A PROPOSAL OF SYSTEMATIC AND COMPLEX SOLUTION IN REGARD TO IMPROVEMENT OF EDUCATION EFFICIENCY TO BE USED IN ECONOMY

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1. Introduction

Stable economic development requires purposeful and systematic education of workers. An issue presented in this article regarding monitoring of education effectiveness and forecasting adjustment of education system to labor market needs, particularly in regard to knowledge and technical competencies constitutes a part of a program called AWT® (Technical Knowledge Accelerator) (Szafrański, Grupka, Goliński, 2008, p.9). AWT® program includes acceleration of technical, mathematical and natural science knowledge in Poland and is a strategic, complex and innovative solution of Wielkopolskie voivodship. Actions planned within AWT® program significantly contribute to development of human capital by increasing the awareness of technology, mathematics and natural science, adjusting to the labor market needs, better adaptation to environmental changes and greater creativity in everyday and professional life. Actions planned for the projects are related to the Wielkopolska region, however their model characteristic allows to transfer all solutions to other regions in Poland. The program was prepared by the team of scientific workers of Poznan University of Technology with cooperation of the representatives of Education and Science Department of Marshal’s office of Wielkopolskie voivodship.

Activities regarding the monitoring of effectiveness and quality of education and forecasting the adjustment of education system to the needs of labor market include several components related to each other. In a planned system of monitoring and forecasting, education is seen as a continuous process. This process is being created in different phases of life. From the perspective of labor market needs, the knowledge and skills may be perceived as product. An opinion may be formulated that the earlier the activities regarding the quality of this product are undertaken the smaller the cost of achieving and guaranteeing this quality will be. The best is to correctly design the quality of education. Correct designing of education processes lowers their costs and their evaluation done by the interested parties is higher. An aspect of effectiveness in regard to ensuring optimal quality of education process should be seen in relation with the issue of efficiency, which means the accordance of results of activities with the goals.

Directions of economy innovativeness improvement for years 2007-2013, Ministry of Economy, Department of Economy Development, Warszawa April 27, 2006, p. 6
Fig. 1. Chart of actions within component AWT-03 – system of monitoring of education effectiveness and forecasting the adjustment of education system to labor market needs in regard to knowledge and technical competencies

Shaping the education processes in order to fulfill the requirements in regard to those processes is particularly difficult as various interested parties expect different results. Accepting an opinion that by developing and improving the knowledge and technical skills we can fulfill the social need of increase of innovativeness and competitiveness of national economy, it becomes necessary to monitor the market and gather current information about needs which should be transformed into features of knowledge and technical skills, that is into their quality and before that into the quality of education systems within which the knowledge of certain quality is created. It is also essential to monitor the ways that information is used in the processes of adjusting the education systems in regard to knowledge and technical skills to the dynamically changing needs of labor market.

2. Actions in a system of monitoring of education effectiveness and forecasting the adjustment of education system to labor market needs, particularly in regard to knowledge and technical competencies

In a planned system of monitoring and forecasting the education is seen as a continuous process. This process is shaped in all stages of life and will include:
- Standard education system in kindergartens,
- Standard education system in classes 0-6,
- Standard education system on junior high school level
- Standard education system on high school level
- Standard education system on university level
Next stages of education will be accompanied in parallel by three subsystems of the program of acceleration of technical, mathematical and natural science knowledge in Poland.
- Career counseling system,
- System of promotion of technical majors and lifelong learning,
- Monitoring of education effectiveness and forecasting the adjustment of education system to labor market needs in regard to technical, mathematical, natural science knowledge and competencies

From the perspective of labor market needs, knowledge and skills may be perceived as product. If such analogy was to be used, we can formulate a thesis, that the smaller the cost of achieving the quality of this product is the faster the actions are undertaken to assure this quality. The best approach would be to properly design the quality of education. Proper
designing of education processes lowers their costs and their assessment done by interested parties is higher. An aspect of effectiveness in regard to ensuring optimal quality of education process should be considered in relation with efficiency, that is concordance of action results with goals.

Shaping education processes in order to fulfill the expectations regarding those processes is particularly difficult as various interested parties expect different results.

If we were to accept a common opinion that by development and improvement of technical knowledge, skills and competencies a social need of increase of innovativeness and competitiveness of economy can be fulfilled, it becomes necessary to research the market and gather current information about needs which should be transformed into characteristics of technical knowledge, skills and competencies, that is into their quality, and before that into the quality of education systems which generate knowledge of certain quality (Szafranski, Bondarowska, Wiecek-Janka, Golinski, 2008, s. 356).

It is also crucial to monitor the way that information is being used in process of adjusting education systems to dynamically changing needs of labor market in regard to technical knowledge and skills.

From the macroeconomic perspective it is also important to gather information, as a result of forecasting actions, how the data from labor market are being used in education systems to create knowledge and technical skills which will be useful in future.

Based on the above deduction we find connection and inseparability of the following actions listed in component AWT-03:
- Labor market needs monitoring
- Education quality monitoring
- Measuring the effectiveness and efficiency of education,
- and creating an IT system supporting the component AWT-03.

A natural subject of research within a pilot project Technical Knowledge Accelerator is technical knowledge, however creating a complex research system in order to explore such a narrow issue would be ineffective. Additionally a created IT system would most probably not meet with users interest, as it would have limited capability of accessing sought information. Moreover, deliberating about the labor market requirements for technical knowledge, without knowing the context in with this requirement arouses would make conclusions about desired directions of education system improvement very poor.

All the above conditions cause that it is suggested to elaborate at once a system of monitoring and forecasting along with supporting IT system which will respond to broader social needs regarding the quality of education of all knowledge and skills and will result in meeting labor market requirements. This proposition appears purposeful, as increasing the scope of information in the system will not proportionally influence the costs of the system, because the construction of the IT system generates high fixed costs of the venture.

Creating a common research system in order to educate in all knowledge areas at high school, university and lifelong learning level is justified by:
- Economical reasons,
- Effects of further stages of education resulting from actions taken in earlier stages,
- Necessity to gather complex data in research process.

The reasoning used in the project is presented on figure 2.
Because of specificity of the project and its goals, such a system of monitoring and research should be provided that will allow to gather exhausting data and information about various aspects of technical education, including that on technical majors.

It should be more underlined that the component AWT®-03 expresses a need of creating a durable, IT supported, modern solution, which will allow comprehensive monitoring and forecasting of labor market needs and effectiveness and efficiency of education in the context of fulfilling those needs.

3. Methodology of monitoring and forecasting processes in the AWT®-03 component.²

3.1. General system goals

1. Gathering information in order to adjust the education profile of high school and university graduates (particularly technical) to the labor market needs.
2. Gathering information that would help to improve the education process adjusted to labor market needs (particularly in regard to technical knowledge)
3. Creating a system, monitoring the demand for workers with defined competencies (technical in particular) and supply of competencies on labor market (technical in particular)

² A methodology concept was elaborated by a team of workers of division of marketing and economic engineering, division of managerial application and computing and division of production engineering of Poznań University of technology, including Maciej Szafranski PhD, Ewa Więcek-Janka PhD, Karolina Bondarowska PhD, Marek Golinski PhD, Zbigniew Włodarczak PhD, Agnieszka Kujawińska PhD. This article contains a brief form of this concept.
5. Delivering information in order to improve the actions within AWT®-02 and AWT®-03 systems
   Monitoring and forecasting processes will be developed for 5 years. For the first year it is planned to design the monitoring and forecasting system, to test methods of monitoring and forecasting, to test IT system supporting the research processes and experiments and to launch initial research. The plan for the next four years is development of research system, including the implementation and improvement of an IT system.
   Place will include: junior high schools; high schools including technical profile high schools; technical universities and other universities and colleges offering technical majors; other subjects offering education services; labor market institutions; education institutions; enterprises: Large, medium, small and micro; businessmen organizations; press and Internet.
   Respondents: pupils, teachers, parents, students, junior high, high schools and university graduates, university workers, employers, workers of labor market and educational institutions, workers of governmental and municipal units.

Research methods will include:

1. Secondary sources research
   a) Education standards,
   b) Organizational structures and organization management systems as elements connecting organizational culture with technology development (Wyrwicka, 2008, p. 690)
   c) Data about infrastructure,
   d) Results of other research,
   e) Regulations,
   f) Accreditation guidelines and results
   g) Press and Internet job offers,
   h) Data from IT system created within a different action,
   i) other

2. Observation (monitoring) of changes in supply and demand for technical and other competencies on laborer, technical and engineering work positions (supported by IT system)

3. Observation (monitoring) of changes in an education process and using technical knowledge.

4. Experiments in form of pilot actions which results will be analyzed over a few years.

5. Survey with representative, non-random selection (selection of typical units, according to the goal and subject of research, approximate sample size: 1500 units).

6. Questionnaires with representative, non-random selection (selection of typical units, according to the goal and subject of research, sample size adjusted to research)

7. Survey (CATI method) in enterprises using technical competencies (or expressing a need of using them), approximate sample size: 1100 units.


**Precision**

1. Descriptive survey:
   a) Systematizing notions and definitions: Knowledge, soft and hard knowledge, competencies, type of knowledge, demand for knowledge, human relations, technical knowledge etc.,
   b) Characterizing high schools and technical universities in regard to infrastructure of majors, specialties, size, standards of education, achievements in contests etc.
   c) Identifying traits of technical school graduate in current and perspective approach.
2. Qualitative research which allows to define attributes (competitive advantage) of particular schools, training units, graduates, pupils or students based on the level of detailed knowledge (mathematics, chemistry, physics, organization of production processes, machines’ construction, materials' endurance, metrology, participating in projects, competitions), graduates’ successes in professional life, technical organizations affiliation etc.

3. Quantitative research which allows to verify the hypothesis, for example:
   d) about necessity of investing into development of technical knowledge,
   e) about improvement of information flow between the business market and schools and universities.
   f) about the necessity of introducing lifelong learning offer for the graduates of high schools and technical majors of all or selected specialties.
   g) about the need for technical education adjusted to various age groups etc.

**Recipients of action results in component AWT®-03**

- Labor market institutions
- Junior high schools
- High schools
- Universities and colleges especially those with technical majors
- Pupils
- Parents
- Students
- Local government units
- Enterprises
- Enterprises’ workers
- Institutions offering training services
- Ministry of Science and Higher Education
- Ministry of National Education

**3.2. Actions related to entire system goals**

For the reasons mentioned above, in all goals which have actions assigned to them, an aspect of technical competencies should be particularly considered. An area of technical knowledge and competencies is a minimal scope which the processes of monitoring and forecasting should cover in component AWT®-03. (fig 3).

![Fig. 3. Action 03.1 Monitoring and forecasting of labor market needs particularly in regard to technical knowledge and competencies Source: Personal elaboration based on (Szafraniński, Grupka, Golitiski, 2009, s. 161)](image-url)

1. Assessment of requirements for workers with given competencies
2. Identifying demand for graduates of high schools and universities
3. An attempt to define trends and cycles characterizing the demand mentioned in points 1 and 2.
4. Monitoring of announcements in selected press titles in Poland and EU from the perspective of labor market requirements for workers with defined competencies.
5. An attempt to define a trend and cycle of changes in regard to the demand for competencies on EU labor market.
6. An attempt to find connections between the trend of changes in Poland and EU (defining relationship between the labor market behavior in EU and Poland in regard to requirements for particular competencies).

Figure 4 presents a proposed action chart to create a systematic solution for monitoring of labor market and forecasting its changes. Every stage should be concluded with assessment whether or not to modify the following stages. Moreover, it might occur that some stages may be carried out in parallel.

![Action Chart]

Fig. 4. An action chart to achieve comprehensive solutions in monitoring and forecasting labor market needs
1. Defining education quality in high schools, including those with technical profile, and in Universities, including technical majors (fig.5)

![Diagram](attachment://awt-03_03_2.png)

Fig. 5. Action 03.2 Education quality monitoring, particularly in regard to technical knowledge and competencies. Source: Personal elaboration based on (Szafkański, Grupka, Goliński, 2009, s. 163)

2. Finding relations and discrepancies between the quality of education in high schools and on technical majors in universities.

3. Recognition and analysis of functioning models of education quality in selected educational units in Europe.

4. Identification of expected and perceived quality of education of high school and university graduates by various interested parties: Employers, graduates, universities, parents, etc.

5. Analyzing discrepancies between expected and perceived quality of education.

6. Measuring deviation from equilibrium point between supply and demand for a given type of knowledge and analyzing the reasons of those deviations in case of their occurrence.

7. Analysis of validity of introducing changes in education process at high school and university level.

8. Assessment of changes’ dynamics in education quality.

9. Assessment of technical knowledge acquirement (level of command of methods, means and forms of technical knowledge)

10. Feeding the IT system with current information (action 03.4) facilitating the adjustment of lifelong learning system to current needs of labor market, as a result of elaborating facultative education programs, courses and trainings for the graduates of high schools and universities with technical majors (fig.7)

![Diagram](attachment://awt-03_03_3.png)

Fig. 6. Action 03.3 Measuring the effectiveness and efficiency of education, particularly in regard to technical knowledge and competencies. Source: Personal elaboration based on (Szafkański, Grupka, Goliński, 2009, s. 164)
Within action 03.3 (fig. 6) the following subactions are planned:

1. Measuring the influence of teaching methods (including innovative\(^3\)) of mathematics, natural science and technology on the choice of technical and natural science majors by high school graduates.

2. Measuring the level of preparation to study on technical majors of high school graduates, including those involved in innovative teaching methods of mathematics, natural science and technology and preparation of technical major graduates for professional work.

![Fig. 7. Action 03.4 Creating IT system supporting monitoring and forecasting in Technical Knowledge Accelerator. Source: Personal elaboration based on (Szafraniski, Grupka, Golinski, 2009, s. 164)\(^{\text{3}}\)](image)

Based on lasting almost a year social consultations between partners willing to participate in AWT\(^{\text{®}}\) program, non-standardized deepened interviews and analysis of some completed research on the needs of labor market and on the education quality, we state that used methodology of research on the labor market needs and education systems functioning does not fully enable its monitoring or changes forecasting. Most often this is small, partial research.

In most common type of research using questionnaires or mail or auditorial surveys, the cycle of such research lasts from 9 month to 1,5 year with budgets from 300 thousand to 1 million zloty. Dynamic migration movements occurring in last few years resulting from global crisis, which have significant influence on Polish labor market, support that observation.

Part of the research mentioned above does not have any continuation – it is rather incidental. Its periodical repeatability depends on gathering funds, lately often EU funds. When the resources have run dry the research is not continued and after several years, sometimes just several month, from their finish their results become out of date. Knowledge about labor market and education effectiveness in order to adjust competencies to labor market vanishes. Decision makers return to a starting point. A gap in knowledge about the demand for knowledge on labor market maintains or periodically renews.

It is necessary to create an **IT system** which will be used to support the research and gathering research results. Such a solution will allow to:

- Shorten the research cycle,
- Broaden the scope of gathered data,
- Enlarge possible analysis,
- Ensure repeatability of research,
- Significantly deepen the research and detail their results,
- Use historic data in forecasting process (forecasting based on historic data has its limitations, thus it will be supplemented with other research methods which will together constitute the entire forecasting methodology),

and after the pilot period is over also to:

– Maintain the scope of research,
– Include in the research system the entire Polish labor and education market (for some parts of the research it is possible to be done even in pilot stage),
– Use all possible scales and scopes of analysis based on gathered data,
– Decrease the fixed costs of system maintenance, because the greatest costs of designing, creating, testing and modification of IT system will have already been paid, and further costs of the system will boil down mainly to its maintenance and modernization.
– Decrease of data archiving cost per unit because of the constant increase of data and slower pace of increase of system functioning cost,
– Decrease of system implementation costs in other regions because of effect of scale (increase of organizational efficiency, implementation know-how, no implementation anxiety, lower promotion expenses, decreasing prices of IT services and equipment).

A place of IT system in monitoring and forecasting process is shown on figure 8.

![Fig. 8. A place of IT system in process of monitoring of education effectiveness and forecasting the adjustment of education system to labor market needs, particularly in regard to knowledge and technical competencies](image)

From the perspective of subjects inputting data to the system (enterprises, training companies, educational units, workers, students, graduates and other) the results of research are not as important as benefits coming from using the system. Considering the needs of users inputting data to the system, IT system apart from being treated as a research tool it will also be seen as a product fulfilling users requirements (fig. 4).

From the perspective of utility, two major functions will be assigned to IT system:
– Internal – research tools (major target groups: Ministries, local government units, labor market institutions, universities, schools, educational units, municipalities) - crucial for research,
– External – tools for information exchange and associations between labor and education market (major target groups: Entrepreneurs, employees, institutions and companies offering education services, schools, universities) – less important for research but required in monitoring and forecasting process.

As shown on figure 8, IT system will be a basic tool used in monitoring process and supporting tool in forecasting process.
4. Connection between IT system and promotion activities.

It is planned in a pilot project of Technical Knowledge Accelerator to create a system of promotion and improvement of the quality of lifelong learning addressed to students of last years of technical majors, graduates of those and other majors, who desire to gain technical competencies required on labor market. Designed and implemented system will be good to implement in other areas of knowledge and skills. Figure 9 presents the scope of promotion and lifelong education quality improvement, defined by identified processes. The figure presents connections between these processes in the system. The border of designed system is represented by a bold line. It also shows the connection with other components of AWT®. AWT®-03 component will include popularization of IT system created within this component. Data and information from the system of promotion and lifelong learning quality improvement will be used in two other systems:

- Recruitment system involving recruitment processes on labor market and other related to them – this system is not a part of AWT®,
- System created within component AWT®-03.

In the first stage of system functioning no promotion actions, such as free postgraduate studies, are planned. However it will be possible to promote offers of postgraduate studies of all universities which will pass such information. In turn, resulting from the research done within component AWT®-03 the information will be passed to universities, what knowledge should be passed in various forms of education, both elementary (studies of first and second degree) and others (for example postgraduate studies).

Partners for this action are, among others: Agricultural university in Poznań, Faculty of Commodity Science of Poznań Economic University, State Higher Vocational School in Gniezno, Konin, Kalisz, Leszno, Piła, REFA Wielkopolska Federation for work organization, operational organization and enterprise development registered association, the Vocational Education Centre in Poznań, Poznań Centre of Lifelong and Practical Learning and other institutions and societies.

5. Summary

Quality of life of citizens of every country, including Poland, is strictly connected with economic development. One of the factors defining economy level is rate of implementation and development of innovativeness in production and services. A corner stone of stable and dynamic development of innovativeness is development of intellectual capital in which a very important factor is human capital⁴ and technical knowledge in particular. For it to be possible it is necessary to awake in the society the need of increasing their technical knowledge, because this need is not common enough nowadays. In order to know how to awake and maintain such need it is necessary to do adequate research. The research should include the issue of education effectiveness, so that the results can be used in the process of improvement of education quality in regard to technical skills and knowledge and adjustment of created technical knowledge to the dynamically changing needs of labor market.

If Poland is to be innovative and competitive in a few years time it is necessary today to do organic work, work at the basis, which will result in systematic solution regarding discussed in this article monitoring of education effectiveness and forecasting the adjustment of education system to labor market needs, particularly in regard to technical knowledge and skills.

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