Application of Correspondence Analysis and Related Methods to Evaluation of Knowledge and Skills of Students

prof. Jozef Dziechciarz
dr Alicja Grzeskowiak
dr Agnieszka Stanimir
Main goal of education reform (Poland, 1999):

“the improvement of quality in formal educational system and its adjustment to requirement of the knowledge-base economy, assuring the access to lifelong learning system for the entire society”

Source: Perspektywy gospodarki opartej o wiedzę w Polsce; World Bank Report, KBN, 2004

Principles of the reform:

• new structure of the education system, ranging from nursery school to doctoral studies
• an independent assessment, external examination system
• supervision separated from management
• new system of financing
• new professional status of the teaching staff linked with the promotion paths
Education Reform and PISA (Programme for International Students Assessment) Surveys

• 1999 – PISA trial version of survey, introduction of Education Reform in Poland
• 2000 – PISA first survey, participating Polish students approaching the end of compulsory education in the old system (very good baseline for comparisons)
• 2009 – fourth PISA survey; after ten years after the introduction of the reform Poland’s participation was summarized as:

“on average, the reform was associated with significant improvements. Poland improved its score in mathematics by 0.25 of a standard deviation, in reading, by 0.28 of a standard deviation, and in science, by 0.16 of a standard deviation”

Source: The Impact of the 1999 Education Reform in Poland, OECD Education Working Paper no.49, OECD, 2010
Scope of Research

• PISA results evaluation was published in 2009 but the newest information taken into consideration was from 2006

• the need for evaluation based on the up-to-date results

• national exam results from 2010 analyzed, similar competences as PISA test regarded

• special attention paid to differences according to gender, place of residence and to changes in time
Gymnasium as a Part of Education System in Poland

• Age of students: 14-16
• General education
• Compulsory school
• No specialization paths

Source: The Education and Assessment System in Poland, Central Examination Board, 1999
Regional Aspect of the Study

- south-western part of the country (two administrative territories)
  - area: 29 thousand km$^2$ (9.1% of total)
  - population: 3.9 million (10.2% of total)
  - number of students taking the exam: 40.9 thousand (9.2% of total)
External Exams Idea

- Standardized Procedures
- Nationwide comparability of results
- Examination papers coded to provide objective assessment
- Not relevant for graduation, relevant for further enrolment
Gymnasium Exam - Division

**Humanities**
- Polish language
- History
- Civic education
- Arts

**Science**
- Mathematics
- Physics
- Astronomy
- Chemistry
- Biology
- Geography

max 50 points

max 50 points
Evaluated Competences Areas

**Humanities**
- Reading and interpretation of texts
- Creation of own text

**Science**
- Finding and using information
- Application of terms and procedures
- Identifying and describing facts, relationships and dependences
- Application of integrated knowledge and skills to solve problems

CARME Conference, Rennes, 8-11 February 2011
General Remarks on Results (2010)

The diagram shows the distribution of number of points between science and humanities. The median for science is 22 points, and for humanities, it is 31 points.

Gender

- Female: 49.97%
- Male: 50.03%

Place of Residence by Commune Type

- Urban (cities more than 80 th inhabitants): 35%
- Urban (towns less than 80 th inhabitants): 21%
- Urban-rural: 19%
- Rural: 25%

- urban commune: limited to the administrative town/city borders
- rural commune: the territory does not comprise a town
- urban-rural: includes a town and some villages
Multivariate CA Based on Burt’s Matrix

• results obtained in points were coded as excellent, good, moderate and weak

• two analyses for two administrative territories (Lower Silesia Region and Opolskie Region) were conducted

• quality of display in two-dimensional space was equal to 26% and 30%, respectively (to regions)
Multivariate CA Based on Burt’s Matrix - Results

Lower Silesia Region

Opolskie Region

Excellent results in big cities

Girls better results than boys in both science and humanities

Weak results associated neither with gender nor with commune type

As the analysis based on Burt’s matrix did not indicated the exact diversification among the gymnasium students the data were analyzed with application of multiway contingency tables.
Analysis Based on Multiway Contingency Tables

- *higher-order associations* were applied between commune type and gender and between knowledge area and exam score.

- Data table used in this analysis is 20x8, dimensionality of this table is 7.

- Percentage of explained inertia in the map is 96%.
Analysis Based on Multiway Contingency Tables – General Results

- Boys from the capital of the region excellent in science
- Girls from big cities excellent in humanities
- Boys from rural and urban-rural communes moderate in humanities
- No particular categories associated with weak results in science
- No particular categories associated with weak results in humanities
- Boys from other big cities good in science
- Boys from the capital of the region excellent in science

\[ \lambda_1 = 0.04 (75.16\%) \]
Analysis Based on Multiway Contingency Tables: Lower Silesia Region – General Overview
Comparison of Results Obtained in 2003 and 2010

From better results in the capital of the region to weaker results in rural

Various changes in science results:
• Cities: better results in 2010
• Urban-rural communes: weaker results in 2010
• Rural communes: weaker results in 2010

No particular differences in humanities results in 2003 and 2010

Weaker results in rural communes
Comparison of Results Obtained in 2003 and 2010

Obtained better results than boys in both areas regardless of the place of residence.

Bigger dispersion of results according to gender was observed in rural and urban-rural communes.
Other Methods: Application of Factor Analysis

- problem – identification of common factors in the competences areas
- design - variants of analysis (issues): students divided according to gender and place of residence; each issue analyzed separately
- result - the competences areas produce one common factor in all variants
Further Research Directions

• PISA results from other European countries

• Exploring results in connection with information from background questionnaires concerning:
  ✓ educational carrier (educational aspirations, school changing, studying interruptions)
  ✓ ICT familiarity (availability of ICT, attitude and use of computers)
  ✓ parents characteristics (educational status, economical status, attitude to reading, perception of and involvement in child’s school, child’s school choice criteria)
Conclusions

• the application of correspondence analysis to the study of knowledge and skills of students allowed to identify the associations among analyzed characteristics (gender, commune type, competences areas, results of exam)

• the application of the multiway contingency table also allowed to identify the relationships in any configuration of variables as well as improves the quality of presentation in low dimensional space

• there are further research directions as taking into consideration results from more years or extending the study to other countries and other characteristics
Thank you very much for your attention