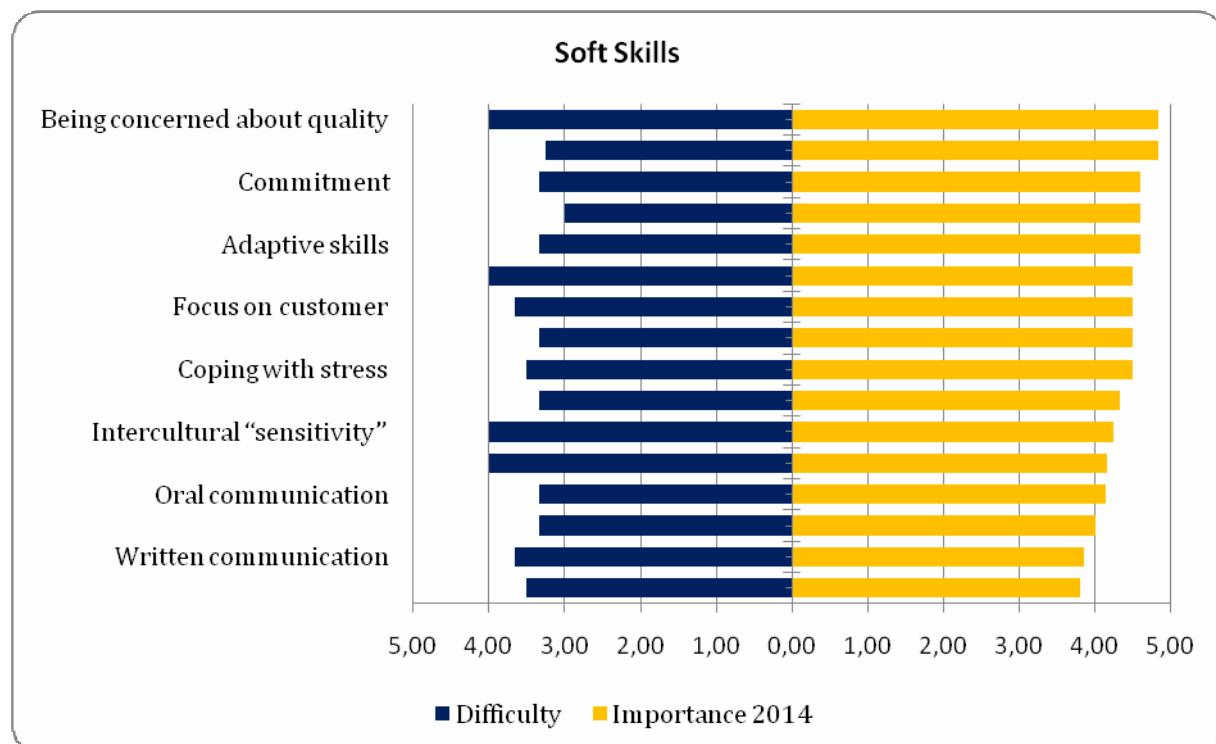
Fig. 11. Importance of and difficulty in acquiring individual competences in the area of "Soft Skills" as perceived by employers.

When recruiting new employees from among Kraków university graduates, employers pay great attention to soft skills which are very important to them. Key competences in this area are: **being concerned about quality**, **initiative**, **intercultural sensitivity**, and **innovation**. It seems rather optimistic that learning, perceived as one of the most important soft skills, is also thought to be relatively easy to acquire.
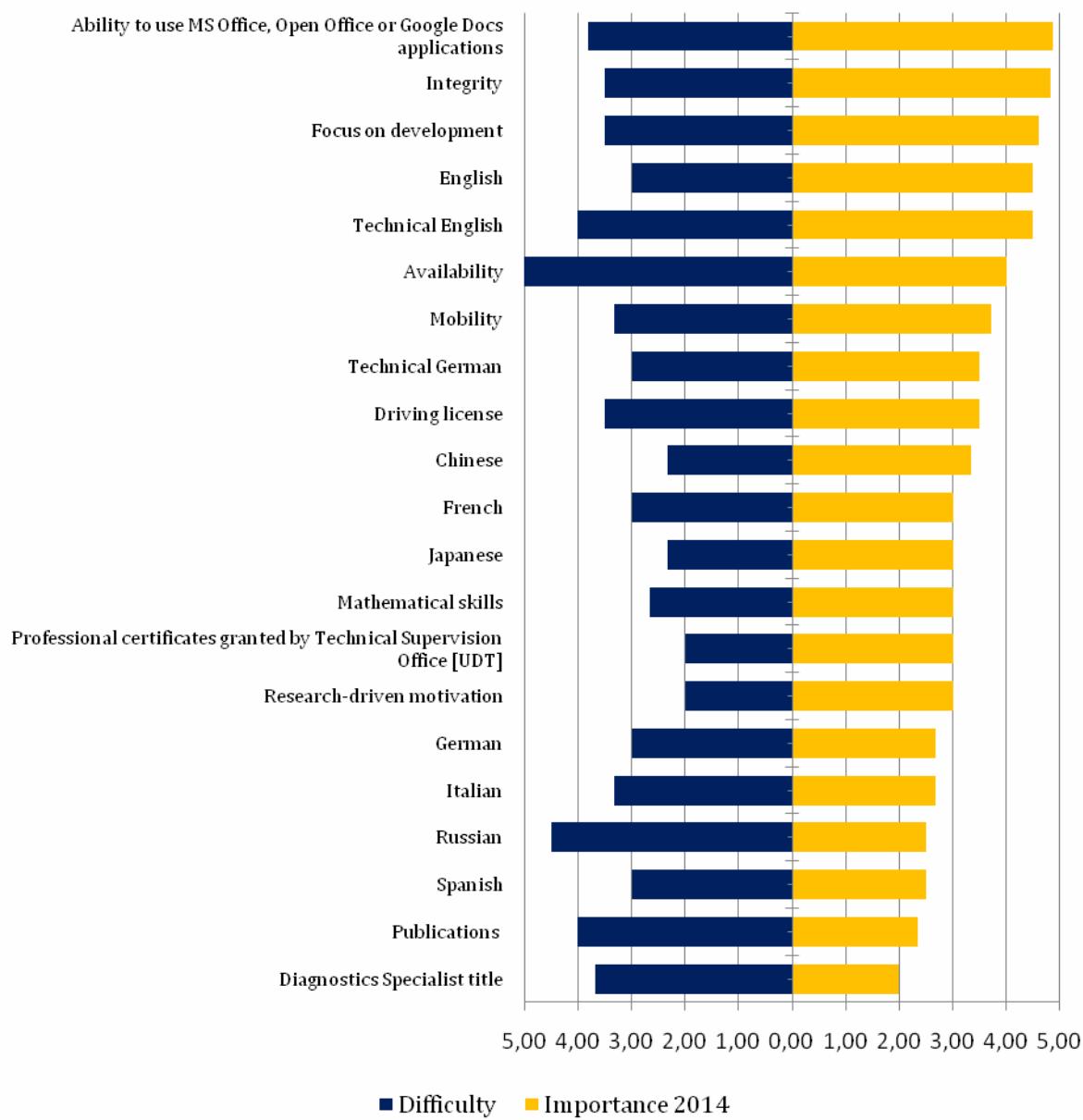
Fig. 12. Importance of and difficulty in acquiring individual competences in the area of "Foreign Languages and Other Requirements" as perceived by employers.

As for languages, the key language (hard to acquire and important) for employers is **technical English**. When it comes to other requirements, **availability** was reported in the surveys as relatively important and difficult to acquire.

Asked about additional skills and expectations of the life science sector towards graduates, other than mentioned in the questionnaire, the surveyed companies mentioned no other skills, which suggests that the list presented to them was exhaustive.

SUPPLY ANALYSIS
EDUCATIONAL RESULTS IMPORTANT FOR THE SECTOR

The analysis of educational effects achieved in fields of study related to the lifescience sector has a complex nature. Educational effects, ex definition, relate to an average student, which means that amongst the graduates are those with a much higher level of professional preparation, as well those with a level of professional preparation being lower than average. Here, the answers concerning the quality of teaching, provided by companies and universities, seem unanimous. Generally speaking, both business and universities agree that the level of teaching (acquiring professional qualifications) has recently decreased. However, this does not mean that the number of well qualified university graduates is smaller. Universities' representatives declare that in the coming years the number of graduates will decrease (by 15% on average). The number of extramural courses will be reduced, as they often are non-profitable to universities and engage considerable teaching resources. The number of students completing post-graduate courses and highly-specialised courses should not change considerably. This means that despite a fall in the total number of students, the quality of teaching and consequent availability of competences most desired in the labour market may rise.

The table below presents the titles of university courses that were indicated by the representatives of companies as those whose profiles best fit the expectations of businesses.

Fields/specialisations/profiles[31] of study most often mentioned by sector companies as best meeting their expectations
Chemical analyses, medical analyses, biotechnological analyses
Automation and construction of machinery
Biochemistry, biophysics
Biology, molecular biology
Biotechnology, business in biotechnology,

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[31] The original names given by entrepreneurs are preserved; individual categories do not always constitute a separate areas. Results supplemented by desk research analysis.

Fields/specialisations/profiles[31] of study most often mentioned by sector companies as best meeting their expectations
agricultural biotechnology
Chemistry, organic chemistry, analytical chemistry
Pharmacy, industrial pharmacy
Medical physics
Genetics
Information technology in medicine, biomedical IT
Biomedical engineering, chemical engineering
Materials engineering
Production engineering, product development management, technical fields of study
Marketing
Microbiology
Environmental protection
Organic and non-organic technology
Food technology
Chemical technology
Public health

Table 6. List of courses, specialisations, and profiles of study most often mentioned by employers as teaching students in areas needed in the life science sector.

Educational effects achieved in each of the four competence groups will be presented in a number of charts (figures) below. Data presented in them are not the averaged replies as it was in the case of the demand for competences, but a percent of fields of study in which the educational effect is achieved at least at the average level. Such approach corresponds to the fact that, except a number of post-graduate studies and very few specialist fields of study, only rarely are most competences important for the sector being taught at a given field of study. On the other hand, there are taught competences that for a given sector are rather irrelevant. (This is likely to be a source of unfair judgements often made by business people that graduates possess a lot of useless knowledge as the knowledge they refer to may be useful in other sectors). Should

we use means or weighted means, the result would be artificially lowered and would not present the full image of the supply of competences.

The most common educational results as regards specialist knowledge, resulting from the syllabuses taught in the analysed university courses are: **OHS principles**, **statistics**, **validation**, **ethics and bioethics**, **GLP principles**. The issues that are hardly present in university syllabuses are those concerning **quality audits and HACCP principles**.
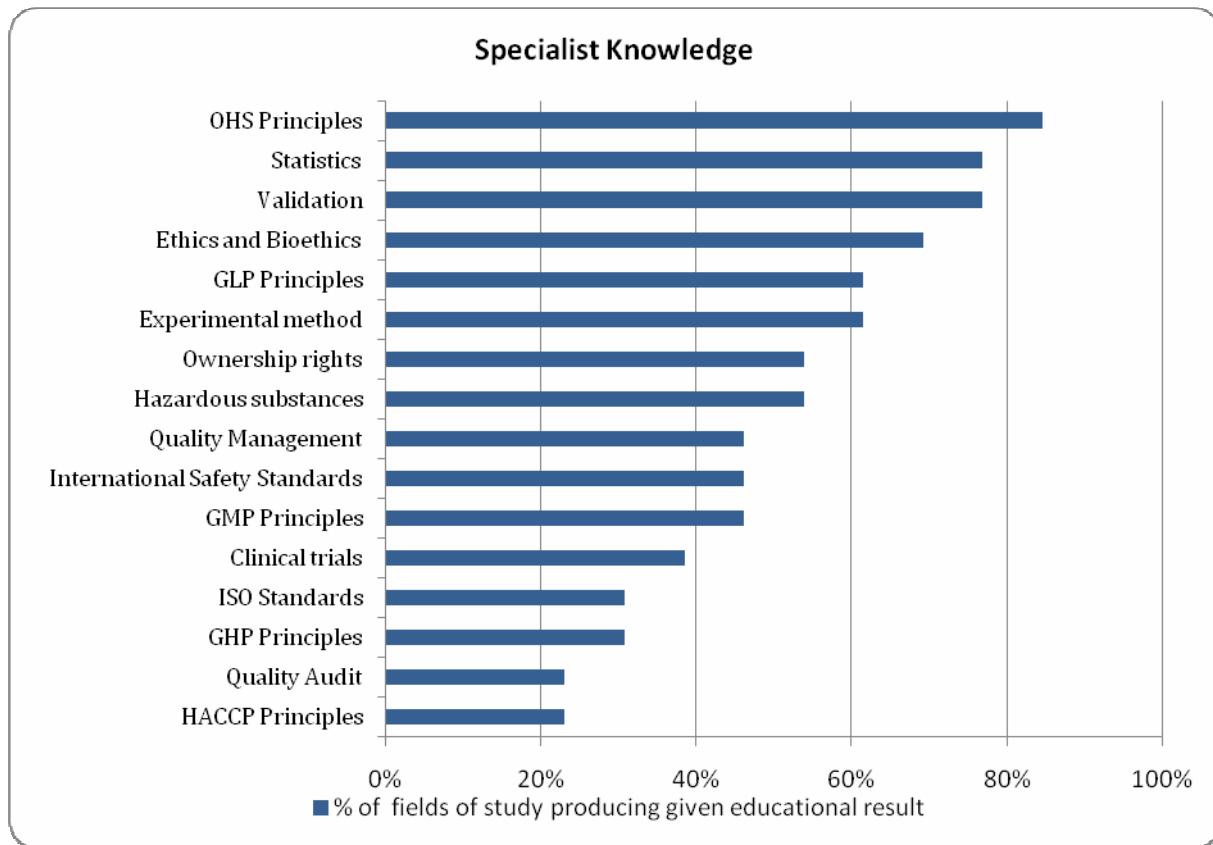
Fig. 13. Percentage of courses and specialisations producing at least medium level educational results in the area of "Specialist Knowledge" (universities' perspective).

As regards educational results in the area of specialist skills, generally they are less frequently achieved by universities. Over in half of the courses the following skills are taught: **ability to effectively use scientific information, reporting, operation of specialist apparatuses, analyses, and laboratory economics.** The competences developed in the smallest degree are: ability to use **information management software** and **computer designing software, Pharmacopeia, and ability to use SAP system**.

Specialist Skills

| Skill	%
Information Science	
Reporting	
Ability to use equipment	
Analysis	
Laboratory economics	
Compliance	
Expert opinions	
Ability to use statistical analysis software	
HPLC analyses	
Technological supervision	
Technological documentation	
Clinical projects management	
Ability to use management software	
Pharmacopeia	
Ability to use CAD/CAM/CAE designing software	
SAP	

■ % of fields of study producing given educational result

Fig. 14. Percentage of courses and specialisations producing at least medium level educational results in the area of "Specialist Skills" (universities' perspective).

Business skills in the area significant from the life science sector perspective are developed by universities to a very limited degree – more than 50% of analysed courses and specialisations provide their graduates only with the **knowledge of the law and legal provisions** applicable to the sector and nearly half – the **knowledge of new trends in the sector and of the sector as such. The competences taught in the smallest degree are: the knowledge of project management methodologies, negotiations, and preparation of business offers**.
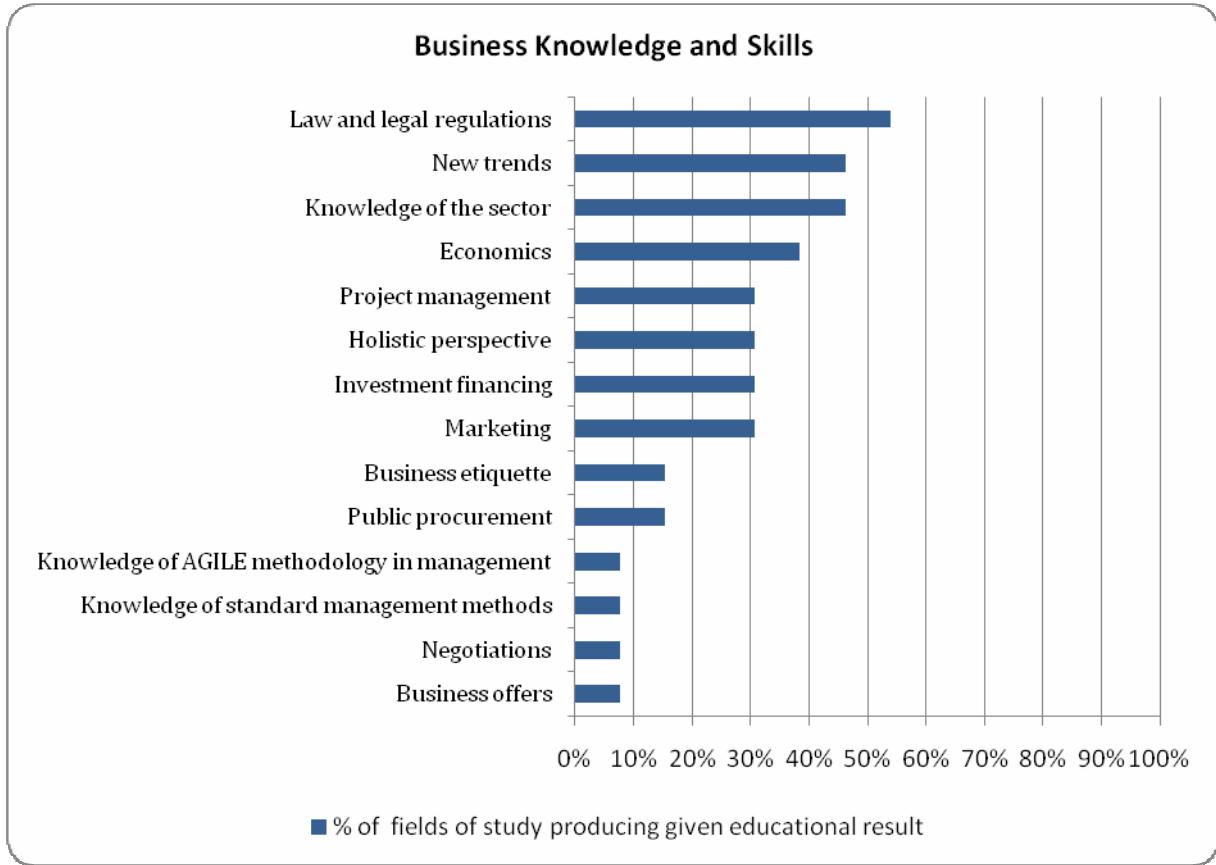
Fig. 15. Percentage of courses and specialisations producing at least medium level educational results in the area of "Business Knowledge and Skills" (universities' perspective).

Rather unoptimistic situation in the area of business knowledge and skills is also observed as regards achievement by universities of educational results concerning soft skills. Although over half of the specialisations and courses covered by the research **reports achieving educational results in the area of learning, adaptive skills, commitment, and collaboration**, only less than one third develops such competences as **focus on targets**, and **intercultural sensitivity**.
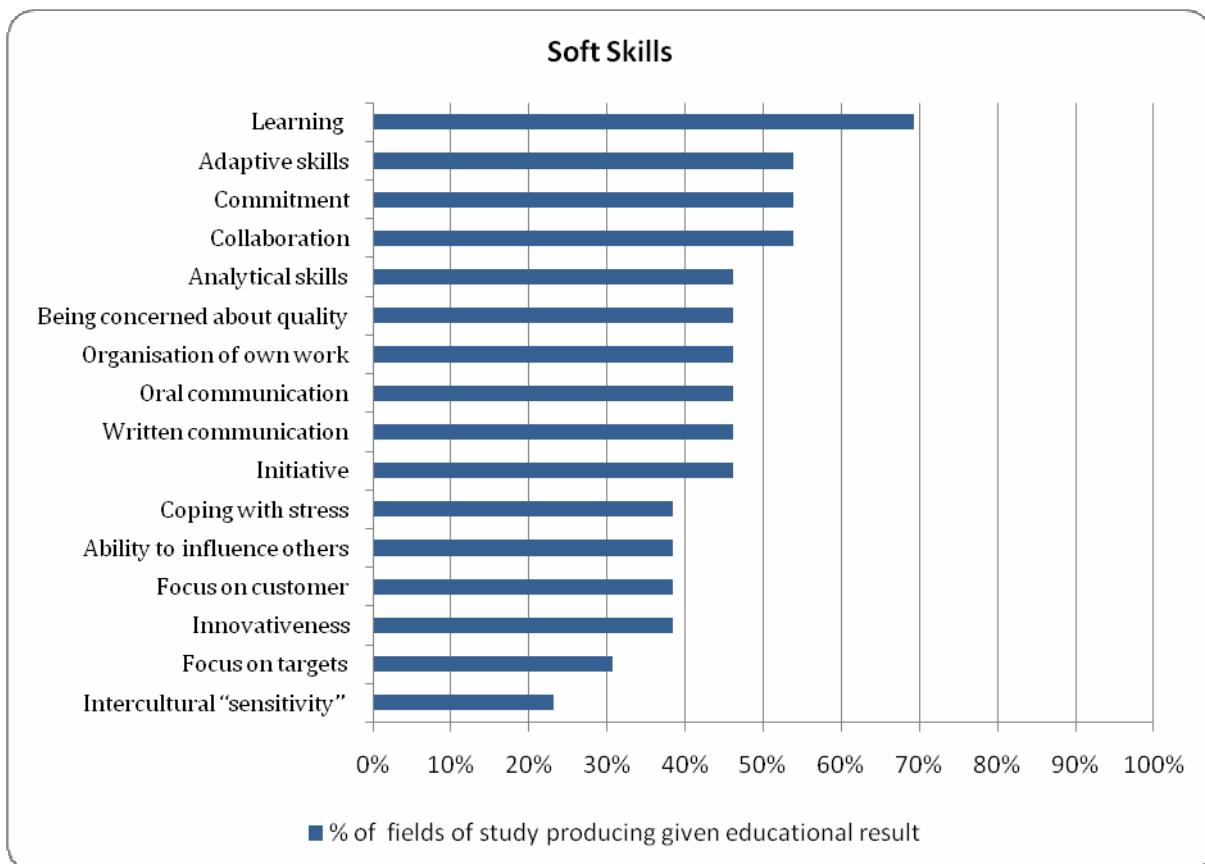
Fig. 16. Percentage of courses and specialisations producing at least medium level educational results in the area of "Soft Skills" (universities' perspective).

Among competences which, by their nature, cannot be classified as specialist knowledge and skills, universities declare that their graduates achieve the following educational results: **focus on development**, **integrity** and **ability to use office software**. On the other hand, less common in syllabuses is **research-driven motivation**.
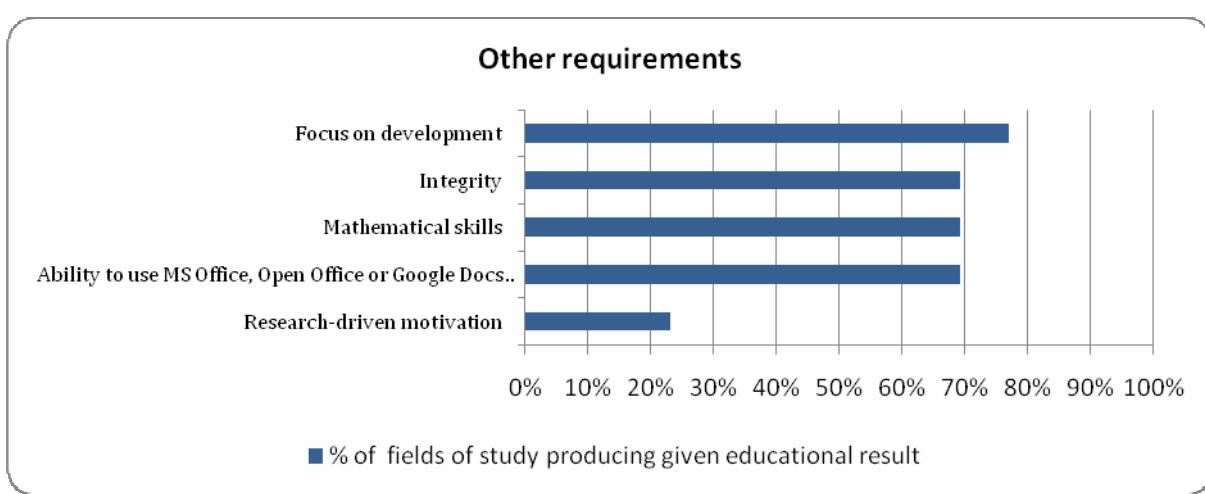

Fig. 17. Percentage of courses and specialisations producing at least medium level educational results in the area of "Other Requirements" (universities' perspective).

As regards education in language skills, the institutions directly responsible for the quality of education are foreign language colleges of universities. The English language is a mandatory course at almost all fields of the 1st and 2nd levels of university studies. However, students may elect to attend an additional free-of-charge course in a foreign modern language. An additional value is offered in the form of lectures administered in the English language. Foreign language courses are not included in the curricula of most post-graduate studies. According to figures showing the attendance of foreign language classes, most students chose the English language (level B2), then German French and the English language of a higher level.

According to statements by the representatives of foreign language colleges, the offer of foreign language courses is quite flexible and may be easily adapted to the requirements of the labour market and/or students' preferences. The status of foreign language courses at universities is such that students may have a decisive vote by subscribing, or refusing to subscribe to certain courses and developing their language competences at least at the basic level. (The development of language skills at higher levels is obstructed by a limited number of available classes.)

To sum up, the analysis of the supply of competences suggests that the courses and specialisations covered by the research are capable of delivering, at medium level, at least half of the educational results important for the life science sector (56 % of the educational results in the case of specialist knowledge and 46% – specialist skills). This is not surprising since individual companies recruit employees often for very varied jobs. Thus, the picture seems to be a natural consequence of this situation, which is confirmed by the findings resulting from the juxtaposition of business expectations with educational results. Much better values as regards the Nelson complexity index are obtained by highly-specialised post-graduate courses (the best tailored course declares achievement of 94% of educational results concerning knowledge and 69% of educational results concerning skills). This, however, would not be possible without the educational results achieved by students in I and II level of education.

BALANCE OF COMPETENCES
TRANSFER OF COMPETENCES FROM UNIVERSITIES TO BIZNESSES

The demand analysis, carried out by us, revealed competences that are perceived by the sector as core ones, along with shifts in their importance in the future, and difficulties suffered by employers in recruiting graduates possessing actual knowledge and skills. The analysis of supply showed what educational effects are acquired at fields of study related to the sector, and how comprehensive is relevant education. In this chapter, we juxtaposition the two perspectives, giving focus to the comparison of difficulties in acquiring competences with the average level of their being achieved at universities. In this context, certain reservations need to be made in relation to differences we observed in the assessment of said difficulties and university education.

In the event that the views of businesses and of universities were the same, we would have a situation in which competences that employers find difficult to acquire would not be taught at universities in the universities' opinion. In the presented results, moderate relationship of this type (correlation r from -0.31 to -0.41[32]) is observable with respect to almost all types of competences, except business knowledge and skills where there is no relationship between the perception by business and universities (r = 0), and with respect to soft skills and other requirements where the relationship is the strongest (r=-0.67). The conclusion is that the employers and universities agree in their assessment of the educational offer in the life science sector. Yet, it should be noted here that the discrepancy in the assessment of business knowledge and skills among graduates does not mean that the "blame" is attributable only to universities which inadequately assess their teaching offer. There are also other possible and equally probable interpretations here[33].

One of them is related to the method of educational effect defining. The educational effect refers to qualifications acquired by an average student, which means that the labour market is entered

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[32] Correlation (or Pearson's r) is a coefficient describing a linear relationship between two variables, varying between –1 (with -1 a perfect negative relationship – every increase in the value of one variable means proportional decrease in the value of the other), through 0 (no relationship – every increase of the value of one variable means random change in value of the other) to +1 (every increase in the value of one variable means proportional increase in the value of the other).

[33] More information can be found in Appendix 2, containing all quantitative data obtained from the surveys. The comparison of difficulties in acquiring a given competence with a percentage of university courses in which it is developed at least in a moderate degree and with the average score assigned to a given educational result, gives a better picture of the reasons for such discrepancies (e.g. significant difficulties in acquiring along with high assessment of average level of achieved educational results compared with very small percentage of university courses where such skill is being taught suggests that one of the reasons for problems with recruitment is a small number of graduates having the relevant skill or knowledge, etc.).

by graduates who present a level above average as well as those who present a level below average. Another reason may be sought in the fact that graduates of the fields of studies indicated as fitting the sector profile are employed in other sectors of economy, in other towns and even abroad. Although there is no data available, but it is likely that employment abroad is found by student of high language and business skills. The perception of competences by business and universities may vary because what may represent a satisfactory level to one party may be below an acceptable minimum to the other. Eventually not all competences that are sought may or should be taught at universities, which fact is confirmed by a juxtaposition presented at the end of this chapter, in which the opinions of universities concerning the tasks of universities are shown. Therefore, the results of the study of competences should be perceived as a tool to be used by universities and businesses to establish an effective co-operation and debate about teaching curricula.

Figures 18 present a matrix illustrating interdependencies between difficulties in acquiring certain competences and educational results achieved for the 20 competences of key importance for the sector. The strongest disagreement between business and universities, concerning the competences needed in the life science sector, is observed with respect to **validation**, **integrity**, **ability to prepare expert opinions**, **and knowledge of GMP principles**. On the one hand, employers are of the view that these features are hard to find in graduates, while on the other, universities claim that these skills are being developed in the course of study. There is much more agreement as regards the competences related to **being concerned about quality**, **initiative**, **and focus on customer** – these skills are hard to find, both in graduates and in syllabuses of university courses teaching students in areas needed in the life science sector.
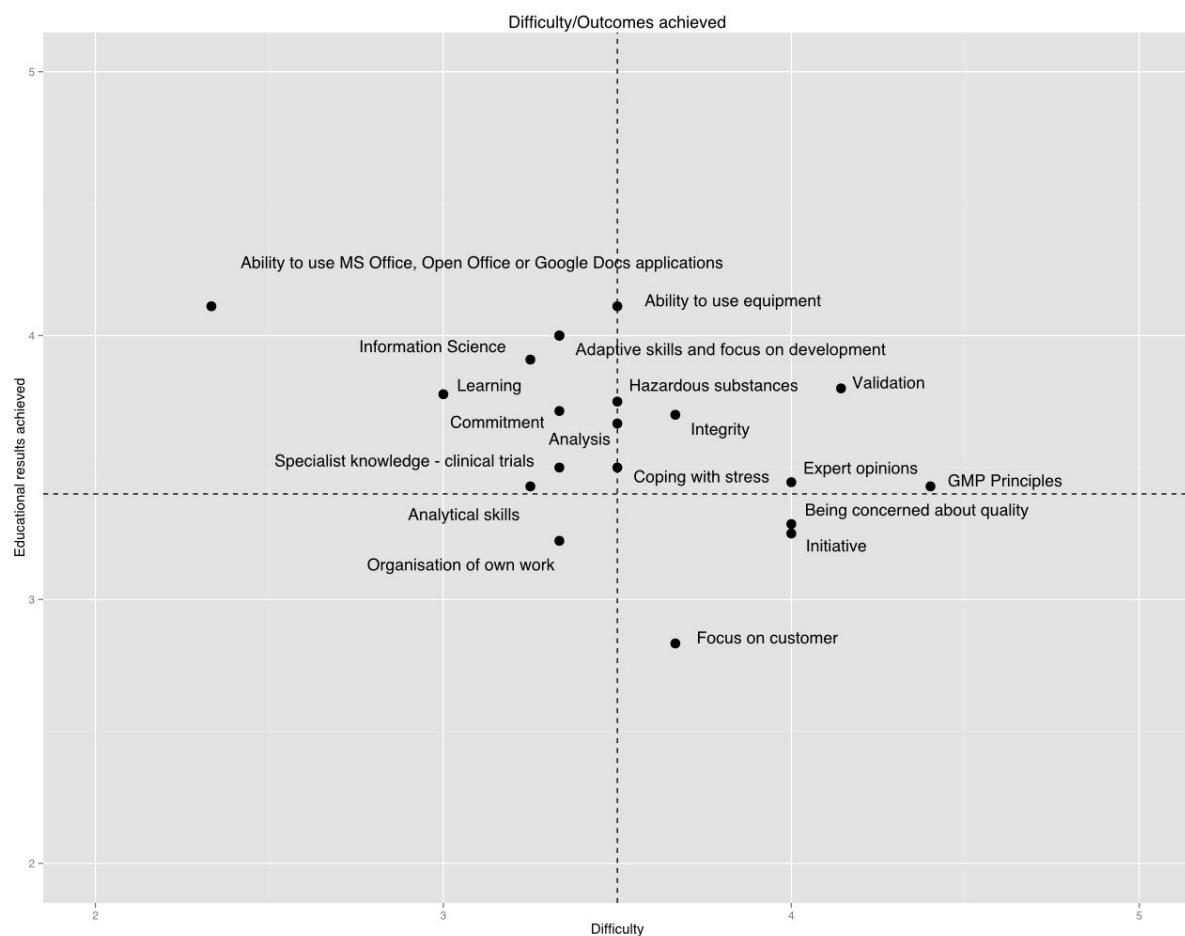
Fig. 18. The matrix illustrating interdependencies between difficulties in acquiring certain competences (employers' perspective) and educational results achieved (universities' perspective) for the 20 competences of key importance for the sector. Limited scale (from 2.5 to 4.5) is used in the graph for better "readability".

The charts below present difficulties in acquiring competences (employers' perspective) and the achieved educational results (universities' perspective) in five basic groups of competences (specialist knowledge, specialist skills, business knowledge and skills, soft skills, languages and other requirements).

There is a rather limited direct relationship between the perception of the level of achievement of the educational results by universities and the difficulties in acquiring specialist knowledge from the business perspective – the competences that are the most difficult to acquire (**quality audits and HACCP principles**) in the universities' opinions are rather well taught in the course of studying, while **OHS principles** are commonly taught by universities and, therefore, are quite easy to obtain. The exception here is the **knowledge concerning validation, experimental method, GLP principles, statistics, and quality management** – these competences are perceived as difficult to get on the labour market, but, in the opinion of universities, are rather commonly taught.
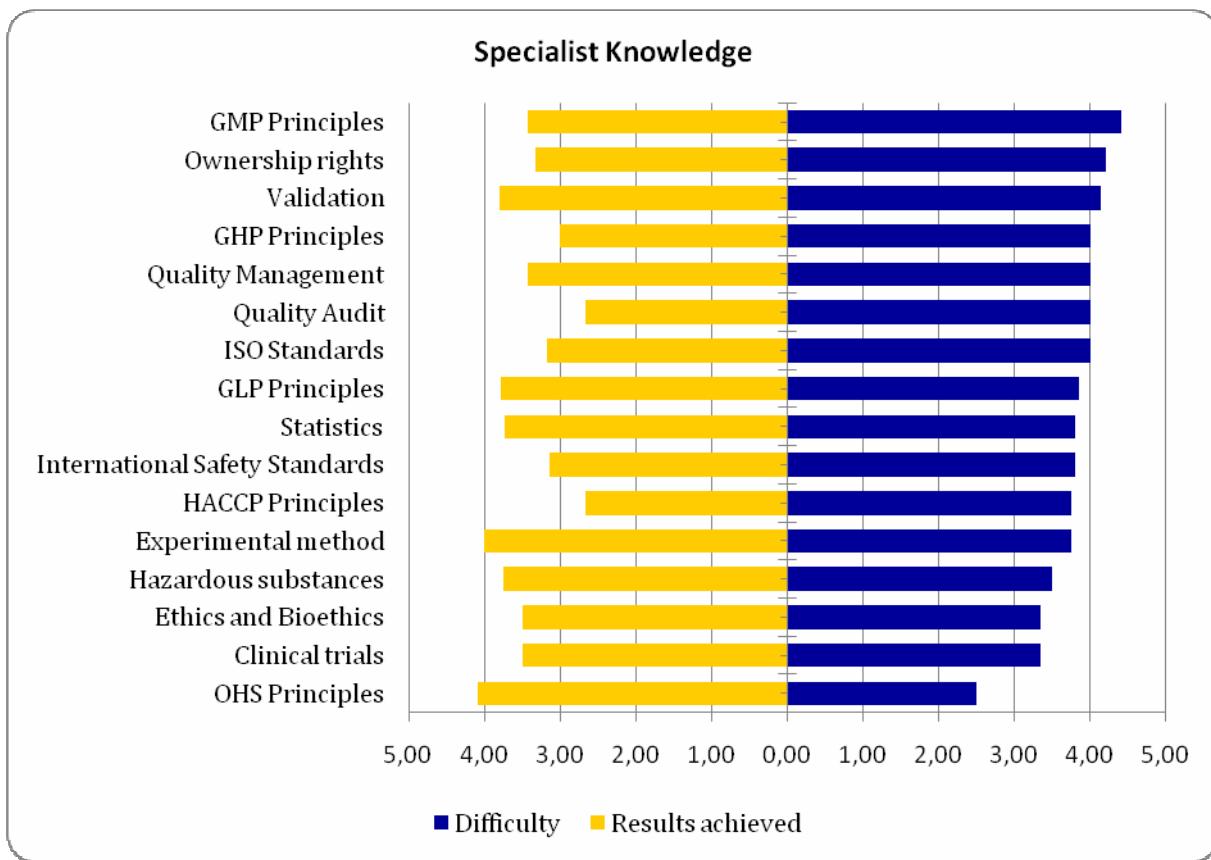
Fig. 19. Juxtaposition of difficulties in acquiring competences (employers' perspective) with educational results achieved (universities' perspective) in the area of "Specialist Knowledge".

As regards specialist skills (Fig. 20), the skills that are hard to find on the labour market but, at the same time, according to the representatives of universities, are taught to students, include: **clinical projects management**, **preparation of expert opinions, operation of apparatuses, reporting, and analyses**. In the case of business knowledge and skills (Fig. 21), hard to acquire from the business perspective, but claimed to be developed in the opinion of universities, are the skills concerning **knowledge of new trends in the sector and negotiations.**

An interesting picture emerges from the analysis of the soft skills and other requirements that employers expect from graduates (Fig. 22 and 23). It appears that in the case of three competences that are the most difficult to acquire – **initiative**, **innovation**, and **being concerned about quality** – universities rather positively assess their performance as regards the achieved educational results.

The situation is quite similar in the case of **integrity**. Although, according to employers, this attitude is hard to find, representatives of courses and specialisations participating in the research perceive it as a feature developed in the course of studying at Kraków universities.
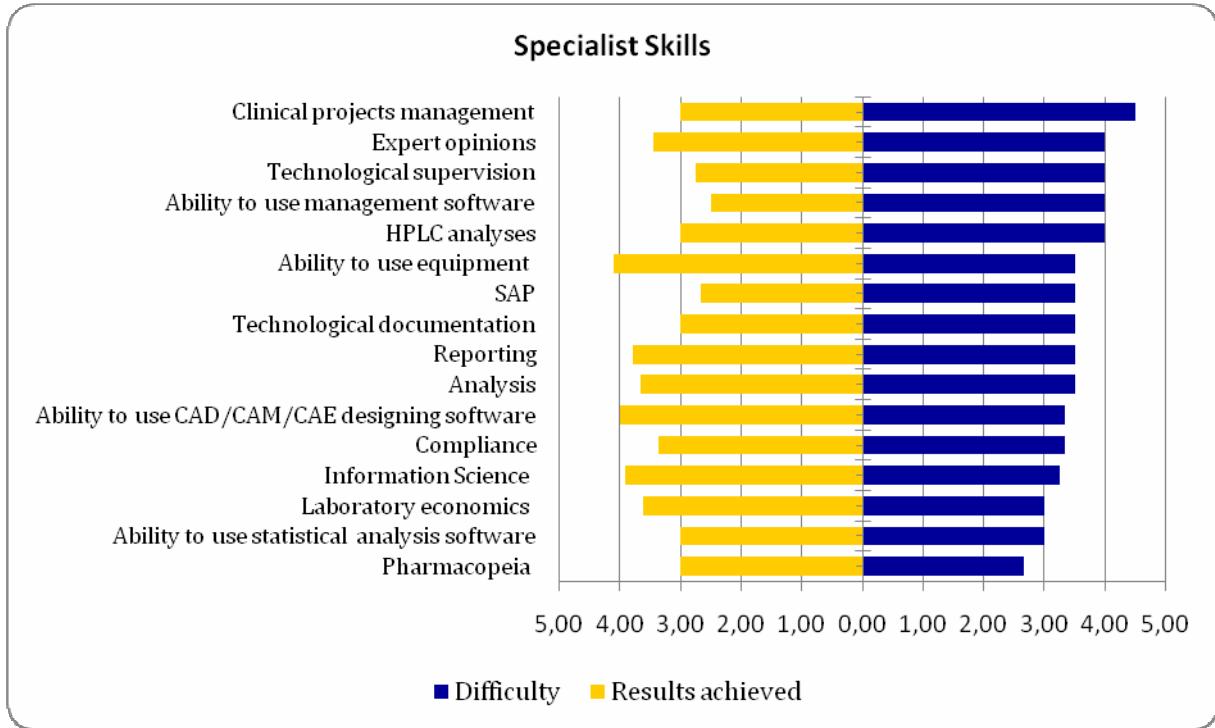
Fig. 20. Juxtaposition of difficulties in acquiring competences (employers' perspective) with educational results achieved (universities' perspective) in the area of "Specialist Skills".
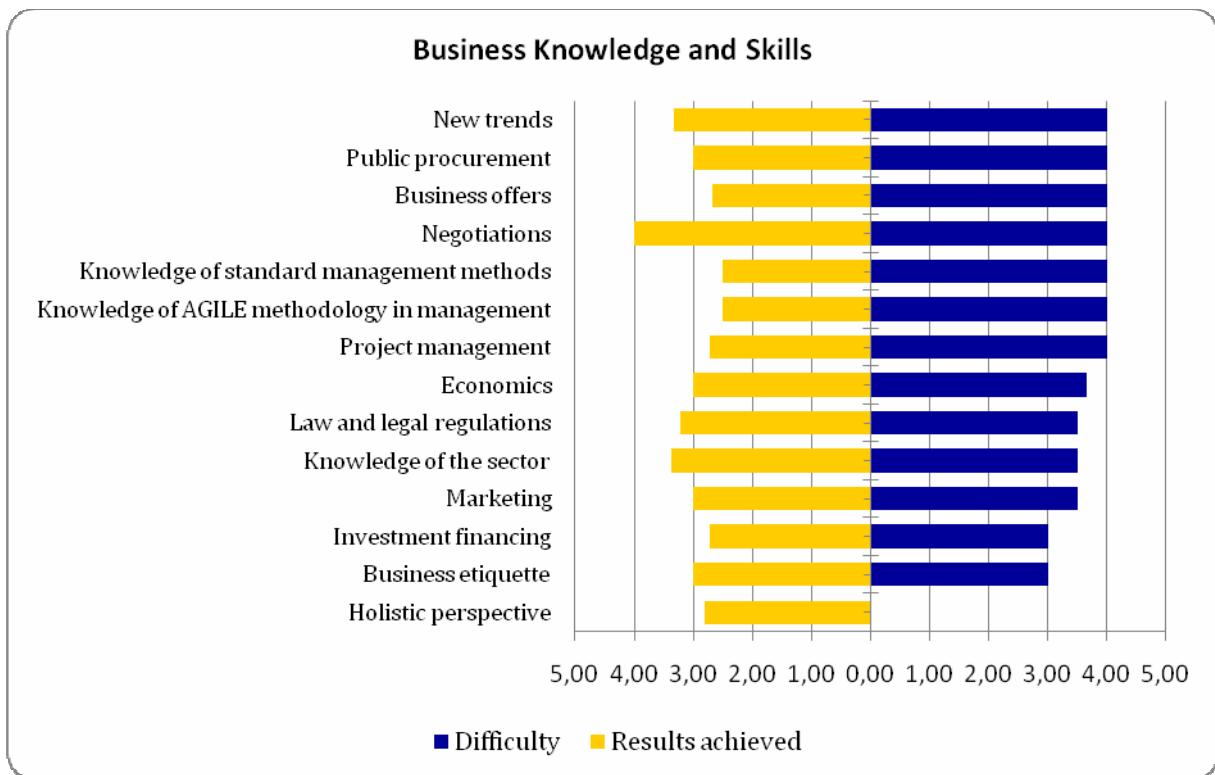
Fig. 21. Juxtaposition of difficulties in acquiring competences (employers' perspective) with educational results achieved (universities' perspective) in the area of "Business Knowledge and Skills".
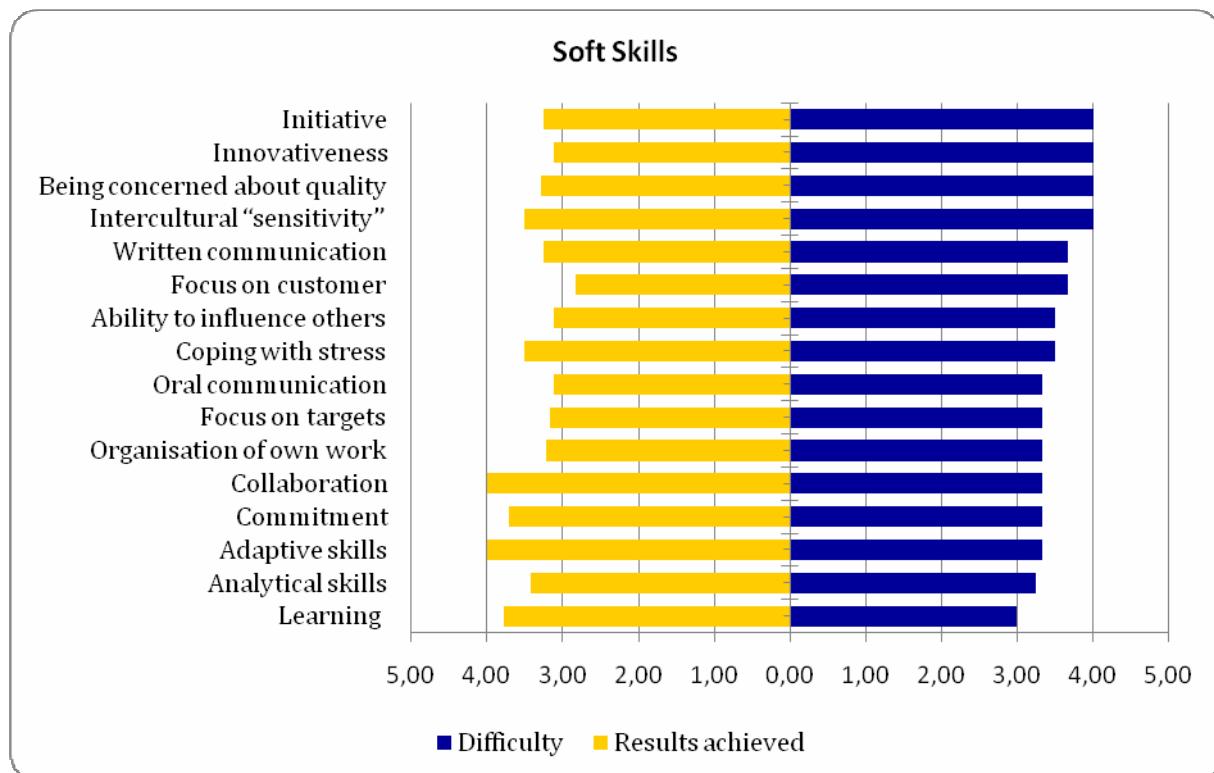
Fig. 22. Juxtaposition of difficulties in acquiring competences (employers' perspective) with educational results achieved (universities' perspective) in the area of "Soft Skills".
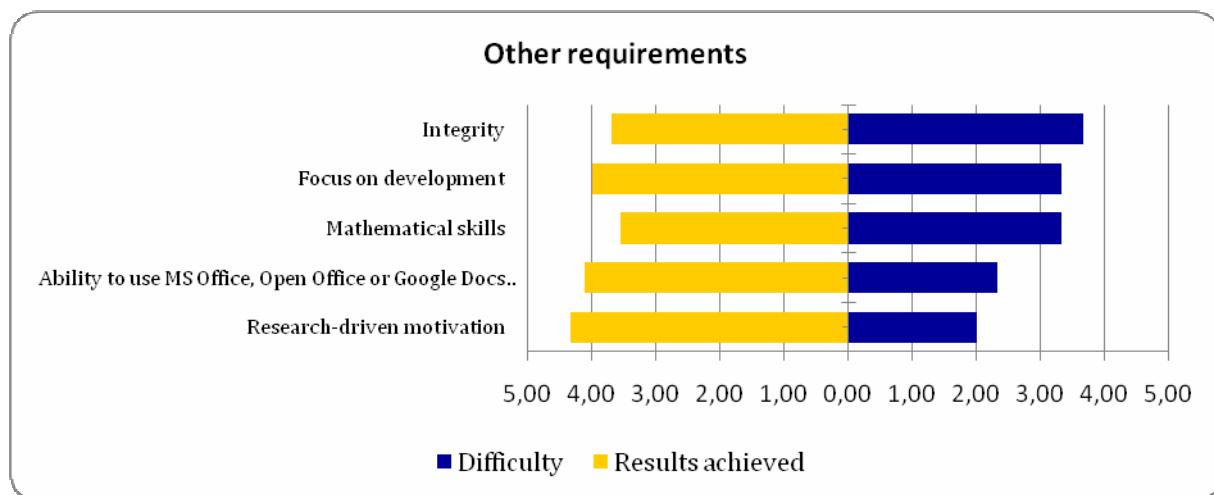
Fig. 23. Juxtaposition of difficulties in acquiring competences (employers' perspective) with educational results achieved (universities' perspective) in the area of "Other Requirements".

TASKS OF UNIVERSITIES

One of an additional aspects subject to analysis within the framework of the study of competences was constituted by the convictions of the representatives of business and of universities as to how far the teaching of competences should be a task of universities. The inclusion of the area implied a certain risk: at the stage of consultations related to the research tool, certain doubts appeared as to whether (or not) such question may be applied in any other manner than what entrepreneurs claim, i.e. that the whole responsibility for education rests with universities. The results of research show that our fears were groundless, while the inclusion of them allowed better understanding of the relationships between the supply of and demand for competences in the sector.

Where the opinions of employers and universities were identical as to which competences should be taught at universities, we could expect that there would be a relationship between the perception of the problem by businesses and that by the representatives of analysed fields and specialisations of study. In the presented results, moderate relationship of this type (r=0.48) is observable only with respect to specialist knowledge, whilst no such relationship is observable in all the other types of competences. This means that there is no agreement – except for specialist skills – between universities and business as to what business-specific competences should be taught.

Figure 25 presents opinions of the representative of business and universities, concerning the extent to which the teaching of each of the 20 competences considered presently the most important is a task of universities. It shows that with respect to some characteristics important for the sector (**analytical skills**, **ability to analyse**, **operation of apparatuses**, **information science**, **ability to use office applications**, **being concerned about quality**, **validation**, **knowledge about hazardous substances**) business and universities agree as to their place in syllabuses of university courses preparing graduates for this sector. As regards commitment and focus on customer, universities and employers also speak with one voice – there is no place for these competences in the university syllabuses.

Much bigger challenge for the collaboration between science and business are the competences located in other fields of the matrix. As regards **focus on development**, **learning, integrity**, preparation of expert opinions, organisation of own work, and initiative – which are mainly soft skills – universities see the development of these competences as their role less frequently than business does. In the case of GMP principles, the situation looks just the opposite – it is the universities that are more convinced about the role they have to play in teaching these skills than it would be expected from them by business.

Universities' task as perceived by business / Universities' task as perceived by universities
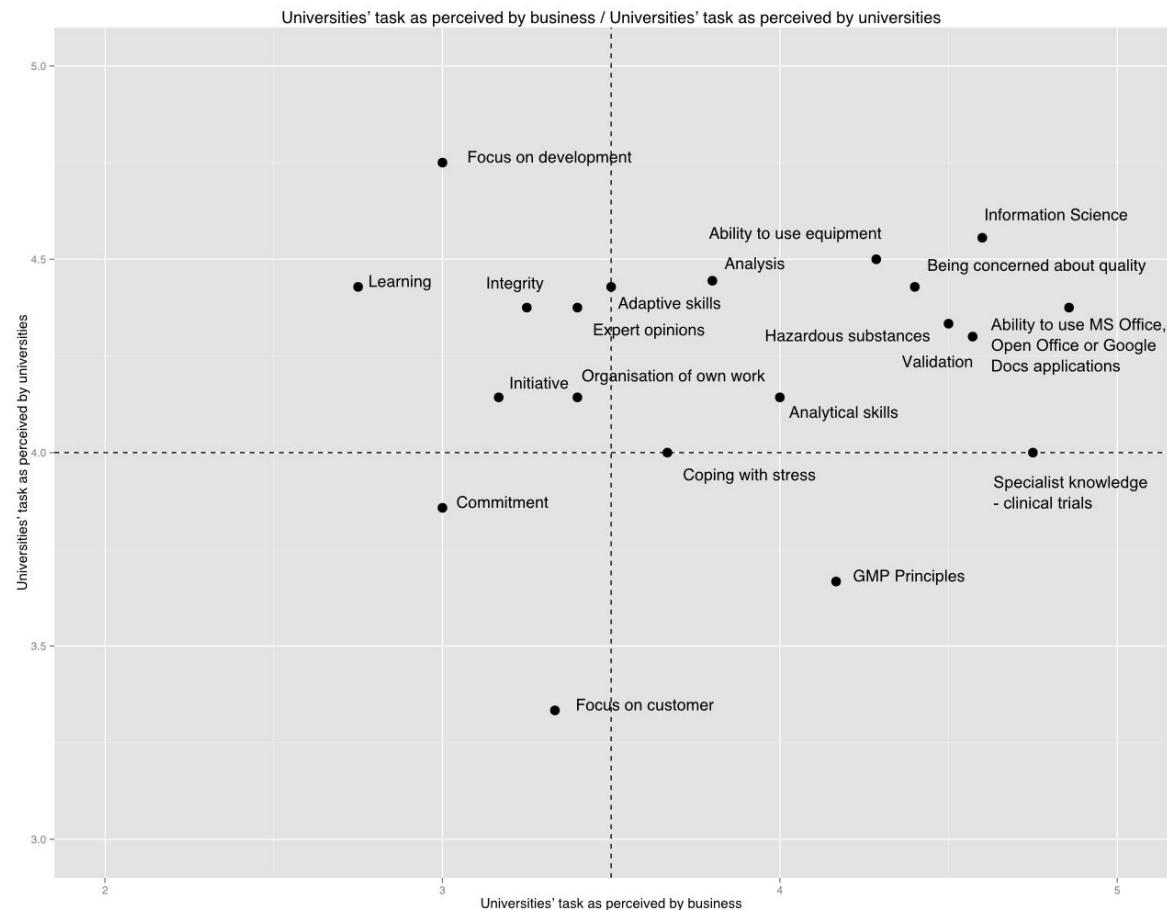
Fig. 24. The Matrix illustrating differences in the perception of development of certain competences as a universities' task by representatives of business and of universities for the 20 competences of key importance for the sector. Limited scale (from 2.5 to 4.5) is used in the graph for better "readability".

There is a considerable agreement between companies and universities as regards the understanding of the role of universities in developing specialist knowledge. They agree that these competences should be taught at universities. However, their opinions differ as regards the degree to which they should be taught. The strongest disagreement is observed with respect to **GMP principles**, **quality audit, clinical trials, quality management, and international safety standards** – here, employers' expectations towards universities are much bigger than those of the universities themselves.
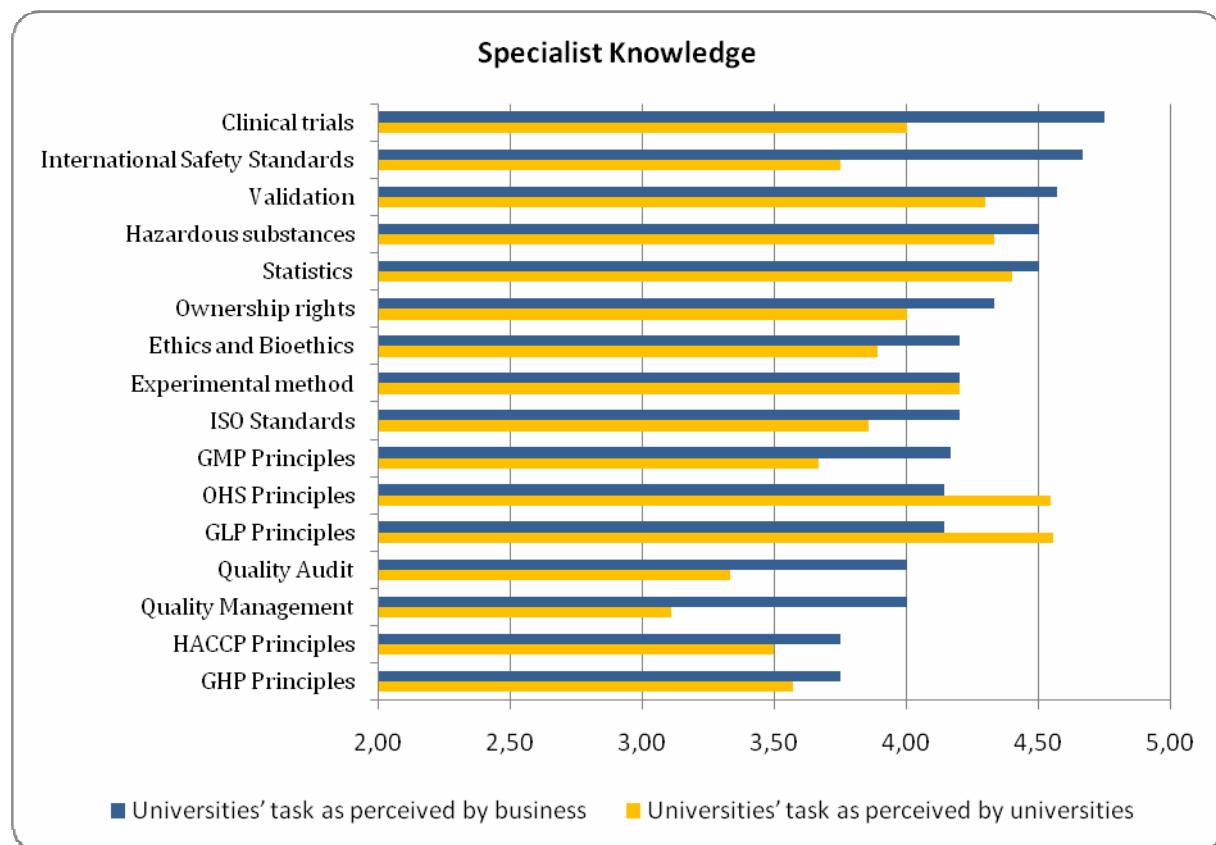
Fig. 25. Perception of the role of universities in developing competences in the area of "Specialist Knowledge".

As for specialist skills, **companies have more expectations towards universities as regards developing the competences in the area of SAP, HPLC analysis, ability to use information management software. The situation is just the opposite with laboratory economics and expert opinions** – here universities, to a much greater extent than business, think that this is their task to teach these skills.
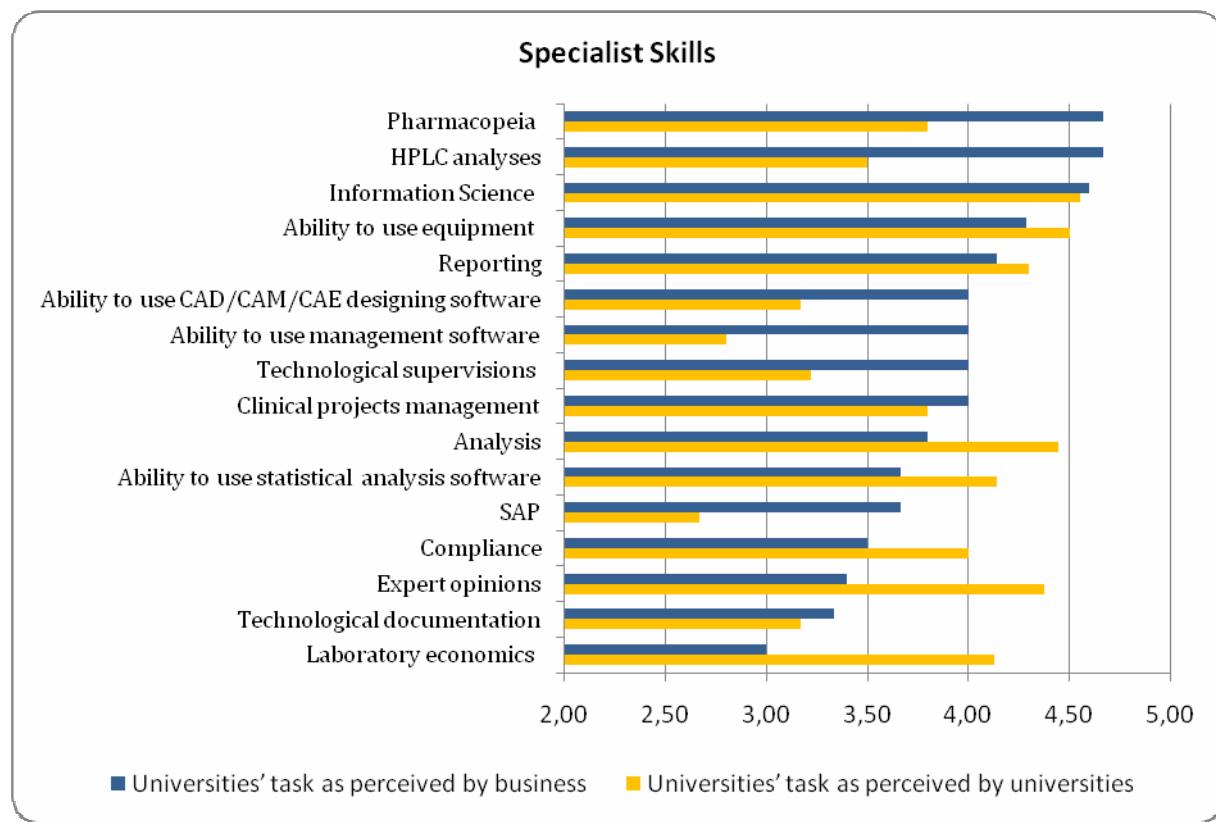
Fig. 26. Perception of the role of universities in developing competences in the area of "Specialist Skills".

Very interesting are the results for business skills and development. **Both companies and universities very highly assess the role of universities in developing knowledge of law and legal provisions** – it shows that both parties are convinced about the important educational role that universities can and should play in this respect. Companies are much more convinced than universities about the role of the latter in teaching standard project management methodologies to students. **Employers' opinion is similar as regards the knowledge of AGILE methodology in project management, Economics, and public procurement.**

What's very interesting, the competences such as: **Knowledge of the sector, of public procurement issues, preparation of business offers, or familiarity with business etiquette are more often perceived as tasks of universities by universities than by business.** Naturally, this does not mean that total responsibility for these areas should be attributed to companies. The data gathered from the surveys rather suggest that these competences need to be developed in collaboration between companies and universities (the concept of student traineeship/internship programmes and employee exchange called for many times both by universities and firms) and be inspired by own initiative of students and graduates.
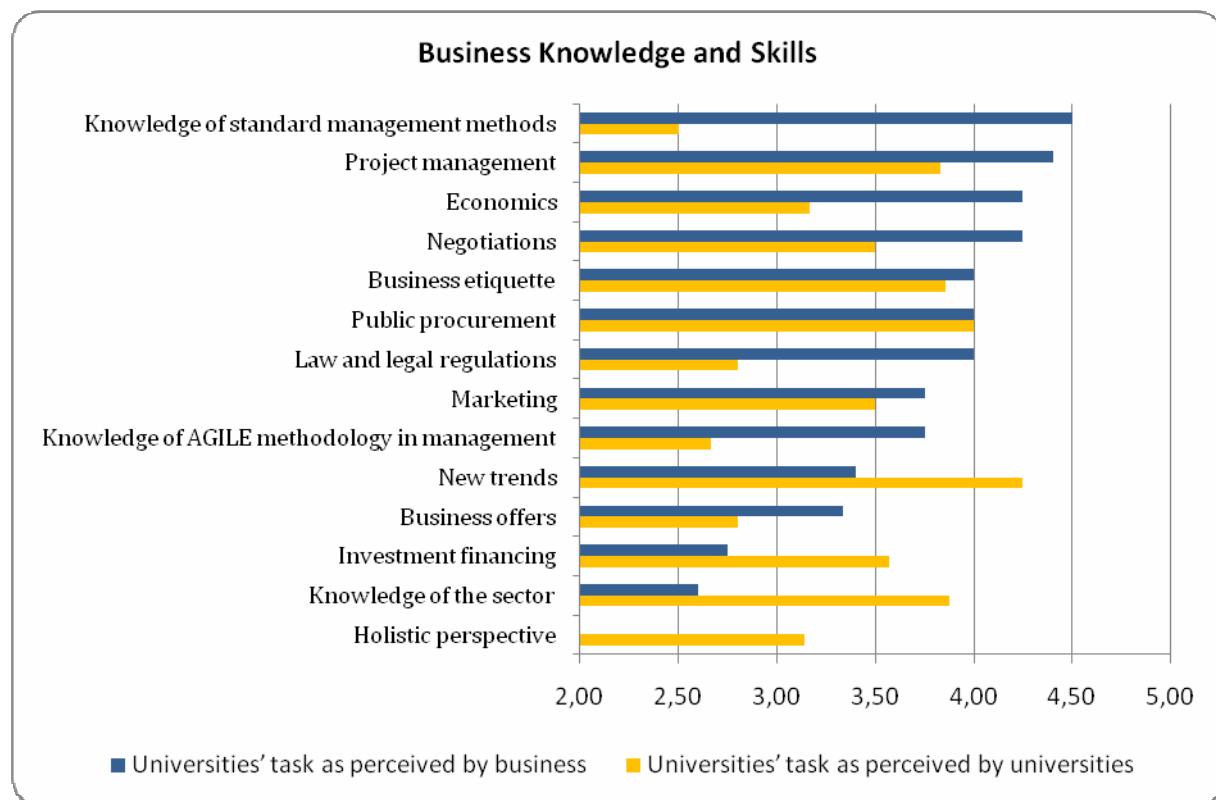
Fig. 27. Perception of the role of universities in developing competences in the area of "Business Knowledge and Skills".

Rather surprising are the results concerning the perception of the role of universities in teaching soft skills and other requirements. **Only in the case of being concerned about quality, analytical abilities, and focus on customer are companies convinced about the role of universities in developing these competences to a greater degree than universities themselves.** In other cases, although the representatives of companies think that these skills should be included in syllabuses, their expectations in this respect are much smaller. **In other words, employers expect such competences from graduates; however, they are not fully convinced that they should be taught and developed at universities.** This conviction is much stronger among representatives of universities. Such approach of universities is fully justified – soft skills are transferable and useful practically in any working (and not only working) environment where graduates may find a job. The solutions that might be adopted by universities with a view to better developing soft skills among students are discussed in a separate chapter in 2012 Study of Competences in BPO/SSC and IT/ITO sectors[34].

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[34] Study of Competences in BPO and ITO in Kraków. http://www.krakow.pl/zalacznik/1165
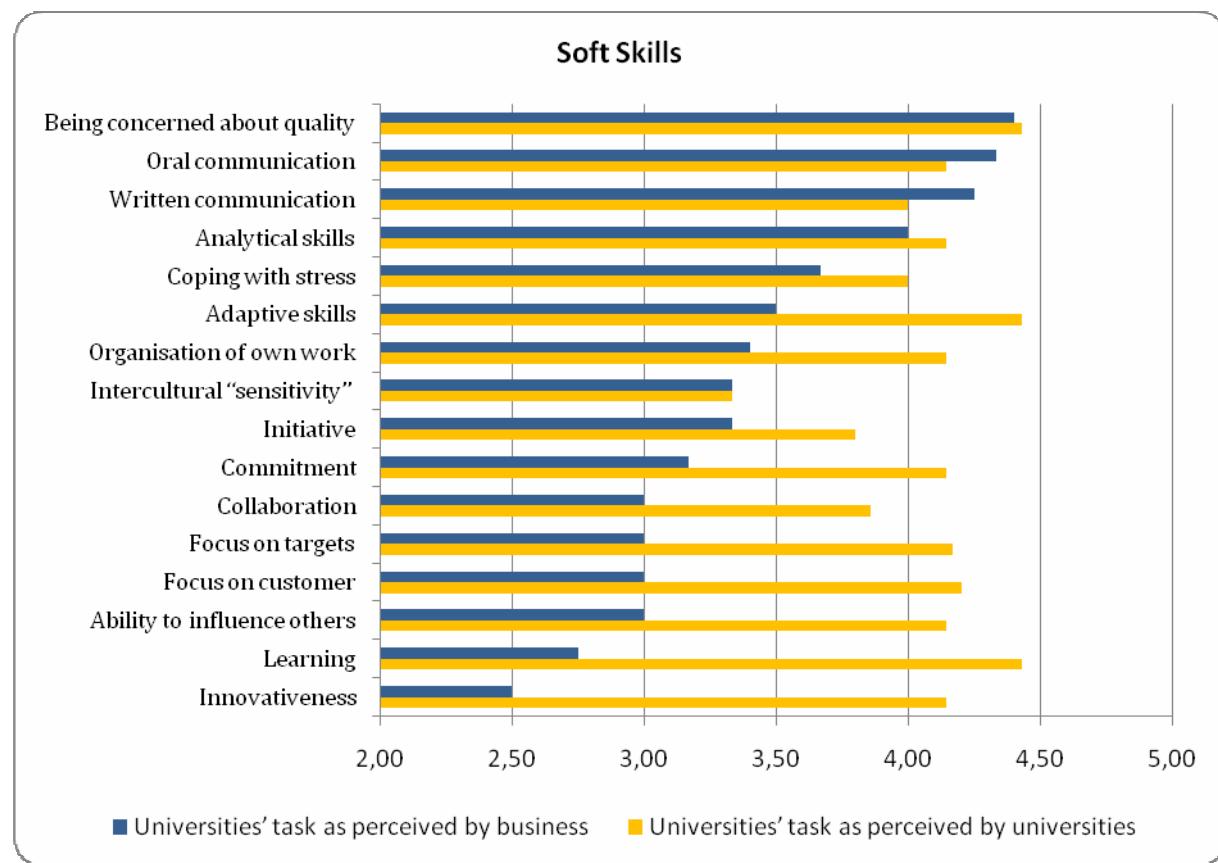
Fig. 28. Perception of the role of universities in developing competences in the area of "Soft Skills".
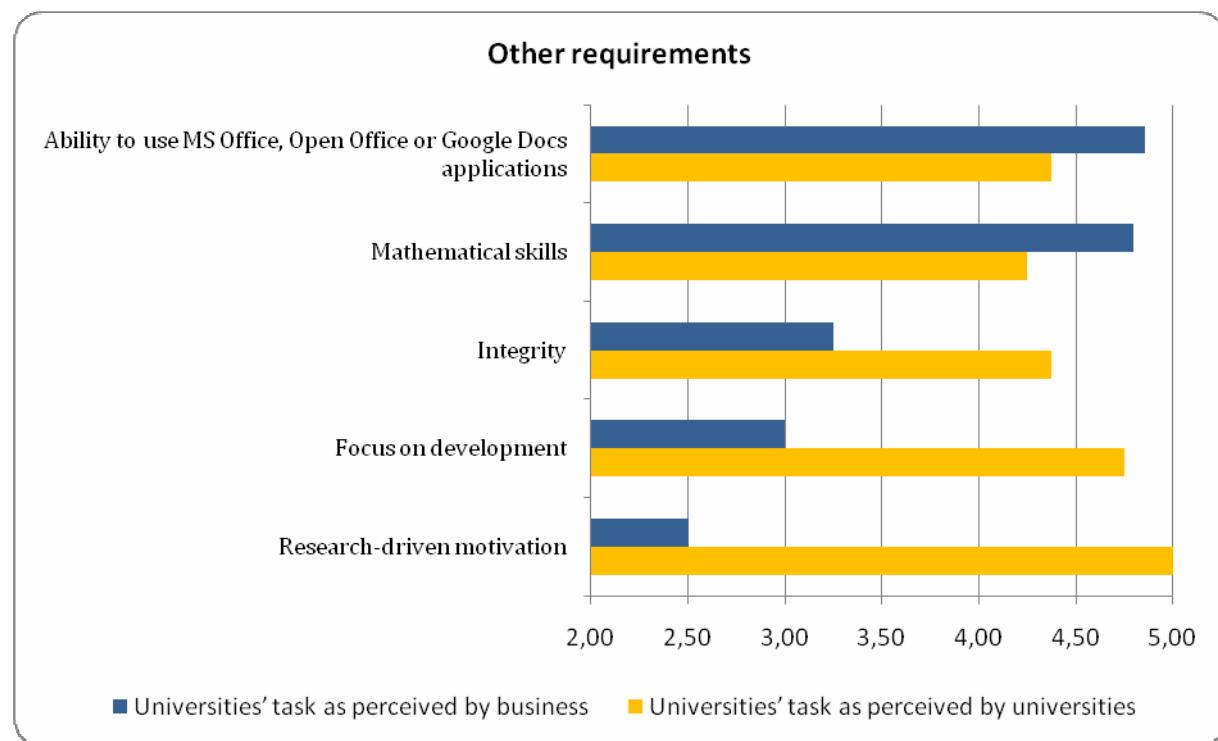
Fig. 29. Perception of the role of universities in developing competences in the area of "Other Requirements".

According to experts, life science-oriented university courses do not educate students directly for the industry, but have much better results in teaching theoretical knowledge and skills necessary, e.g. to work at a pharmacy's (employers have a slightly better opinion in this respect about AGH University of Science and Technology where students have more laboratory classes, than about the Jagiellonian University or Cracow University of Technology). Experts say that there are not enough practical training/traineeship (interestingly enough, not necessarily in the sector) envisaged in the syllabuses or laboratory classes.

FINAL CONCLUSIONS AND RECOMMENDATIONS

Life science is one of the fastest growing fields of knowledge and the life science sector is the source of many most fascinating business innovations. No wonder that for Kraków, with its huge capital of well-educated graduates and state-of-the-art laboratories, life science is one of the foundations of its development strategy.

Unfortunately, life science sector in Kraków, although supported by numerous public and private initiatives, must address many serious internal and external challenges. **A characteristic feature of the sector, already mentioned in the present report, is a considerable predominance of a few huge players in the pharmaceutical business, who, despite state-of-the-art laboratories and top-class specialists, do not conduct any advanced research and development works in Kraków, and the dispersion of numerous smaller actors with relatively small innovative potential.** Moreover, when talking to the report's authors, employers were rather circumspect in their estimates concerning the sector development. They were of the view that in the coming years it will remain rather limited.

The key findings of the research on demand for and supply of competences in the life science sector are provided in the synthetic form in the Table 8 below.

Key findings of the Study of Competences for the life science sector (summary)	
Key competences currently looked for by employers (as stated by employers)	Ability to use office applications, being concerned about quality, integrity, analytical skills, knowledge concerning clinical trials
The most considerable relative growth in importance of competence over 5 years (as stated by employers)	Experimental method, HPLC analyses, technical English
Important competences which are the least available on the labour market (as stated by employers)	Being concerned about quality, validation, technical English, GMP principles, Initiative
Important competences which are the most available on the labour market (as stated by employers)	Ability to use office applications, analytical skills, learning, English
The most often educational results important for employers (in universities' opinion)	Validation, integrity, ability to prepare expert opinions, knowledge of GMP principles

Key findings of the Study of Competences for the life science sector (summary)	
Tasks of universities (from business perspective)	Ability to use MS Office, OpenOffice lub Google Docs applications, mathematical skills, clinical trials, international safety standards, Pharmacopeia, HPLC analyses
Tasks of universities (universities' perspective)	Focus on development, information science, GLP principles, OHS principles, operation of apparatuses, analyses

Table 8. Synthetic summary of the Study of Competences findings for the life science sector in Kraków

In order to utilise the enormous potential of intellectual capital and Kraków's infrastructure, it is necessary to make decisive steps with a view to attracting investment projects in the area of advanced research and development works and to increasing knowledge sharing between universities and business. **Presently, the cooperation between business and science is perceived as based mainly on non-formal cooperation networks, although there are quite numerous examples of organising several-month traineeship programmes for students, during which they can get acquainted with the specificity of laboratory work.**

Major barriers mentioned by employers are related to financing of universities and unwillingness of university teachers to modify syllabuses. Another barrier noticed by experts are limits imposed in state universities on teacher's salaries. As a result, even the best courses have problems with employing specialists who could enrich the teaching process with their practical experience. On the other hand, the incentives as regards scientific development and professional career are questioned. Experts say that a large number of graduates continue education in doctoral courses in order to escape unemployment and only few can find a job in Poland in the area compatible with their education immediately after graduation; with a doctor's degree it is relatively easy to find a job in the sector abroad.

Employers who took part in the study of competences also indicated a number of competence shortages found in graduates from Kraków's universities. What is of particular importance is that the results of both: quantitative analysis and qualitative analysis of universities show that the representatives of universities generally agree as to the core of such diagnosis. Employers emphasised the shortages related to practical skills and specialist knowledge.

The nature of the life science sector translates directly into the sector's expectations towards universities as regards the level of demand for particular competences. Based on the opinions of the surveyed companies, key competences for the sector can be identified, that is the competences which are very important, but difficult to acquire. These are: being concerned about quality, validation, technical English, GMP principles, and initiative.

As for development of soft skills considered by life science employers as very important for professional success, it is recommended that the elements of project teaching and more workshop and laboratory classes be introduced in syllabuses, most preferably in

cooperation with business. Although it will not be an easy task, our suggestion concerning tailoring universities' educational offer to business needs is to expand the syllabuses of post-graduate course to include technical foreign languages courses, particularly English and – if practicable – also German.

The most important recommendations stemming from the report findings must pertain to coordination of cooperation between public institutions, universities, and business representatives. Some employers pointed out that there was too little information from the City Hall, perceived as effective absorber of UE assistance, on possible forms for co-financing activities in the area. Companies expect some kind of direct support, most importantly in the form of eliminating financial barriers in running businesses, e.g. lower real estate tax rates. **On the other hand, universities see in the City Hall a prospective facilitator of a dialogue between science and business. This is the role that should be assumed in building competitiveness of the sector based to such a considerable degree on innovation and intellectual capital.**

APPENDIX 1. LIST OF COMPETENCES AND EDUCATIONAL RESULTS

Specialist Knowledge		
Name	Competence Description	Educational result
Quality audit	Knowledge of principles of conducting quality audits	Student has knowledge on how to conduct quality audits
Ethics	Knowledge of ethics and bioethics	Student has knowledge of ethics and bioethics.
Experimental method	Knowledge on designing and implementing experimental patterns	Student has knowledge on how to design and implement experimental patterns
International safety standards	Knowledge of international safety standards applicable to a given research area (e.g. BRC or IFS)	Student has knowledge of international safety standards applicable to a given research area (e.g. BRC or IFS)
ISO standards	Knowledge of ISO standards applicable to a given position (22000, 9001 etc.)	Student has knowledge of ISO standards applicable to a given position (22000, 9001 etc.)
Ownership rights	Knowledge about protection of industrial property and copyrights	Student has knowledge about protection of industrial property and copyrights
Statistics	Knowledge of mathematical statistics	Student has knowledge mathematical statistics.
Hazardous substances	Knowledge about the use and storage of hazardous substances in laboratory work (e,g, use of material safety data sheet)	Student has knowledge about the use and storage of hazardous substances in laboratory work (e.g., use of material safety data sheet)
Validation	Knowledge of validation of research methods	Student has knowledge of validation of research methods
Specialist Knowledge	Specialist knowledge of specific field of clinical trials (chemistry, physics, medicine, genomics, transcryptomics)	Student has knowledge of specific field of clinical trials (chemistry, physics, medicine, genomics, transcryptomics)
Quality management	Knowledge of quality management methodologies (Six Sigma, CSM, 5S, TQM, TPM)	Student has knowledge of quality management methodologies (Six Sigma, CSM, 5S, TQM, TPM)

Specialist Knowledge		
Name	Competence Description	Educational result
OHS Principles	Knowledge of occupational health and safety principles applicable to laboratory work	Student has knowledge of occupational health and safety principles applicable to laboratory work
GHP principles	Knowledge of Good Hygiene Practice (GHP) principles	Student has knowledge of Good Hygiene Practice (GHP) principles
GLP principles	Knowledge of Good laboratory Practice (GLP) principles	Student has knowledge of Good Laboratory Practice (GHP) principles
GMP principles	Knowledge of Good Manufacturing Practice (GMP) principles	Student has knowledge of Good Manufacturing Practice (GMP) principles
HACCP principles	Knowledge of Hazard Analysis and Critical Control Points (HACCP) principles	Student has knowledge of Hazard Analysis and Critical Control Points (HACCP) principles

Specialist Skills		
Name	Competence Description	Educational result
Analysis	Ability to analyse experiment outcomes and to draw adequate conclusions	Student can analyse experiment outcomes and draw adequate conclusions
HPLC analysis	Ability to use the knowledge of High Performance Liquid Chromatography (HPLC) analyses in practice	Student is able to use the knowledge of High Performance Liquid Chromatography (HPLC) analyses in practice
Technological documentation	Ability to devise technological documentation	Student is able to devise technological documentation
Laboratory economics	Ability to reasonably use the property, apparatuses, materials, and laboratory equipment	Student is able to reasonably use the property, apparatuses, materials, and laboratory equipment
Expert opinions	Ability to design and prepare laboratory expert opinions	Student is able to design and prepare laboratory expert opinions
Pharmacopeia	Knowledge of pharmaceutical code (Pharmacopeia)	Student has knowledge of pharmaceutical code (Pharmacopeia)

Specialist Skills		
Information science	Ability to actively search for and use objective sources of scientific information	Student is able to actively search for and use objective sources of scientific information
Technological supervision	Ability to execute technological supervision over research equipment and reagents	Student is able to execute technological supervision over research equipment and reagents
Operation of apparatuses	Ability to operate specialist apparatuses and laboratory equipment	Student is able to operate specialist apparatuses and laboratory equipment
Ability to use statistical analysis software	Ability to use statistical analysis software(R, Statistica, SPSS)	Student is able to use statistical analysis software(R, Statistica, SPSS)
Operation of CAD / CAM / CAE designing software	Ability to use CAD / CAM / CAE designing software (e.g. CATIA, AutoCAD, Unigraphics)	Student is able to use CAD / CAM / CAE designing software (e.g. CATIA, AutoCAD, Unigraphics)
Operation of project management software	Ability to use information management software (np. Trackwise, Documentum)	Student is able to use information management software (np. Trackwise, Documentum)
Reporting	Ability to prepare cohesive and competent written reports on research work	Student is able to prepare cohesive and competent written reports on research work
SAP	Ability to use SAP software	Student is able to use SAP software
Clinical project management.	Ability to manage clinical trials projects	Student is able to manage clinical trials projects
Compliance	Ability to manage laboratory substances and waste products in compliance with applicable provisions of law	Student is able to manage laboratory substances and waste products in compliance with applicable provisions of law

Business knowledge and skills		
Name	Competence description	Educational effect
Economics	**Ability to analyse**, calculate and practically apply key profitability parameters concerning the application of various solutions (for instance, investment profitability, return form investment, depreciation/amortisation, etc.)	The student is able to apply knowledge on the profitability of various solutions, using the analysis and calculations of important parameters/indices (for instance, return from investment, depreciation/amortisation, etc.)
Business etiquette	Knowledge and practical application of business savoir-vivre rules. Ability to behave according to standards, and to select proper dressing and adequate language register, also in the context of customer relations and international cooperation.	The student possesses knowledge about business savoir-vivre. He/she is able to behave according to standards (including the selection of proper dressing, use of a language register adequate to situation etc.)
Investment financing	Knowledge about various forms and methods for the financing of investments and other performed projects	The student possesses knowledge about various forms and methods for the financing of investments and other sector projects.
Marketing	Knowledge about marketing methods and techniques	The student possesses general knowledge about marketing.
Negotiations	Ability to conduct business negotiations and knowledge of their rules	The student is able to conduct trade negotiations according to art.
New trends	Knowledge about new trends in the sector, development directions and technical novelties specific to a given sector.	The student possesses knowledge about technical novelties, development directions and about development trends in the sector related to his/her profile of education.
Business offers	Ability to prepare and analyse commercial and business offers, including the diagnostics of customer needs and expectations. Ability to develop optional solutions, etc.	The student is able to analyse and prepare commercial offers and optional solutions with regard to customer needs and expectations.

Business knowledge and skills		
Holistic perspective	Knowledge and understanding of social and professional roles which are present in the project execution process (for instance, investor, customer, external customer, user, designer, contractor, maintenance worker, etc.) Application of own actions and co-ordination of own tasks with regard to differences related to the specific features of the aforementioned roles.	The student possesses knowledge on various social and professional roles present in the process of the execution of projects related to the sector (for instance, investor, external and internal customer, user, contractor, etc.) He/she is able to adjust and coordinate his/her own actions with regard to differences related to the specific features of the aforementioned roles.
Law and legal regulations	Knowledge about and understanding of laws, regulations, parliamentary acts and standards specific to the sector.	The student possesses knowledge about laws and regulations specific to the sector related to his/her profile of education. He/She knows and understands certain laws, regulations and standards.
Knowledge about the sector	Knowledge about entities operating in the sector, and of their environment; understanding of specific aspects and context related to behaviour in the sector; acquaintance with key opinion leaders.	The student knows specific features of the sector related to his/her profile of education. He/She knows and understand the role of entities operating on the market as well as their business and organisational environment.
Public procurement	Knowledge about procurement laws and regulations in force.	The student possesses knowledge about procurement laws and regulations.
Project management	Ability to effectively manage the activities of project teams	The student is able to effectively manage the activities of project teams.
Knowledge of AGILE methods in project management	Ability to work effectively in groups using soft project management methods (AGILE, SCRUM, etc.)	The student is able to work effectively in project groups managed by the rules of soft management methods (for instance, AGILE, SCRUM).
Knowledge of standard management methods	Ability to work effectively in groups using standard ("hard") project management methods (for instance, PMBok, PRINCE2)	The student is able to work effectively in project groups managed by the rules of standard management methods (for instance, PMBok, PRINCE2).

Soft Skills		
Name	Competence description	Educational effect
Adaptive skills	Easy and quick adaptation to changing conditions	The student is able to adjust his/her own habits and behaviours to changing conditions.
Initiative	Initiating new activities and assuming responsibility related thereto	The student is able to initiate, at his/her own, a new action (initiative) in a certain organisational and social context, and to assume responsibility for the performance of the initiative.
Innovation	Generating of ideas, creating and implementing new solutions streamlining working processes.	The student is able to generate his own new ideas (innovations), in a certain organisational and social environment, as well as to develop and implement the same in an innovative manner in order to solve problems.
Written communication	Development and presentation of messages in writing, development of clear written reports.	The student is able to develop and present messages, professional documents and reports in a written form, using an adequate language register and form comprehensible for the recipient/commissioning party.
Oral communication	Presentation and delivery of information in the verbal form,; ability to speak smoothly and fluently	The student is able to communicate smoothly with other people, and to develop and present information in the verbal form, using the language and form comprehensible to the recipients.
Organisation of own work	Scheduling of own work and organising actions purported to carry out plans; assigning priorities to tasks	The student is able to organise his own actions and time in a reasonable manner, as well as to assign priorities and optimise their performance. He/she is able to assign clear and challenging targets in his/her work on a specified task.
Goal-oriented (focus on targets)	Attainment of long- and short-term targets assigned to the position.	The student is able to understand and accept short- and long-term targets of the organisation in which he/she operates, and then undertake actions in order to perform them in a timely manner.

Soft Skills		
Customer-focused	Satisfying customer needs and expectation, consideration of customer's perspective when offering solutions.	The student is able to identify needs and expectation of the recipients of his actions (customers or beneficiaries) in the organisation in which he/she operates, and then to apply knowledge to undertake actions purported to satisfying them.
Coping with stress	Acting effectively and with ease in stressing situations	The student is able to act under pressure, using effective strategies to cope with stress.
Being concerned about quality	Actions compliant with the organisation's rules, regulations and procedures, diligence and accuracy in the performance of tasks	The student is able to identify quality criteria applicable to his/her own work (perceived as the fulfilment of the expectations of the customer or the beneficiary of his/her actions). He/She is able to identify the manner in which his/her actions are translated into the result of the organisation, and then to undertake actions compliant with the spirit and letter of rules in force, in a specific organisational context; he/she is diligent and accurate in performing the same. He/she cares of quality and diligence of the performance of his/her tasks.
Learning	Easy and quick learning new knowledge	The student is able to effectively and quickly assimilate new knowledge.
Ability to influence others	Influence on others, persuasion with the use of real arguments and other means of influence, assertiveness in presenting own views	The student is able to conduct substantive discussions, and use arguments to convince others, and to defend his/her own view in a given organisational milieu without giving rise to antagonising relations.
Intercultural "sensitivity"	Practical use of knowledge concerning inter-cultural differences, adjusting own behaviour to different cultural patterns	The student is able to adjust his/her behaviour in the organisation to different cultural patterns. He/She is able to identify cultural determinants of various human behaviours in the organisation. He/she is able to respect differences in viewpoints and cultural differences of co-workers and customers.

Soft Skills		
Collaboration	Effective work in a group, focus on the performance of group targets	The student is open to co-operation and is able to work with others in the group, assuming a role in the group, which helps to achieve group targets.
Commitment	Enthusiasm and passion for work, "Can do" approach, care of the company's image	The student is able to engage into actions and demonstrate enthusiastic approach and passion for the performance of tasks. He/she acknowledges that the care of the company's image is important in a given organisational context.
Analytical skills	Collecting and processing of information with ease, quickly and reliably	Regardless of conditions, he/she is able to quickly and reliably search, analyse and process information required in order to perform a task.

Foreign languages and other requirements		
Name	Competence description	Educational effect
Availability	Flexibility as to working hours, taking overtime jobs with an option to get leave in return of the overtime worked	N/A
English	Ability to use the foreign language in a degree allowing effective and smooth oral and written communication. (B2 level)	The student is able to communicate verbally and in writing in a given language at least at the B2 level of the Common European Framework of Reference for Languages (CEFRL or CEF). (He/She is able to understand the key aspects of real or abstract problems presented in complex texts, including specialist discussion related to his/her professional matters. He/She is able to communicate smoothly and spontaneously so that a conversation with a native speaker is free from stresses on either party to the conversation. He/She is able to express himself/herself in many topics in a clear and detailed manner; he/she is able to express his/her opinion on a given subject showing positive and negative sides of various (proposed) options.
German		
Russian		
French		
Italian		
Spanish		
Chinese		
Japanese		

Foreign languages and other requirements		
Mobility	Acceptance of requests to take travels related to business responsibilities and learning (conferences, training sessions) outside the location of his/her employment.	N/A
Research-driven motivation	Willingness to carry out scientific research and to share knowledge in the form of publications	The student understands the value of scientific research and is willing to develop and publish his own achievements in recognised journals.
Focus on development	Willingness to broaden his/her knowledge and skills at his/her own, also in new fields and areas.	The student acknowledges the need of constant development of his knowledge and skills, also in new fields and areas.
Ability to use MS Office, Open Office or Google Docs applications	Effective use of key office software packets	The student is able to use and apply office software (MS Office, OpenOffice, Google Docs) in his/her work .
Driving license	Possession of the category B driving licence	N/A
Publications	Documented scientific achievements in a given research field	N/A
Technical English	Ability to use foreign specialist language so that maintenance, comprehension and creation of technical documents, as well as oral and written communication with other representatives of the sector are possible.	The student is able to use foreign specialist language so that maintenance, comprehension and creation of technical documents, as well as oral and written communication with other representatives of the sector are possible.
Technical English		
Diagnostics Specialist title	Possession of a certified diagnostics specialist title	N/A
Integrity	Observance of commonly accepted moral standards.	The student accepts the need of ethic behaviour standards and integrity as well as he/she follows them in his/her actions.
Mathematical skills	Ability to perform advance mathematical operations	The student is able to perform various mathematical operations in order to solve problems and generate knowledge.
UDT licence	Licence to operate UDT instruments	N/A

APPENDIX 2. SUMMARY OF QUANTITATIVE DATA

					Specialist Knowledge		
Name	Importance 2014	Importance 2019	Difficulties in acquiring	% of university courses achieving the educational result	Evaluation of achieving the educational result	Tasks of universities – business's perspective	Tasks of universities – universities' perspective
Specialist knowledge – clinical trials	4.67	4.78	3.33	38%	3.50	4.75	4.00
Validation	4.57	4.43	4.14	77%	3.80	4.57	4.30
GMP principles	4.50	4.33	4.40	46%	3.43	4.17	3.67
Hazardous substances	4.43	4.29	3.50	54%	3.75	4.50	4.33
GLP principles	4.25	4.13	3.86	62%	3.78	4.14	4.56
Experimental method	4.17	4.50	3.75	62%	4.00	4.20	4.20
GHP principles	3.83	3.60	4.00	31%	3.00	3.75	3.57
Quality management	3.71	3.57	4.00	46%	3.43	4.00	3.11
OHS Principles	3.63	3.63	2.50	85%	4.09	4.14	4.55
Ownership rights	3.63	4.29	4.20	54%	3.33	4.33	4.00
ISO standards	3.57	3.29	4.00	31%	3.17	4.20	3.86
HACCP principles	3.50	3.33	3.75	23%	2.67	3.75	3.50
Quality audit	3.50	3.33	4.00	23%	2.67	4.00	3.33
International safety standards	3.40	3.80	3.80	46%	3.14	4.67	3.75
Statistics	3.38	3.67	3.80	77%	3.73	4.50	4.40
Ethics and bioethics	3.17	3.40	3.33	69%	3.50	4.20	3.89

Specialist Skills						
Name	Importance 2014	Importance 2019	Difficulties in acquiring	% of university courses achieving the educational result	Evaluation of achieving the educational result	Tasks of universities – business's perspective	Tasks of universities – universities' perspective
Analysis	4.50	4.20	3.50	54%	3.67	3.80	4.44
Operation of apparatuses	4.43	4.14	3.50	69%	4.11	4.29	4.50
Expert opinions	4.40	4.20	4.00	46%	3.44	3.40	4.38
Information science	4.33	4.33	3.25	77%	3.91	4.60	4.56
Reporting	4.29	4.14	3.50	69%	3.78	4.14	4.30
Compliance	4.17	4.25	3.33	46%	3.38	3.50	4.00
HPLC analysis	4.14	4.50	4.00	31%	3.00	4.67	3.50
Technological documentation	4.00	3.80	3.50	23%	3.00	3.33	3.17
Operation of CAD / CAM / CAE designing software	3.67	4.00	3.33	15%	4.00	4.00	3.17
Technological supervision	3.67	4.00	4.00	31%	2.75	4.00	3.22
Pharmacopeia	3.60	3.60	2.67	15%	3.00	4.67	3.80
Ability to use statistical analysis software	3.50	3.80	3.00	38%	3.00	3.67	4.14
Laboratory economics	3.00	2.75	3.00	54%	3.63	3.00	4.13
SAP	2.75	3.00	3.50	15%	2.67	3.67	2.67
Operation of project management software	2.60	3.20	4.00	15%	2.50	4.00	2.80
Clinical project management.	2.25	3.00	4.50	23%	3.00	4.00	3.80

Business Knowledge and Skills							
Name	Importance 2014	Importance 2019	Difficulties in acquiring	% of university courses achieving the educational result	Evaluation of achieving the educational result	Tasks of universities – business's perspective	Tasks of universities – universities' perspective
New trends	4.14	4.29	4.00	46%	3.33	3.40	4.25
Project management	4.00	3.71	4.00	31%	2.71	4.40	3.83
Law and legal provisions	3.86	3.67	3.50	54%	3.22	4.00	4.00
Marketing	3.80	3.80	3.50	31%	3.00	3.75	3.50
Business etiquette	3.80	3.20	3.00	15%	3.00	4.00	3.86
Knowledge about the sector	3.67	3.60	3.50	46%	3.38	2.60	3.88
Knowledge of standard project development methodologies	3.57	3.60	4.00	8%	2.50	4.50	2.50
Business offers	3.40	3.40	4.00	8%	2.67	3.33	2.80
Negotiations	3.40	3.40	4.00	8%	4.00	4.25	3.50
Economics	3.20	3.00	3.67	38%	3.00	4.25	3.17
Investment financing	2.80	2.80	3.00	31%	2.71	2.75	3.57
Public procurement	2.80	3.00	4.00	15%	3.00	4.00	2.80
Knowledge of AGILE methodology in management	2.50	3.00	4.00	8%	2.50	3.75	2.67
Holistic perspective	2.33	2.00		31%	2.80	2.00	3.14

Soft Skills							
Name	Importance 2014	Importance 2019	Difficulties in acquiring	% of university courses achieving the educational result	Evaluation of achieving the educational result	Tasks of universities – business's perspective	Tasks of universities – universities' perspective
Being concerned about quality	4.83	4.83	4.00	46%	3.29	4.40	4.43
Analytical skills	4.83	4.67	3.25	46%	3.43	4.00	4.14
Commitment	4.60	4.60	3.33	54%	3.71	3.00	3.86
Learning	4.60	4.40	3.00	69%	3.78	2.75	4.43
Adaptive skills	4.60	4.60	3.33	54%	4.00	3.50	4.43
Initiative	4.50	4.33	4.00	46%	3.25	3.17	4.14
Focus on customer	4.50	4.50	3.67	38%	2.83	3.33	3.33
Organisation of own work	4.50	4.33	3.33	46%	3.22	3.40	4.14
Coping with stress	4.50	4.33	3.50	38%	3.50	3.67	4.00
Collaboration	4.33	4.67	3.33	54%	4.00	3.00	4.17
Intercultural sensitivity	4.25	4.25	4.00	23%	3.50	3.33	3.80
Innovation	4.17	4.17	4.00	38%	3.13	2.50	4.14
Oral communication	4.14	4.17	3.33	46%	3.13	4.33	4.14
Focus on targets	4.00	4.20	3.33	31%	3.17	3.00	4.20
Written communication	3.86	4.00	3.67	46%	3.25	4.25	4.00
Ability to influence others	3.80	4.00	3.50	38%	3.13	3.00	4.14

				% of university courses achieving the educational result	Evaluation of achieving the educational result	Tasks of universities – business's perspective	Tasks of universities – universities' perspective
Foreign Languages and Other Requirements							
Name	Importance 2014	Importance 2019	Difficulties in acquiring				
Ability to use MS Office, OpenOffice or Google Docs	4.88	4.63	2.33	69%	4.11	4.86	4.38
Integrity	4.83	4.83	3.67	69%	3.70	3.25	4.38
Focus on development	4.60	4.40	3.33	77%	4.00	3.00	4.75
English	4.50	4.57	3.00	-	-	4.88	-
Technical English	4.50	4.43	3.8	-	-	5.00	-
Availability	4.00	4.00	3.00	-	-	2.25	-
Mobility	3.71	4.00	3.50	-	-	2.00	-
Technical German	3.50	4.00	4.00	-	-	5.00	-
Driving license	3.50	3.20	2.33	-	-	1.50	-
Chinese	3.33	4.00	4.50	-	-	5.00	-
French	3.00	2.00	3.50	-	-	5.00	-
Japanese	3.00	2.00	5.00	-	-	5.00	-
Mathematical skills	3.00	3.00	3.33	69%	3.56	4.80	4.25
Professional certificates granted by Technical Supervision Office [UDT]	3.00	3.25	4.00	-	-	2.50	-
Research-driven motivation	3.00	3.00	2.00	23%	4.33	2.50	5.00
German	2.67	3.00	3.00	-	-	5.00	-
Italian	2.67	1.50	3.00	-	-	5.00	-
Russian	2.50	1.00	3.00	-	-	5.00	-

Foreign Languages and Other Requirements							
Name	Importance 2014	Importance 2019	Difficulties in acquiring	% of university courses achieving the educational result	Evaluation of achieving the educational result	Tasks of universities – business's perspective	Tasks of universities – universities' perspective
Spanish	2.50	1.00	3.50	-	-	5.00	-
Publications	2.33	2.33	2.00	-	-	4.50	-
Diagnostics Specialist title	2.00	2.00	2.67	-	-	4.75	-

APPENDIX 3: OVERVIEW OF THE TOOLS USED

DEMAND QUESTIONNAIRE

The tool for competence demand survey applied in two formats: the electronic on-line form (using Limesurvey software) and MS Excel sheet (where a given company preferred direct contact with the pollster).

The tool consisted of 3 main parts

1.   Company particulars and plans

– company's name

– number of employees employed under a labour contract by the company or its Kraków's branch

– number of employees under a civil law contract or self-employed entrepreneurs employed by the company or its Kraków's branch

– names of positions to which the company recruits employees most frequently (maximum: 5 positions) and the assessment of difficulties in recruiting candidates who meet expectations (currently and in 2019)

– plans concerning the employment of graduates (who graduated within the last 12 months) under a labour contract (in 2014 and 2019).

– plans concerning the employment of graduates (who graduated within the last 12 months) under civil law contracts or as self-employed entrepreneurs (in 2014 and 2019).

2.   Assessment of competences by 5 thematic groups (in sequence: specialist knowledge, specialist sills, business knowledge and skills, soft skills, foreign languages and other requirements – list available in Appendix 1, this based on four criteria:

– importance today (How important it is for your company, that students or graduates possess a given competence, where 1 means: "definitely irrelevant" while 5 means "definitely important")

– importance in 5 years (How important it is for your company, that students or graduates will possess a given competence in 5 years, where 1 means: "definitely irrelevant" while 5 means "definitely important")

– difficulties in acquiring the competence (How difficult it is today to recruit a person whose competence level meets requirements, where 1 means "very easily", while 5 means "very difficult to acquire".

– university task (Is, in your opinion, the teaching of a given competence a task of universities?) Please use scores from 1 to 5 where 1 means "teaching of a given competence definitely should not be a task of universities", while 5 means "teaching of a given competence should be definitely a task of universities")

– using the same criteria, provide and asses maximum 10 additional competences that have not been put on lists previously presented.

3.   Additional information

– indication of 5 fields of study that meet best the needs of the company (maximum 5 fields of study; if necessary, also indicate the name of a university)

– indication of maximum 5 competences that are of vital importance in the context of the promotion of a graduate employed by your company

– additional comments

SUPPLY QUESTIONNAIRE

The tool for competence supply survey applied per analogy to the demand questionnaire, in two formats: the electronic on-line form (using Limesurvey software) and MS Excel sheet (where a representative of a field of study subject to survey preferred direct contact with the pollster).

The supply questionnaire consisted in 3 parts

1.   Particulars

– name of the university , department, chair, institute and the field of study

– available forms of studying of the given field of study (full-course studies, other)

– available levels of studies offered in the given field of study (Level I, level II, post-graduate studies, other)

– indication of specialisation paths/profiles/specialisations which, in the view of the sector, achieve similar educational effects

– anticipated number of students graduating from each of the aforementioned paths (in 2014 and in 2019)

2.   Assessment of competences by 5 thematic groups (in sequence: specialist knowledge, specialist sills, business knowledge and skills, soft skills, other requirements – list available in Appendix 1, based on two criteria:

– achieved educational effects (To what degree, in your opinion, educational effects referred to in this questionnaire are achieved at the field of study, where 1 means "not achieved at all", while 5 means "achieved at a very high level".)

– tasks of the university (Is, in your opinion, education for a specific educational effect a task of the university, where 1 means: "definitely not", while 5 means: "definitely yes".)

3.   Additional information

– indication of additional educational results which are achieved at a given field of study, but have not been put on the list, and are potentially important from the point of view of the sector

– indication of mandatory courses in foreign modern languages and opportunities to learn other languages free-of charges

– additional comments