DATA PROCESSING AND STATISTICS IN THE SLOVENIAN CURRICULUM

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Besides the basic capabilities of reading, writing and calculating, also other capabilities of literacy are emphasised, such as information, statistic, digital, media, mathematical and other literacies which are important for acting in the society. In our article we are going to present certain views on information, statistical and data literacies as well as on the integration of the contents on data processing and statistic in the Slovenian curriculum. An individual is considered literate in information if he/she is capable of critical thinking about information, of assuming and argumentation, and of interpreting and evaluating information. An important component of the information literacy is statistical literacy, the capacity of critical thinking about the basics of the descriptive statistics. A special skill is analysis, interpretation and evaluation of statistics functioning as the evidence. Data literacy is the component of both literacies, which means the capacity of accessing, manipulating, merging and presenting data.

INTRODUCTION

Information literacy is the capability of an individual to define the range of necessary information, the access, the efficiency and the capacity of information, as well as to critically evaluate that information and its source, to use effectively the information for specific purposes, to understand their economic, legal and social origin as well as to use information ethically and legally (Schield, 2004). In 1998 the ALA (American Library Association)/ACRL (Association of College and Research) published a number of different programmes and views on information literacy. However, they had one element in common: the need for critical evaluation and critical interpretation of information, data and statistical results (Schield, 2004).

A large part of information involves statistics. Today, in the 21st century we hardly imagine information literacy without being also statistically literate. How would it be possible to talk about the valid results of researches in natural or social sciences without using statistical tools? And with the introduction of computers and internet each of us is daily faced with a flood of statistical information.

In grammar schools pupils are supposed to acquire the basics of statistic thinking and the skills of critical thinking when reading and interpreting texts, which involve statistical data and analysis. They are expected to get experiences in using statistical information and certain simple statistical methods. Through practical examples (from everyday situations) pupils are supposed to recognise, how to interpret statistical information, how to evaluate and present it, as well as how to find in the data the information, which is necessary for further processes of making decisions. Basic knowledge of statistically literate individual is as follows: capability of selecting adequate statistical method regarding the objective of the statistical analysis (descriptive, inferential) and the type of data (measurement scale), understand the statistical programme print outs, capability of critical assessment of presentations and interpretations of statistical data in reports and media. Joel Best (2001, 2004) identified the key to being statistical literate when he noted that all statistics are socially constructed. This isn't some deep philosophical claim. It merely states that people choose what to count or measure, how to assemble those measurements into summary statistics, what comparisons to form from the statistics and how communicate these statistics.

A part of the mathematical literacy is also fundamental knowledge on data processing. Financial–economic pages of newspapers, advertisements, political argumentations and other media messages usually contain also tables, graphs, and comparisons between averages. Data literacy requires understanding of such messages and a critical view on presented information.

Data literacy basically responds to the questions how to obtain and manipulate data. Data literacy is a skill of critical searching, understanding, evaluating and the use of data when solving problems.

Today an individual has to have a wide range of tools for access, transformation and manipulation with data. This also requires understanding the statistical programmes for data processing (SPSS, STAT, MINITAB, MS Excel) as well as the programmes for the presentation of

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data (MS Excel, PS Power Point). In the Slovenian curricula (2008) we speak of digital competences and above all about the activities for their development, e.g., how to use the information-communication technology critically (computer programmes, e-learning, the use of internet, of e-mail, videoconferences etc.). In case of problems where we have to collect data we develop the so called pupils' data literacy (http://sl.wikipedia.org/wiki/Podatkovna_pismenost). Data literacy is a skill of critical searching, understanding, evaluating and the use of data for solving problems. It contributes to a more effective acting of an individual in various areas, where critical assessment of data forms a basis of presented contents, in science, in education and in every day life. Compared to general literacy, we still pay little attention to the programmes of data literacy at various levels of education.

DATA PROCESSING IN PRIMARY SCHOOLS

In the framework of primary school curriculum for mathematics from 1998 (Curriculum for mathematics for primary schools, 2002) and also from the updated curriculum for mathematics from 2008 (Curriculum for mathematics for primary schools, 2009), we speak exclusively of data processing and not about statistics.

We are enumerating the contents from the 6th grade of primary schools onwards, although they appear systematically from the 1st grade on and are spirally upgraded into upper grades. The contents of data processing in primary schools between the 6th and 9th grades (Updated curriculum for mathematics for primary schools, 2009) are: *collecting, organising and presenting, criteria for mean and dispersion, experiences with random events.*

Data processing includes any kind of work with data. In primary schools we specially emphasize collection and organization of data, presentation and representation of data as well as their interpretation. The emphasis lies on understanding concepts, linked with data processing and on learning of the strategies of work with data. Thus, for example when presenting data it is not important only that pupils know different displays and that they know how to draw them, but that they select adequate display for a given situation, i.e., that they also understand the diagrams and displays. In other words, during mathematical instruction and the instruction on data processing we are not supposed to learn only the techniques of presenting data, but primarily the logical use of data processing by understanding. Even if we help ourselves with computer programmes which tremendously simplify work when making displays we are expected to know how to interpret the displays and select an adequate display in accordance with the nature of data.

The holistic procedure of finding facts based on data collection and presentation, on data elaboration, making conclusions and ascertaining regulations is at primary schools presented to pupils through empirical "explorations". Besides the basics in data processing, pupils are expected to learn in the instruction of mathematics also about random *events* and with the probability, but only at the *level of experience.* With this, we want to make learning probability at secondary schools easier, where an important obstacle for understanding of mathematical concept of probability is the lack of experiences with accidental events as well as lack of knowing how to work with data. And, for the introduction of empirical probability we implement the knowledge of data processing.

How does data processing contribute to the teaching of mathematics?

Data processing is an effective way of developing quantitative understanding and making conclusions as well as using arithmetic for solving problems. Techniques of data treatment are an important part of problem knowledge, as they enable or at least make it easier to detect rules and patterns, to set hypotheses and questions also in entirely mathematical contexts (learning strategies, organised data can enable us to have an insight into the solution of a problem).

It is therefore necessary to know the techniques of data presentation with diagrams from many different aspects. By using diagrams we describe or convey data and results to others in a clear way. Quite often an adequately selected display gives a holistic insight into the collected data, which can make it easier to search for regularities and rules, linked with the collected data. In the end properly selected displays enable simple comparison of data.

Data elaboration is a very natural link between the instruction of mathematics and other subjects and out of school experiences (functional illiteracy, solving realistic problems). Activity, linked with the work with data can serve also as a first experience with probability.

For many school subjects, above all for social sciences subjects, the area of data processing is the most genuine link with mathematics. And for the teachers of mathematics it is important that they can, through their knowledge of data processing, present a part of mathematics more as taken from real life.

Various knowledge on data processing can be included into the proceedings of common mathematical contents (e.g., when measuring time we learn about a table (timetable); various angles are arranged according to size; triangles are classified by one or two criteria; rectangles are arranged into a tree structure).

Certain knowledge has to be considered as an entire frame, usually in connection with other mathematical and non-mathematical knowledge, as an integrative work in projects and in activity lessons. Projects can be carried out within the mathematical instruction or on special days dedicated to them. A simple example of a project is making decision on the final excursion (working out a questionnaire, collecting data, analysis and presentation of results).

Techniques of work with data are an important part of problem knowledge. Data are processed for various reasons and within the frame of different, even mathematical operations. Knowledge about data processing is a particularly important part of problem knowledge, since it is a certain kind of tool making it possible to see the rules and regularities in the huge amount of data. Data processing is an effective way of developing the understanding of quantities, making conclusions and using arithmetic for solving problems.

Problem knowledge enables us to use newly learnt concepts and procedures in practice in new situations. One of the usual approaches when being faced with the new situation is to assemble the results of calculations, organise them adequately and try to present them so that we detect a certain rule or path to the solution. And here we use our knowledge of data processing.

We help ourselves with the knowledge of data processing also in the exercises where we deal with a lot of data which we have to arrange somehow before we even start solving the problem; however there might be too many data or even not enough when we have to collect them.

Our experiences from secondary schools show us that direct introduction of mathematical definition of probability is difficult for pupils since they cannot back new concepts with their own experiences. One of the objectives of data processing instruction is therefore creation of empirical concept of probability, as the basis for later understanding of mathematical probability. In primary schools pupils should find out or assess through experiments the probability of a certain event, while they should be fully aware of the number of attempts. They should recognise that a very large number of repeated attempts, the relative frequencies of event settle near a certain value, called probability of event. Pupils are supposed to recognise also through their experience that they cannot non-critically generalise their findings obtained on a small sample (Magajna Z., Žakelj A., 2000). In such examples pupils observe appearance of random events in several repeated attempts, and when recording and dealing with observations they help themselves with their knowledge of data processing. In this way they get a certain idea and an insight into the concept of probability of an event.

A holistic approach of data elaboration can be dealt within the framework of empirical explorations. Examples can refer to every day life, i.e., to mathematical contexts, by which we want to demonstrate how pupils can use and consolidate their knowledge of data processing

STATISTICS IN GRAMMAR SCHOOLS

Statistics deals with data processing, analysis, presentation of mass phenomena in science, economy, industry, farming, health, social life, education, biology, transport, trade, protection of environment and geographical sciences. Statistical data processing formulates data in the way that enables reaching the idea on larger population, than it has been presented by the sample. This kind of processing includes exploration of assumptions (e.g., survey questions with two possible replies), determination of features of collected quantitative data, time sequence (e.g., forecasting future trends), describing connections (correlation), establishment of relations between variables regression) and others. The task of statistics is to extract the »best« information from available data. That is the reason some people rank it into the theory of decision making. Fundamental concepts are population, samples and patterning it as well as probability of assumptions.

We are giving the contents of statistics which are dealt with in the grammar syllabus and are upgraded form primary schools (Curriculum for mathematics for grammar schools, 2008):

fundamental statistical concepts, types of data; data collection; data organisation and structuring; presentation of data (bar, position, pie diagram, histogram, strain diagram, line and curved diagram, box–whiskers plot); arithmetic mean, median; mode; variation range; standard deviation, inter-quartile range.

In grammar schools the emphasis is on understanding and the use of criteria for mean and dispersion, standard deviation as well as on working out a more demanding statistical assignment. We also sensibly introduce the *use of diagrams for statistical data processing* into the instruction. Pupils are expected to know how to work out the statistical assignment at various subjects and within project work at schools. We deal with realistic problems which are taken form the context of real life, which are not solvable by using routine procedures and demand connections between different content areas (e.g., psychology, sociology, biology, physical education, ICT). Of course, first of all we try to find out prior knowledge of pupils form primary schools and upgrade the contents and widen it with more complex examples.

CONCLUSIONS

Informational, statistical and data literacies as well as data processing and statistics are gradually gaining an important role in the school curricula. In statistics we work with data always with the objective to learn something about the population which we statistically process. The task of statistics is to show at least two features of statistical population and its parts, statistical units. The first among them are common features of statistical units, i.e., how different units are linked among them and what common features they create. The second feature is diversity of statistical and descriptive statistics to obviously present variability. Basic and most often used data of descriptive statistics to present common features, are arithmetic mean, mode and median of a certain population, and also some other values as cumulative frequencies and percentiles. Variability of units in the population can be presented with variance, standard deviation and data span.

Besides the capabilities of reading, writing and calculating which are considered as the fundamental capabilities of literacy, today also the significance of other literacies is emphasised as being important for a successful acting in the society. As an ability and social practice, literacies may be acquired and developed. The acquired knowledge and skills as well as developed capabilities enable an individual to manage a successful and creative personal growth and a responsible acting within his/her professional and social life.

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