ŠIAULIAI UNIVERSITY

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EDUCATION STATISTICAL SKILLS OF PRIMARY SCHOOL PUPILS

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INTRODUCTION

With a developing news and information society new characteristics emerge, which P. F. Drucker (1993) defines as accelerating changes and intensifying complexity of problems. As changes in various domains of life demand adequate changes in one's education, the system of education encounters a significant task: to prepare pupils to live, work and create efficiently in a rapidly changing society. The content of education in the Lithuanian system of education undergoing the reform is one of the areas preconditioning modern civic, democratic self-consciousness and lifestyle of a person and a nation. The modern society is focusing more on the education with a key dimension of new skills. The last decades has seen rapid increase of new information flows, emergence of complementary scientific theories, cognition criteria, change of priorities in the value system and it is obviously more important to be able to think, use (read and represent it) and select the information rationally, autonomously and reasonably than just to accumulate it. Therefore a number of scholars (Ennis, 1985; Gal, 2002; Monterio, 2002; Shaughnessy, 1992; Schield, 2000; Rouncefield, 1993; Holmes, 2003; Konold, Pollatsek, Well, 1997; Pereira-Mendoza, 1991; Konold, Biehler, Steinbring, 2000; Garfield, 1994; Garfield, Hogg, Schau, Whittinghill, 2002) in reference to the above mentioned ideas distinguish ***statistical skills*** enabling to understand, analyse and assess statistical information.

Scholars of many countries having summarised experience of teaching statistics from pre-school education to university studies have foreseen the following trends for the future research in this area: *psychological aspects* of teaching statistics (Wares, Jones, Langrall, Thornton, 2000; Perelli D'Argenzio, Rigatti Luchini & Moncecchi, 1998; Fischbein, 1975, 1987; Piaget, Inhelder, 1975; Hawkins, Kapadia, 1984); statistinių gebėjimų ugdymo *pedagoginius aspektus* (Dolan, 2002; Rouncefield, 1993; Konold, Pollatsek, 1997; Pereira-Mendoza, 1995; Kader, Perry, 1994; Perera-Mendoza, Dunkels, 1989; Bowman, 2002; McLean, 2000; Hilton, Grimshaw, Anderson, 2001; Holmes, 1993; Garfield, 1993; Ledolter, 1995; Hawkins, Kapadia, 1984). A special emphasis is placed on *problems of teaching statistics in developing countries* (Rozga, 1998; Mina, 1998; Ogum, 1998; Lam, 2002; Odhiambo, 2002; Cheung, 1998; Wong & Tang, 2000) and *teacher training* (Garfield, 1997; Godino, Cañizares, & Díaz, 2003; Watson, Moritz, 1999; Lopes, 2003).

Thus it is not a mere coincidence that the analysis of statistical skills and developing of such skills is attracting more and more attention in the world and Lithuania as well. In this context of pedagogical strivings a few researches are to be mentioned as they cover various aspects: *defining of concepts* (Perelli D'Argenzio, Rigatti Luchini, Moncecchi, 1998; Hawkins, Jolliffe, Glickman, 1992; Amit, 1998; Nilsson, 2003; Batanero, 2003), *optimal teaching time* (Holmes, 1993; Anderson, Loynes, 1987), *application of various teaching concepts and technologies* (Davidson, 1990; Resnick, 1989; Campos, Bacelar, Oliveira, Gome, 1999; Gal, Garfield, 1998; Kader, Perry, 1994; Monterio, Ainely, 2003; Glencross, Binyavanga, 1996; Ben-Zvi, 2000), *accessibility of integration* (Pereira-Mendoza, 1989). A special focus is on formation of *statistical thinking* (Wares, Jones, Langrall, Thornton, 2000; Snee, 1999; Wild, Pfannkuch, 1999); *statistical reasoning* (Garfield, Gal, 1999; Chervaney, Benson, Iyer, 1980; DelMas, Gafield., Chance, 1999), fostering of *statistical literacy* (Walman, 1993; Schield, 1999, 1998, 2002; Barbieri, Giacche, 2001) at respective age periods.

It is evident that there is a global interest in theoretical underpinning of developing statistical skills, organisation of the teaching process, enhancing of statistical competences of educators; some researches analyse communicative skills of pupils via representation of data and offer individual models for statistical elements formation and methods to alleviate acquisition of such skills. Nonetheless, despite the above mentioned positive experience of research in the area of developing statistical skills, it must be noted that the researches give little thought to what types of statistical skills should be developed at certain age periods and what subjects are most favourable to developing of statistical skills.

Introduction of a basic course on statistics and probability theory in Lithuanian schools is to be linked to the general reform of education in Lithuania, although separate elements of statistics had been taught previously. The first to write about teaching statistics and probability theory at school was V. Liutikas (1978, 1992, 1994, 1996). Textbooks of the basic school with elements of stochastics[1] were published in 1995 (Cibulskaitė, Stričkienė). Statistical elements in the course of mathematics for primary school were discussed by P. Gudynas (1994), P. Survila (2000), A. Kiseliovas, D. Kiseliova, A. Kazlauskienė (2002, 2003) and B. Balčytis (2001). In 1993 a basic course on statistics and probability theory was introduced into the syllabi of mathematics in Lithuania. It was primarily introduced in the 11^{th}-12^{th} forms and later in basic school, and in 1995 it reached the primary school with the textbook of B. Balčytis *Land of Numbers*"(*Skaičių šalis*) for the 3^{rd} form, although the General Curriculum of the Comprehensive School and Standards of Education (hereinafter referred to as the General Curricula) only in 1997 proposed introduction of statistical elements in the primary school.

No researches providing grounds for developing statistical skills in the context of primary education have been conducted in Lithuania. The need for such research is supported by the TIMSS results of 2004 (Mullis, Martin, Gonzalez, 2004): statistical skills of the fourth formers of Lithuania were the poorest in comparison to the results of other units of mathematics.

The object of the research is teaching of mathematics in primary school; the **problem of the research is** systematic approach and accessibility of the content of developing statistical skills for primary school pupils.

The hypothesis of the research. **Pupils of primary school are capable of mastering elements of statistics and probability theory, provided:**

- they are exposed to an item system corresponding the level of mathematical competencies of the pupils and covering a complex of technical skills of statistics (reading and representing of data), skills of mathematical operations (mean calculation, approximation of numbers, percentage determination of a number, determination of a probability of an event in the simplest cases) and a complex of cognitive skills (identification of a problem, defining a hypothesis, data compiling, data analysis, concluding and interpreting);
- material of the items relates to personal experience of pupils and realises interdisciplinary links;
- teachers have the required statistical competencies;

The aim of the research is to determine the content of developing statistical skills to primary school pupils and the premises for its realisation.

Objectives of the research.

1. To provide theoretical underpinning for developing statistical skills to pupils as a didactic problem of primary education.
2. To describe distinguishing features of statistical skills of primary school pupils and teachers in this country and their attitude to development of such skills.
3. To verify the pupils' ability to master elements of statistics and probability theory by an experiment.
4. To prepare and provide for the primary school pupils teaching aids on statistics and probability theory.

The **key statements** for the defence are as follows:

1. The content of developing elements of statistical skills and probability theory integrates pupils' mathematical skills, knowledge of the content of other subjects, general skills of cognition and their personal experience, therefore it is a general problem of primary education;

[1] Stochastics- [Gr. stochasis – forecast], mathematical eventuality, probable (*Tarptautinių žodžių žodynas*, 2001, p. 706).

2. A system of items intended for teaching elements of statistics and probability theory is valid and accessible for pupils provided it covers:
   - technical skills of statistics (an ability to read and represent data);
   - skills of mathematical operations (to calculate the mean, classify data, round off numbers, grasp elements of probability theory, determine percentage of a number);
   - cognitive skills of the level accessible to pupils (ability to word a problem, define a hypothesis, compile data to verify the hypothesis, analyse and interpret data, draw conclusions).
3. The premises for successful development of primary school pupils' statistical skills are as follows:
   - development of primary school teachers' statistical skills in the framework of their academic and continued education;
   - establishment of the content of developing statistical skills corresponding to international standards in the general curricula of the primary school;
   - provision of teaching statistics and probability theory elements based in the skills acquired in the primary school in the mathematics curricula of further forms.

Novelty of the research results: a structure of the primary school pupils' statistical skills has been established and a teaching items system corresponding to such structure has been validated.

Theoretical significance of the results: statistical skills have been established as a goal of the primary education in the context of cultural setting of Lithuania, a theoretical model of their teaching content has been validated.

Practical significance of the study: an item system representing the content of developing statistical skills to primary school pupils has been prepared and tested by an experiment; an item system with elements of statistics and probability theory for 3 – 4 forms has been prepared and validated; a test on statistical skills of the 4th formers has been developed, which could be applied in researching the status of education and didactical studies; the research results may be applied in the system of primary school teacher training and their continued education.

Validation of the research results. Validation and implementation of the research results was undertaken by conducting an experimental research. The conclusions and results have been discussed with the primary school teachers of Gytarių Secondary School in Šiauliai who participated in the experiment. The results of scientific research conducted in the dissertation have been validated and published in scholarly and practical conferences of different levels: in *Rezekne* (1999), in *Minsk* (2001), in *Liepaja* (2002), in *Riga* (2003), in *Tallinn* (2003), in *Berlin* (2003), in *Kaunas* (2001), in *Vilnius* (2002, 2003a, 2003b), in *Klaipėda* (2004), in *Šiauliai* (1998, 1999, 2000, 2001a, 2001b, 2002a, 2002b, 2003) and periodicals: in *Germany* (2003, 2004), in *Lithuania* (2002). The following teaching aids were published: *Matematikos užduotys su statistikos elementais III klasėje (Tasks of Mathematics with Statistical Elments in the 3rd Form*), (2002); *Užduotys su statistikos elementais IV klasėje (Tasks with Statistical Elements in the 4th Form)*, (2003); *Pradžių pradžia*, (2002); *Matematikos pradžiamokslis (Primer of Mathematics)*, (2004).

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3. **Kazlauskienė A**., Kiseliova D., Kiseliovas A. (2002). Ketvirtokų statistinių gebėjimų subtesto diagnostinės kokybės charakteristikos // Pedagogika. Mokslo darbai. - Vilnius, VPU, tomas 61, p. 108 – 116. ISSN 1392-0340,
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27. **Kazlauskienė A**., Kiseliova D., Kiseliovas A. (2003). Characteristics of the Quality of the Statistic Skills' Subtest by the Aspect of the Inform of the Test Tasks // 4th International conference: Teaching Mathematics: Retrospective and Perspectives. Tallinn, 23-24 May, p. 49 – 53.
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30. **Kazlauskienė A**. (2004). Statistical Literacy of Primary Schools Teacher // European Added Value in Teacher Education: The Role Teachers as Promoters of Basic Skills Acquisition and Facilitators of Learning. 7th Teacher Education Spring University (TESU). University of Tartu Estonia, 6-8 May, p. 48. www.tyk.ut.ee.

Structure and contents of the dissertation

The study consists of the introduction, four parts, conclusions and recommendations, 472 entries of the reference list, 21 appendixes. The work contains 42 tables, 52 pictures.

Table of Contents

SUMMARY OF THE DISSERTATION CONTENT

The introduction establishes motives for the selected theme, defines the object of the research, words a scientific problem, aim and key objectives of the study, and notes scientific novelty, theoretical and practical significance of the thesis.

The first section of the thesis *"Overview of the bibliography: Development of statistical skills as a didactic problem"* consists of five chapters where based on works of the scholars (Ennis, 1985; Gal, 2002; Monterio, 2002; Shaughnessy, 1992; Schield, 2000; Rouncefield, 1993; Holmes, 2003; Konold, Pollatsek, Well, 1997; Pereira-Mendoza, 1991; Konold, Biehler, Steinbring, 2000; Garfield, 1994; Garfield, Hogg, Schau, Whittinghill, 2002 ir kt.) ***a concept of statistical skills*** is defined.

The analysis of the scholars' works (Ennis, 1985; Gal, 2002; Monterio, 2002; Shaughnessy, 1992; Schield, 2000; Rouncefield, 1993; Holmes, 2003; Konold, Pollatsek, Well, 1997; Pereira-Mendoza, 1991; Konold, Biehler, Steinbring, 2000; Garfield, 1994; Garfield, Hogg, Schau, Whittinghill, 2002; Freedman, Pisani, Purves, Adhikari, 1989; Utts, 1991; Motore, 1993; Smith G., 1998; Iverson, 1992; Roiter, Petocz, 1996; Lopes, 1998; Carvalho, Cesar, 2002; Teran, 1998) *aims and functions of developing statistical skills* are distinguished. It is maintained that the aims of developing statistical skills are evident, targeted at development of a versatile personality and general skills. Teaching of elements of statistics and probability theory performs cognitive, educational, exploratory, pragmatic and informational functions. Introduction of statistics course opens up great possibilities of experiments, environmental research, and use of communications in the teaching process. Development of statistical skills is not only the goal of mathematics as a subject, such skills are integral to the whole teaching process.

The analysis of ***the content of developing basic statistical skills in the Lithuanian and foreign primary school*** proves that the General Curricular of the Basic School of Lithuania (2003) render theoretical premises for reasonable pursuit of teaching goals of statistical and probability theory elements and define the content of developing statistical skills taking into consideration peculiarities of the pupils' age. The undertaken analysis enables to claim that Lithuanian textbooks provide less focus on teaching of statistical and probability theory elements in comparison to other areas of mathematics. The scrutiny of foreign experience assists in distinguishing of elements of developing statistical skills content and allows concluding that curricula and textbooks of other countries display a broader absolute and comparative scope of items of this type with a continuously increasing focus on development of statistical skills.

Summarising works of E. Fischbein, (1987), M. Shaughnessy (1992), R. D. Snee (1993), J. Garfield (1995), B. L. Chance (2000), C. J. Wild, M. Pfannkuch (1999), L. Pereira-Mendoza (1989), H. Steinbring (1990), J. M. Shaughnessy (1992), D. S. Moore (1992), R. Snee (1993), J. Garfield (1997), J. D. Godino, M. J. Cañizares, & C. Díaz (2003), J. Watson, J. Moritz (1999), C. A. Lopes (2003), which analysed ***problems of developing statistical skills*** it is noted that a timely and purposeful teaching based on development of respective intuitions is particularly important for development of statistical skills; the mandatory provisions in the developing (and learning) process of statistical skills are as follows: teaching material and teaching methods should be targeted at a well-rounded self-knowledge of pupils, competent development of respective skills, intuitions and emotions via autonomous, active practice based on communication. It is suggested that formation of statistical skills should be undertaken during the entire developing process and the content of statistical skills using integration preconditions a more active participation of pupils in the teaching process, cooperation in project work and various research in the real medium. Success of developing statistical skills is related to teacher competencies and their perception that the cooperation should be a principle and formation of their activities, planning, culture fostering and organisation of research.

Statistical skills of the primary school pupils are discussed in detail in the context of ***TIMSS*** (Trends in International Mathematics and Science Study). It is maintained that 4th formers of Lithuania were most successful in items with measurement and calculations, the least successful with statistical items. The results analysis indicates that Lithuania is one of the most dynamic countries, which made the highest progress during the past few years; the results prove success of the education reform and promote further improvement of developing children's statistical skills.

The second section of the dissertation *"Methodology of the research of developing statistical skills"* is based on the following key assumptions and concepts: systemic approach to phenomena, especially to their interrelation; modern view on teaching, which assigns a subject role to a pupil and enables him/her to study; matching of *positive (normative) and interpreting approach* to the selection of the content for teaching elements of statistics and probability theory; cognitive theory and pedagogy of pragmatism.

The stated diagnostic research was conducted in the school year of 2002–2003. Pursuant to an assumption that preparation and empirical validation of the content of teaching statistical elements requires analysis of the current statistical skills of the pupils, a three–fold purpose of the research has been established:

1) To describe 3rd – 5th formers' and primary school teachers' statistical skills of technical level (to read data from bar charts, pie diagrams, graphical charts, pictograms; represent data in bar charts, pie diagrams, graphical charts, pictograms, tables), and skills of mathematical operations (calculation of the mean, indicating of data in percentage).
2) To determine peculiarities of consolidation of statistical skills in passing to the next form.
3) Productivity of the experimental education will be described on the grounds of the research results.

A set of items in the diagnostic tests consists of the following types of items, tested in the 3rd – 5th forms. Variants of the tests were provided in the 3rd, 4th and 5th forms in the beginning and end of the school year. Each test contained 7 to 10 items. The skills were tested at the end of the school year in May and in order to obtain most information on the pupils' skills the tests were used in the beginning of the school year, i.e. in the end of September or beginning of October, after a brief revision of the last form's course. In the 3rd form 628 pupils were tested in the beginning of the school year, and 683 pupils in the end of the school year; in the 4th form 600 pupils in the beginning and 651 in the end of the school year; in the 5th form 383 pupils were tested in the beginning of the school year and 598 in the end of the school year. The scope of primary school teachers amounted to 260 respondents.

The content and form of items in the tests was selected on the grounds of such mathematics textbooks for the 1st – 4th forms as *Skaičių šalis* (Balčytis, 1996, 1998, 1999, 2000) and mathematics textbooks for the 1st – 4th forms by A. and D. Kiseliovai (Kiseliova, Kiseliovas, 1996, 1998, 1999, 2000), textbooks of Lithuanian (Plentaitė, Marcelionienė, 1999, 2000, 2002) and natural studies (Jonynienė, 1995, 1996, 1997, 2001). The tests implemented requirements of the General Curriculum (1998) and General Education Standards (1997) as well as General Curriculum and Education Standards of Comprehensive School (2003). Empirical and research material collected by the author was also taken into consideration (Kazlauskienė, 2001, 2003, 2003a, 2003b, 2004a, 2004b). A few items were selected targeting at future prospects of dynamics of mathematics teaching content and general skills, little related to the learned information.

Constructive validity is described in establishing difficulty of the test items. In compilation of the test and item selection, also in description of the test results the scales were constructed and later reliability of the test scale was established. The research applies the split-half model. Upon compiling of two additive scales a correlation ratio was calculated between these subtests. Since the ration defines reliability of only a half of the test, the reliability ratio of the whole test is derived by applying Spearman – Brown correction. An analysis of the empirical Item Characteristic Curve of the items was also undertaken.

The test content was drafted on the grounds of the theory of the diagnosed construct. The obtained diagnostic information (statistical skills of the primary school pupils) forms a solid complex of data. This assumption was verified by statistical methods, i.e. inter–correlations of all diagnostic indices were calculated and a factorial analysis was conducted.

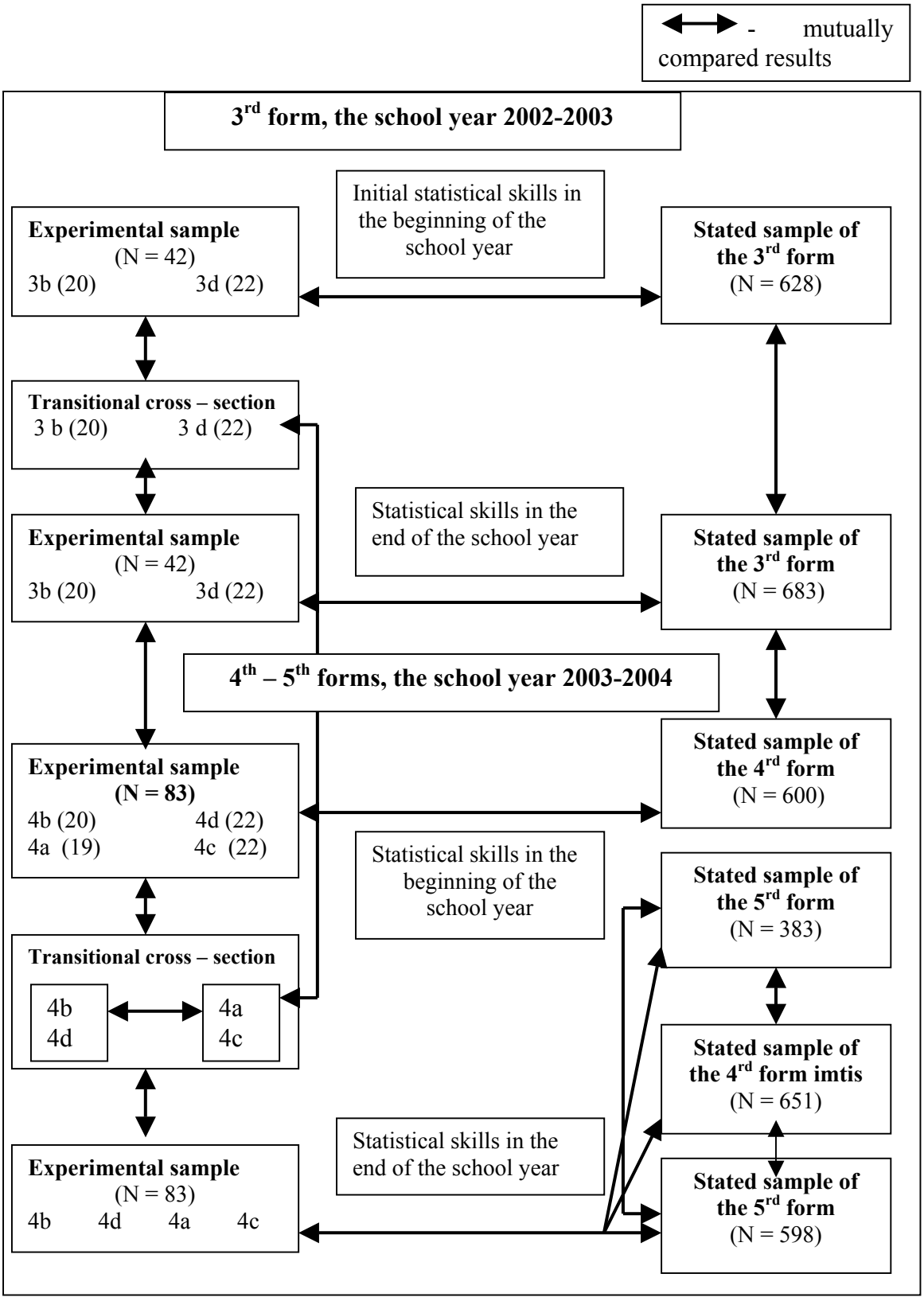
A questionnaire provided for the primary school teachers (a sample of 219 respondents) was intended for determining how the teachers assess distribution of statistical items, clarity of their provision in the textbooks and practice books. The questionnaire was used to find out the teachers' view concerning the pupils' motivation in solving these items and what main statistical skills had been emphasised, what challenges the pupils and teachers face.

By surveying the primary school pupils (the 3^{rd} – 4^{th} formers, sample 890 respondents) we wanted to find out what subject is their favourite, what activities are predominant at mathematics classes, what procedures they perform most often and what procedures of the statistical elements they would prefer. Each question in the questionnaires was evaluated applying the principles of Likert's scale, for some statements a popularity index was calculated. Significance of influence of social – pedagogical factors on the answers of the teachers and pupils was measured by verification of parameter hypotheses (Bitinas, 1998).

The purpose of the ***educational experiment*** was to determine the content of teaching elements of statistics and probability theory and premises for its realisation by means of application a ready-made item system in the primary school in the 3^{rd} – 4^{th} forms not only in the mathematics classes, analysis of the experiment progress, determining of its peculiarities, describing difficulties, and providing possible ways for prevention of pedagogical mistakes. The experiment was conducted at Gytarių Secondary School in Šiauliai. Two 3^{rd} forms were selected in the school year 2002-2003 and in the school year 2003-2004 four 4^{th} forms were chosen. A diagnostic research (testing) covering a representative sample in proportion to the country was conducted alongside with the testing of pupils from experimental forms. Statistical skills of the pupils from experimental forms were compared with the research revealing statistical skills of the 3^{rd}, 4^{th} and 5^{th} formers of the country. Due to this reason special control forms were not necessary. A phenomenon of mass practice and its result was of a diagnostic nature only and it was not an object of the experimental research. The structure and progress of the conducted research is shown in Figure 1.

Table 1 shows components of the items in the set according to statistical skills, an area of application and a number of phases in the items. Presumably the distinguished characteristics subject to the analysis will assist in determining topics of the content most accessible to the primary school pupils, an optimal number of phases in items and enable to determine the content of teaching elements of statistics accessible to the primary school pupils by selecting appropriately fitted levels of technical, mathematical operations and general cognitive skills.

Diagnostic cross-sections were made to foresee the result of the experimental education. The purpose of the primary, mid-school year and final cross-sections was not only to assess the pupils' technical skills of statistics, but to foresee the prospects and dynamics of their further training. A level of acquisition of statistical skills was determined by evaluation of the test results. The tests items included problems analogous to the items solved during classes, and relatively new items, requiring more or less autonomous application of the acquired knowledge. The content of the test items in the process of diagnostics are divided into partial questions, problems and practical assignments. The tests helped to verify how the pupils acquired all main component of the content. The test consisted of a system of controlling items and an instruction of providing it to the pupils. The items were easily understood (without any additional explanations), laconic (no need for numerous transitional operations), relatively new for the test subjects (they do not repeat, solving of one is not a key to others), the items were sparing, solved in a shorter period of time, accidentally solved items were eliminated.



II. 1. Picture. Structure and progress of the research

Considering difficulties of selecting close items and their insufficient reliability in the current tests, especially didactic ones, the open items were predominant: the pupils themselves construct and write answers, which they deem correct. It is one of the reliability indices (Bitinas, 2002, p. 60).

While selecting items for the control tests, which could best represent the thrust of the test subjects' acquisition of statistical skills, on the basis of the expert analysis validity of the entirety of the items was postulated and a cross-section mean, standard deviation were calculated, parameter hypotheses were verified. *Compound (accumulative) percentage* graphs were employed for the result analysis. With the aim of comparing the results of statistical skills (data reading and representing) of the forms participating in the experiment and the test results of such skills of 3rd, 4th, 5th formers of the whole country; also for the comparison between the pupils participating in the experiment from the 3rd form and those who joined the experiment in the 4th form and for determining the dynamics of statistical skills of pupils from the experimental classes, the hypotheses concerning the difference between frequencies of two ratios were verified (Bitinas, 1974). In addition, the pupils were surveyed with the purpose of showing what experimental education was accepted and appreciated by the pupils. The results of the pupils' answers were processed statistically. A popularity index PI for each close statement was derived and significance of the influence of social – pedagogical factors on the pupils' answers was measured applying verification of parameter hypotheses (Bitinas, 1998). Open statement were discussed qualitatively.

Table 1

Distribution of teaching items of the 3rd – 4th form according to the levels of statistical skills, areas of application and distribution of item phases

Content components according to skills			**Teaching aids**	
			3RD FORM	**4TH FORM**
			Number of variants	**Number of variants**
Technical level	Representation of data:	bar chart	14	10
		pictogram	2	2
		table	6	6
		pie diagram	1	2
		area diagram		1
		graph chart	5	2
	Data reading from:	bar charts	7	9
		pictograms	8	21
		pie diagrams	2	5
		pictures		3
		tables	12	2
		graph chart	1	2
Mathematical operations	Operations	approximation of numbers	1	1
		classification of data	7	15
		calculating the mean	2	16
		percentage		6
		probabilities	2	11
Cognitive level	Cognitive elements 3rd form – 22; 4th form -40.	identification of a problem		
		wording a hypothesis		
		preparation of data registration sheets		
		data collection		
		summary of the data, conclusions		
		interpretation of the results		
Content components according to the areas of			**Teaching aids**	
			3RD FORM	4TH FORM

application	Number of variants	Number of variants
social	28	27
nature, geography	10	35
economic	4	8
sports	3	4
mathematical model	7	7
Number of the item phases	**Teaching aids**	**Teaching aids**
	3^{RD} FORM	3^{RD} FORM
	Number of variants	**Number of variants**
1 phase	5	7
2-5 phases	8	43
6-10 phases	23	19
11 and more phases	15	11

The third section of the thesis *„Results of the stated research"* consists of six chapters discussing the ***general results of statistical skills diagnostics*** of the 3^{rd} – 5^{th} formers in the beginning and in the end of the school year, verifying the influence of social – pedagogical factors on the pupils' skills in question (data reading and representation).

During the research it appeared that sex and a type of school do not have impact on statistical skills of the pupils ($p > 0,01$). Statistical significance was noted among the pupils who had studied from different textbooks on mathematics in the end of the 4^{th} ($\chi^2 = 25,38$, $p < 0,001$) and 5^{th} form ($\chi^2 = 20,8$, $p < 0,001$) school year and in the beginning of the fifth form school year ($\chi^2 = 18,6$, $p < 0,001$). In the fourth form at the end of the school year the pupils who were/had been learning from the mathematics textbook *Matematikos pasaulyje* could represent data better, in the fifth form at the beginning of the school year the pupils who had studied from *Skaičių šalis* B. Balčytis in the primary school, showed better test results than in the end of the fourth form. In the end of the fifth form school year the pupils who had studied from the textbook *Matematika ir pasaulis* did better on the test. The 3^{rd} – 5^{th} formers could read data easier than represent it. The most accessible form of representing and reading data was a bar chart and the most difficult – a graph chart.

Having analysed the ***pupils' data reading skills***, one can state that the teaching content and its nature is the decisive moment, determining tendencies in pupils' statistical skills quality on separate aspects. Systematic "return" to the acquired statistical skills and their extension allows employing of the already existing knowledge and supplement it. Those skills might be exhaustively supplemented by the present-day life. Nonetheless, pupils' statistical skills (basic sample results), when poorly gained, do not enable the children to master the skills during the year and a considerable loss (forgetting) of knowledge may be observed in the 5^{th} form in the beginning of the school-year with the same tendency at the end of it.

Socio-pedagogical factors: the difference between statistical skills (data reading) of pupils living in town and in other regions come to light at the end of the 3^{rd} form school year ($p < 0,01$; $\chi^2 = 7,68$), in the beginning ($p < 0,01$; $\chi^2 = 11,58$) and at the end of the 4^{th} form school year ($p < 0,01$; $\chi^2 = 14,5$). Pupils living in town showed better results. Statistically important differences were noticed among pupils who were taught according to different manuals of mathematics ($p<0.01$). Better results were gained by pupils learning from the mathematics textbook "Matematikos pasaulyje" (Kiseliovas A., Kiseliova D.).

Pupils' skills to represent the data slightly improved or decreased in the beginning and the end of the 3^{rd} form school year. In the 4^{th} form they noticeably fell in all respects of the routines. Teaching content analysis allows stating the lack of a presentation of the items system in the data representing aspect. Some items only propose to depict data in one or other way, yet additional

instructions are missing. In higher forms it has not been returned to certain routines presented in the 1st and 2nd forms. Whereas, in the real life pupils have to represent data more often than read it, thus, the knowledge acquired in life cannot serve in this aspect.

Pupils' skills especially grow worse in representing data in bar charts and pictograms, which are most often present both in teaching and other methodological aids. The offered items with this type of routines have been very similar (both structurally and in terms of representation requirements) since the 1st form. They are not made more difficult and remain stagnant, thus pupils' mental-cognitive activity does not improve on the grounds of such skills. Any change or request to represent data in any other way present difficulties to the pupils, since they have been forgotten and distorted in the influence of interference (especially, when influenced by every-day experience), or some items contain complicated calculating procedures, and as a result there is less time to determine the elements of data representation.

In terms of social – pedagogical aspects significant differences have been observed in the fifth form among the pupils who had studied from different *textbook* ($p < 0,01$). Better results were shown by the pupils who had studied from to the mathematics textbook of N. Cibulckaitė and M. Stričkienė than from the mathematics textbooks by A. and G. Bakščiai. In the end of the school year in the fourth form a difference between the pupils living in different territories emerged. The test results of the pupils residing in town were higher than the results of the pupils residing in other areas ($p < 0,01$). No significant differences have been noted in other forms.

Statistical skills of the primary school teachers are provided in Table 2.

Table 2

Distribution of frequencies of the primary school teachers' correct solutions

Correct solution frequency (%)					
Data representation		**Data reading from**		**Mathematical operations**	
in a bar chart	50,8	a bar chart	87,7	Calculation of the mean	36,2
in a pictogram	84,6	pictogram	60,7	Marking of the data in percentage	18,5
in a pie diagram	27,7	a pie diagram	47,7	Approximation of numbers	7,7
in a graph chart	44,6	a graph chart	83,1		

The teachers with a higher non-university pedagogical *education* (graduates of the higher schools or colleges) did rather poorly. The general result of correct performance amounts only to 35%. Those primary school teachers who had bachelor degree demonstrated best skills (69%). In order to interpret this fact more precisely, more thorough research should be carried out but from the data obtained it can be assumed that the introduction of two-stage education assures the preparation of better qualified teachers. Significant differences based on the qualification acquired were observed ($p < 0,001$). The best results completing the items were shown by supervisors (59%). A significant difference was observed ($p < 0,001$; $\chi^2 = 19,.56$) in the choice of mathematics *textbooks*. Better results were achieved by those teachers who work with the mathematic textbook *Matematikos pasaulyje* by A. and D. Kiseliovai (62%). Supervisors who have bachelor degree and who work with the textbook *Matematikos pasaulyje* by A. and D. Kiseliovai demonstrated the best statistical skills (65%). Statistically important difference was observed among the teachers who work in the cities or region centres and those who work in rural areas ($p < 0,5$; $\chi^2 = 9,6$). Teachers who live in the cities manifest better statistical skills than those who live in rural areas.

Researching ***the teachers' attitude towards the teaching of statistical elements*** it was observed that most teachers are more interested in the general cultural education of a personality (66,7%)

than in training pupils in their particular subject. The evident statistical difference between teachers who have different experience in teaching has shown that teachers who have teaching experience of 11 and more years are apt to prioritize mere explanation of their subject ($p < 0,001$; $\chi^2 = 19,56$). The distribution of answers shows that primary school teachers who work with the textbook *Matematikos pasaulyje* as well as the teachers who work in secondary schools and in cities mention the lack of statistical items in textbooks and workbooks as well as the lack of methodical material. Primary school teachers *would pay more attention to statistics* if there were more time (84%) and more teaching aids (91,7%). Most of the teachers agree that the completion of statistical items requires a lot of effort (55,2%). Summarizing the teachers' answers it can be said that the teachers understand the benefit of statistical skills. The majority of respondents complain about the lack of visual, didactic and methodological materials as well as the obscurity of the presentation of statistical elements, which points at the existence of such problems and makes it necessary to look for their possible solutions.

On the basis of the ***opinion of primary school pupils*** an assumption can be made that such activities as data collection, surveys, research and drawing of diagrams and pictograms are very rare in their mathematics lessons. The fact that these activities and procedures are not widely used in the teaching process does not determine their attribution to least appealing activities.

The drawing of diagrams is a more common activity to the pupils which predetermines the fact that it is a more appealing activity than the drawing of graphs and pictograms or data collection, inquiries and research (PI = 0,.52).

The research showed that in the opinion of primary school pupils' mathematics is one of the top 3 subjects. Their answers show that in primary school during mathematics lessons the teacher usually explains the material and then pupils perform the items themselves. Pupils are not taught to look for problem solutions themselves.

The forth section of the dissertation *"Results of Educational Experiment"* consists of four chapters in which the following successful assumptions of the **organization of experimental teaching** are highlighted: activities should be based on the principals of constructive acquisition; the teacher plays the role of a mediator who supports, models and instructs his/her pupils.

Carrying out the analysis ***of the comparative development of the primary school pupils' statistical skills (at the level of technical skills)*** it was estimated that those tendencies in separate samples (pupils of the basic sample, experimental sample of the 3rd form pupils (E3–4) and experimental sample of the 4th form pupils (E4) are different. Three directions can be noted:

1. statistical skills remain at almost the same level (not equal, jumpy) (basic sample);
2. statistical skills slightly go up but in the 5th form a significant fall is observed (pupils of E4 form);
3. statistical skills constantly go up (pupils of E3–4 form).

Consequently, the development of statistical skills is not a simple phenomenon. Further education at school randomly affects the pupils' skills acquired earlier. Age differences also do not completely determine the tendencies of pupils' abilities.

The main factor which helps trace the uneven development of statistical skills is the content of education especially its distribution in a number of school years.

3rd form pupils who took part in the experiment regardless of the subject taught would use the knowledge they acquired much earlier in the subsequent process of education, studying the same statistical element further, they would integrate certain elements from the level of acquisition in the items of technical level and vice versa. Deeper usage of skills which were acquired earlier in subsequent education is important in the development of skills. *Data reading*: in the 4th form comparing the research results of *basic sample* with the results of the *pupils taking part in the experiment* a significant difference was observed at the beginning of the school year in reading the data presented in a bar chart ($p < 0,01$; $\chi^2 = 8,9$), pictogram ($p < 0,001$; $\chi^2 = 21,1$), pie diagram ($p < 0,001$; $\chi^2 = 18,5$), graph chart ($p < 0,001$; $\chi^2 = 11,8$). At the end of the school year in the 4th form the difference expands between the results of *basic sample* and those of the E3–4 *pupils* ($p < 0,001$) as

well as the pupils of E4 forms ($p < 0,01$). Better results were achieved by those pupils who took part in the experiment.

Data representation: in the 3rd form (at the end of the school year) the difference in the test results of the pupils from the *basic sample* and the *pupils from the forms which were taking part in the experiment (E3–4)* became evident ($p < 0,001$; $\chi^2 = 16,4$). In the 4th form comparing the research results of the pupils from the *basic sample* and the *pupils E3–4 forms* a significant difference was observed at the beginning of the school year reading the data presented in a bar chart ($p < 0,01$; $\chi^2 = 11,9$), pictogram ($p < 0,01$; $\chi^2 = 21,1$), pie diagram ($p < 0,001$; $\chi^2 = 22.5$), graph chart ($p<0.01$; $\chi^2=13.7$). Better results were achieved by those pupils who took part in the experiment. This way the difference between the results of the pupils from E3-4 and E4 forms became evident. The pupils who participate in the experiment from the 3rd form are able to present all the data in the way requested quicker ($p < 0,01$). At the end of the school year in the 4th form the results of the pupils from *E3-4* forms in presenting the data in bar chart, pie diagram, pictogram or graph chart were significantly better than the results of pupils from *E4* forms ($p < 0,001$). In the middle of the school year in the 4th form the analysis of diagnostical cross-sections was carried out which shows that the skills to present data in a bar chart or pictogram of those pupils who participated in the experiment from the 4th form did not differ from those pupils who participated in the experiment from the 3rd form, this skill, however, became weaker at the end of the school year in the 4th form. In the 5th form at the beginning of the school year the results of the pupils from *E3–4* forms were much better than those of the pupils from *E4* forms ($p < 0,001$). It can be stated that the skills acquired systematically remain and tend to improve. Revising the acquired knowledge at the same level or not revising it at all, this knowledge is partially sustained in memory, forgotten or it does not become deeper.

Results show that statistical skills of the pupils are dynamic. Under the influence of further education at school as well as other factors and weakly formed skills (peculiarities of the pupils' age, environment etc.), skills undergo a complex and uneven process of development in pupils' mind. The quality of pupils' skills changes in both directions (gets both better and worse). One of the main aims of didactics is to trace the conditions, which determine the existence of pupils' statistical skills as well as to eliminate those which are negative and to support those which are positive.

The development of pupils' statistical skills (reading and representation of data) is a process not a solitary action. It proceeds in a number of school years with the acquisition of the content of subjects taught which determines the fact that the statistical skills of the pupils who participated in the experiment from the 4th form was slightly going up but in the 5th form they significantly fell down. It is evident that an important role is played by well designed curricula, text books in the contents of which a unified system of skills is reflected.

Having analysed the conditions, which determine the development of pupils' statistical skills in the aspect of statistical technical skills it can be stated that the tendencies of their development are predetermined by their usage in the subsequent course of education and especially their supplementation with new, deeper knowledge together with general cognitive skills irrespective of the subject taught.

Thus, the success of education is determined by the organization of the content of education, consistent supplementation of the system of knowledge and the way it is deepened in the subsequent course of education within the framework of mathematics as well as the whole content of education according to the principle of interdisciplinary relations and carrying out cognitive activities.

Researching the ability of primary school pupils to perform mathematical operations it was revealed that the 4th form pupils are able to: determine the percentage of a number; distinguish between the events of equal and unequal probability; in the simplest cases determine the probability of events (the strategies manifested by the pupils with regard to the aspect of the elements of the

theory of probability allowed the stages of development to be described and the usage of certain concepts in primary school to be justified); to classify data according to two or more features, approximate them, organize; to calculate the mean, to understand it and apply it in practice.

Researching ***peculiarities of teaching general cognitive elements*** after systematic activities it was noted that the fourth formers are able of: identifying a problem with a help of a teacher, raise a hypothesis for the intended activities (a distinct shift from egocentric to socialised thinking was observed); to collect data from the immediate milieu by conducting experiments, researches, surveys, etc.; to prepare data registration sheets, to register them during the research; provide conclusions, interpret data. In this stage a leap of the pupils' thinking from the primary to analytical reasoning is noted. In the end of the experiment the fourth formers' thinking manifested a greater degree of the socialised thinking (which in the third form was the entirety of their major views, whereas in the fourth form it became just a one view along the other possible views). It was noted that on the basis of developing general cognitive skills teaching a social experience of the children was accumulated; the pupils are able not only verify objectivity of existence of reality, but also feel important in it and sense the commonness of experience with others.

A level of general cognitive skills applied along with a level of technical and mathematical operations skills confirmed dependence of the tendencies of pupils' skills on coherent and consistent presentation of the teaching material during a number of years, learning many related subjects. When the skills are not systematically developed in the teaching content, there is no palpable development of the pupils' skills. The entirety of statistical skills, especially its quality (systematic distribution, dynamics and depth), indicates the pupils' comprehension level and a level of intellectual development as well as thinking. Consequently, the development of pupils' statistical skills in the course of education undergoes on the grounds of the teaching content by acquiring the amount of systematic knowledge via cognition.

Teaching of elements of statistics and probability theory by solving items of technical, cognitive and mathematical level performs cognitive, educating, exploring, pragmatic and informational functions.

The research showed that certain elements of statistics and probability theory are accessible for third formers, but only in the fourth form the premises for acquisition of elements of the teaching content of statistics and probability theory are being formed.

The research of ***"primary school pupils' attitude towards teaching of elements of statistics"*** reveals that the pupils who participated in the experiment have a positive view on the items in the course of education, relate the acquired knowledge to practice. The pupils prefer drawing diagrams, graph charts to performance of the routines of other units of mathematics (enlarge/refine of measure units, draw geometric figures, etc). The pupils could easily provide data in a table and read it from a bar chart. The most interesting activity for them is conducting a survey. Responses to other questions of the questionnaire confirmed the validity of the proposed content of developing statistical skills.

Conclusions

- The research proved that the optimal content of teaching elements of statistics and probability theory consists of the items in solving which pupils develop: a) *technical* skills (reading and representing data); b) *skills of mathematical operations* (to calculate the mean, classify the data, approximate numbers, grasp elements of the probability theory, identify percentage of a number); c) *general cognitive skills* (an ability to word a problem, raise a hypothesis, compile data for its verification, to analyse and interpret the data, to draw conclusions).
- The research showed that the content of developing statistical skills, taking into consideration the age peculiarities, level of mathematical competences of the pupils, is

systematically realised by integrating the pupils' mathematical skills, knowledge of other disciplines, personal experience and is therefore a general problem of the primary education.

- The results of the educational experiment indicated that success of developing statistical skills depends on systematic approach of the teaching content, gradual supplementing of the knowledge system, its deepening in the further teaching process both of mathematics subject and the framework of the entire teaching context, complying with the principle of interdisciplinary links and undertaking cognitive activities (data compiling, raising hypotheses, verifying them, drawing conclusions, interpreting) and adequate competence of educators.
- Statistical skills in the primary school are developed not only by forming special skills, but they are also targeted at development of a versatile personality. Teaching of elements of statistics and probability theory performs cognitive, educating, exploring, pragmatic and informational functions. Introduction of such course on statistics opens up great possibilities of experiments, environmental research, and use of communications in the teaching process.
- Development of the primary pupils' statistical skills is successful providing teaching aids are prepared with the scope of absolute and comparative scope of their content corresponding to international standards.
- The research revealed a two-fold nature of the continuity of developing statistical skills between the primary and basic school forms: the primary school pupils are being prepared for acquisition of the mathematics teaching content of higher forms, and such content is determined on the ground of what is acquired in the primary school.
- The research proved that certain elements of statistics and probability theory are accessible to the third formers, but only in the fourth form the premises for acquisition of elements of the teaching content of statistics and probability theory are being formed.
- A positive attitude of the primary school pupils to learning elements of statistics and probability theory is preconditioned by the following factors: relation between content of items and immediate milieu of the pupils; a possibility to conduct a survey autonomously and obtain the results satisfying their interests; knowledge of various fields acquired additionally; methods used by teachers fostering individual and group activities.
- The research revealed that the teachers, who did not gain statistical skills during their studies, undergo a number of difficulties realising the content of teaching statistics and probability theory; development of their statistical skills in the framework of the continued education is a major prerequisite for successful teaching of elements of statistics and probability theory.
- Analysis of academic articles of scholars from different countries and the conducted empirical research prove that the content of teaching mathematics in primary school must be a component of national cultural setting operating on a par with a mathematical component.

Guidelines

- **For the developers of the General Curricula**: in compiling a new content of education for the primary school mathematics unit it is expedient to suggest teaching to read data from a bar, pie, area diagram, graph chart, pictogram, which are used in other subjects, information sources, and representing data by their means; calculating the mean, approximation of numbers, determining percentage of a number, introducing events of equal and unequal probability, in the simplest cases establishing probability of an event.
- **For the educators of the primary school**: a) covering various topics of education it is worthwhile to introduce to your pupils events of equal and unequal probability, it is necessary to teach determining of the estimate of the result probability, by wording it orally and in writing. Your pupils should be provided with possibilities to experiment, discuss in

order to ascertain in practice that the test results may be both equally and unequally probable; b) take into consideration the validated content of statistical skills, in wording the teaching items and compiling practice digests of mathematics and other subjects.

- **For the institutions training primary school teachers**: to focus more on teaching the basics of the statistics and probability theory, methods of their presentation, grasping of teaching gaols and principles. A particularly serious consideration should be showed to development of teacher competence in the area of teaching statistics and probability theory.
- **To institutions of continued career education**: the programmes for improvement of qualification should provide for their qualifying in the area of statistics and probability theory.
- **To further scholarly researchers the following areas of study are suggested:**
  - development of statistical thinking at classes of various subjects;
  - application of statistical skills in other subjects;
- teacher training for development of pupils' statistical skills.

DISERTACIJOS SANTRAUKA

Formuojantis žinių ir informacinei visuomenei, išryškėja naujos charakteristikos, kurias P. F. Drucker (1993) apibūdina kaip greitėjančius pasikeitimus ir intensyvėjantį problemų sudėtingumą. Kadangi pokyčiai įvairiose gyvenimo srityse reikalauja lygiagrečių pokyčių išsilavinime, todėl švietimo sistemai iškyla labai svarbus uždavinys: paruošti mokinius gyventi, veiksmingai dirbti ir kurti besikeičiančioje visuomenėje. Reformuojamoje Lietuvos švietimo sistemoje ugdymo turinys – viena iš sričių, dedančių pagrindus šiuolaikinei pilietinei, demokratinei žmogaus ir tautos savimonei bei gyvensenai. Šiandieninėje visuomenėje vis plačiau akcentuojamas ugdymas, kurio pagrindinė dimensija – nauji gebėjimai. Pastaraisiais dešimtmečiais, sparčiai didėjant naujos informacijos srautui, atsirandant viena kitą papildančioms mokslinėms teorijoms, pažinimo kriterijams, kintant vertybių prioritetams, akivaizdu, kad svarbiausia yra ne žinių kaupimas, bet mokėjimas racionaliai, savarankiškai, pagrįstai mąstyti, naudotis informacija (ją skaityti, vaizduoti), mokėti ją pasirinkti. Todėl daugelis mokslininkų (Ennis, 1985; Gal, 2002; Monterio, 2002; Shaughnessy, 1992; Schield, 2000; Rouncefield, 1993; Holmes, 2003; Konold, Pollatsek, Well, 1997; Pereira-Mendoza, 1991; Konold, Biehler, Steinbring, 2000; Garfield, 1994; Garfield, Hogg, Schau, Whittinghill, 2002) atliepiant išsakytas mintis, išskiria ***statistinius gebėjimus***, kurie leis suprasti, analizuoti ir vertinti statistinę informaciją.

Tyrimo objektas – matematikos mokymas pradinėse klasėse.

Tyrimo problema – pradinių klasių mokinių statistinių gebėjimų ugdymo turinio sistemingumas ir prieinamumas.

Tyrimo hipotezė. Pradinių klasių mokiniai pajėgūs įsisavinti statistikos ir tikimybių teorijos elementus, jei:

- teikiama užduočių sistema, atitinka mokinių matematinių kompetencijų lygį ir apima statistikos techninio lygmens, matematinių operacijų ir bendrųjų pažintinių gebėjimų lygmenų kompleksą;
- užduočių medžiaga susieta su mokinių asmenine patirtimi, realizuojant tarpdalykinius ryšius;
- mokytojai turi reikiamas kompetencijas.

Tyrimo tikslas – nustatyti pradinių klasių mokinių statistinių gebėjimų ugdymo turinį ir jo realizavimo prielaidas.

Tyrimo uždaviniai.

1. Teoriškai pagrįsti mokinių statistinių gebėjimų ugdymą kaip pradinio mokymo didaktinę problemą;
2. Apibūdinti šalies pradinių klasių mokinių bei mokytojų statistinius gebėjimus, ypatumus ir požiūrį į jų ugdymą;
3. Eksperimentu patikrinti mokinių gebėjimą įsisavinti statistikos ir tikimybių teorijos elementus;
4. Parengti ir pateikti pradinių klasių mokiniams statistikos ir tikimybių teorijos elementų mokomąsias priemones.

Ginamieji disertacijos teiginiai.

1. Statistikos ir tikimybių teorijos elementų mokymo turinys integruoja mokinių matematinius gebėjimus, kitų mokomųjų dalykų turinio žinias, bendruosius pažinimo gebėjimus ir asmeninę patirtį, todėl yra bendroji pradinio ugdymo problema;
2. Statistikos ir tikimybių teorijos elementų mokymui skirta užduočių sistema yra validi ir prieinama mokiniams, jeigu apima:
   - statistikos techninio lygmens gebėjimus (gebėjimą duomenis skaityti ir vaizduoti);
   - matematinių operacijų lygmens gebėjimus (apskaičiuoti vidurkį, klasifikuoti duomenis, suapvalinti skaičius, suvokti tikimybių teorijos elementus);

- mokiniams prieinamo lygio pažintinius gebėjimus (gebėjimą formuluoti problemą, hipotezę, rinkti duomenis jos tikrinimui, duomenis analizuoti, interpretuoti, daryti išvadas).

3. Sėkmingo pradinių klasių mokinių statistinių gebėjimų ugdymo prielaidos:
   - padinių klasių mokytojų statistinių gebėjimų ugdymas jų akademinio ir tęstinio rengimo struktūroje;
   - tarptautinius standartus atitinkančio statistinių gebėjimų ugdymo turinio įtvirtinimas pradinės mokyklos bendrosiose programose;
   - statistikos ir tikimybių teorijos elementų mokymo, paremto pradinėse klasėse įgytais gebėjimais, pateikimas aukštesniųjų klasių matematikos programose.

Tyrimo rezultatų naujumas: atskleista pradinių klasių mokinių statistinių gebėjimų struktūra ir aprobuota šią struktūrą atitinkanti mokomųjų užduočių sistema.

Rezultatų teorinis reikšmingumas: statistiniai gebėjimai įtvirtinti kaip pradinio ugdymo tikslas Lietuvos kultūrinės erdvės kontekste, aprobuotas jų ugdymo turinio teorinis modelis.

Praktinis darbo reikšmingumas: parengta ir eksperimentiškai išbandyta užduočių sistema, reprezentuojanti pradinių klasių mokinių statistinių gebėjimų ugdymo turinį; parengtas ketvirtos klasės mokinių statistinių gebėjimų testas, kuris gali būti taikomas švietimo būklės ir didaktikos tyrimuose; tyrimo rezultatai gali būti taikomi pradinių klasių mokytojų rengimo ir jų tęstinio mokymo sistemoje.

Tyrimo metodologijos remiasi šiais esminiais požiūriais bei koncepcijomis:

- *Sisteminis požiūris* į reiškinius, ypač jų tarpusavio sąveiką (Jucevičienė, 1989). Pradedama nuo tiesioginės vaiko patirties, o vėliau atskleidžiami vis įvairesni kontekstai. Kartu ryškėja ugdomų gebėjimų sisteminiai kontūrai. Mokymasis yra socialinis vyksmas, kurį įtakoja ankstesni gebėjimai ir naujos mokymosi patirties sąveika.
- Grindžiant statistinių gebėjimų ugdymo turinį buvo laikomasi *šiuolaikinio požiūrio į mokymą, kuris mokiniui suteikia subjekto vaidmenį ir įgalina jį mokytis*, turint omenyje, kad savarankiškas mokymasis maksimalistine forma išreiškiamas *mokymosi paradigma* (Novikienė, Šiaučiukėnienė, 2001).
- Darbe derinamas *pozityvistinis (normatyvinis) ir interpretacinis požiūris* į statistikos ir tikimybių teorijos elementų mokymo turinio parinkimą.
- Metodologija remiasi *kognityvine teorija*. Mokytojas yra galimybių kūrėjas, pagalbininkas, leidžiantis vaikams taip sąveikauti su aplinka (žmonėmis, vietomis, daiktais, idėjomis), kad jie patys įsisąmonintų naujus santykių modelius, dėsningumus, t. y. vaikai mokosi patys atrasdami. Mokinys yra aktyvus pats iš savęs, norintis įgyti naujų žinių, suprasti save, aplinką. Padeda mokiniui susieti naują medžiagą su turima informacija ir taip susidaryti naują santykių modelį.
- Remiamasi *pragmatizmo pedagogika*, nes ugdymo turinio pagrindu imama ugdytinio sąveika su realia gamtine ir socialine aplinka. Visas ugdymas yra probleminis, o ugdymo turinys – integruotas.
- *Konstruktyvistine pažinimo teorija,* kuri remiasi šiomis pagrindinėmis tezėmis: 1) mokiniai kuria (konstruoja) savo žinių sistemą aktyviai; 2) įgytos žinios ir gebėjimai turi būti interpretacinio pobūdžio (von Glasersfeld, 1995).

Tyrimui taikyti tokie **metodai**:

- *Mokslinės literatūros ir dokumentų analizė* įgalino, nagrinėjant statistikos ir tikimybių teorijos elementų mokymo problemas tarpdisciplininiu požiūriu, atskleisti būtinumą ugdyti statistinius gebėjimus, jų ugdymo tikslus ir funkcijas, proceso problemas Atskleisti statistinių gebėjimų ugdymo turinį Lietuvos ir užsienio mokymo programose bei vadovėliuose, taip pat pradinių klasių mokinių statistinių gebėjimų pasiekimus tarptautiniu mastu. Atskleisti „statistinių gebėjimų“, „statistinio raštingumo“, „statistinio mąstymo“, „statistinio samprotavimo“ apibrėžtis.

- *Konstatuojamas tyrimas (testavimas)* padėjo įvertinti pradinių klasių mokinių bei pradinių klasių mokytojų statistinius gebėjimus.
- *Pedagoginiu eksperimentu* buvo patikrintas siūlomo statistinių gebėjimų ugdymo turinys pradinėje mokykloje bei jo realizavimo galimybės.
- *Statistinių metodų taikymas* įgalino patikrinti visų eksperimentinių tyrimų išvadų statistinius patikimumus.
- *Modeliavimas* padėjo formuoti ir tobulinti statistinių gebėjimų ugdymo turinį, ieškoti tinkamų ugdymo metodų.
- *Lyginamosios duomenų analizės* metodo taikymas leido koreguoti tyrimo kryptį, tikslinti tyrimo uždavinius, gretinti ir lyginti statistinių, dokumentų analizės metodais gautus duomenis..
- *Anketinė apklausa* norėta sužinoti pradinių klasių mokinių bei mokytojų nuomones apie statistikos ir tikimybių teorijos elementų mokymą pradinėje mokykloje bei susidaryti bendrą vaizdą apie siūlomo projektinio turinio poveikį mokinių nuostatų formavimui(si).
- *Eksperimentiniu įvertinimu* patvirtinta mokymo(si) eksperimentui parengta medžiaga. Interpretuojant rezultatus remtasi pedagoginio eksperimento metu mokytojų rašytais dienoraščiais, video įrašais.

IŠVADOS

1. Tyrimas parodė, kad statistikos ir tikimybių teorijos elementų mokymo optimalų turinį sudaro užduotys, kurias atlikdami mokiniai ugdosi: a) *techninio lygmens* gebėjimus (duomenų skaitymas ir vaizdavimas); b) *matematinių operacijų gebėjimus* (apskaičiuoti vidurkį, klasifikuoti duomenis, suapvalinti skaičius, juos išreikšti procentais suvokti tikimybių teorijos elementus); *bendruosius pažintinius gebėjimus* (gebėjimą formuluoti problemą, hipotezę, rinkti duomenis jai tikrinti, duomenis analizuoti, interpretuoti, daryti išvadas).
2. Tyrimas parodė, kad statistinių gebėjimų ugdymo turinys, atsižvelgiant į mokinių amžiaus ypatumus, matematinių kompetencijų lygį, sistemingai realizuojamas integruojant mokinių matematinius gebėjimus, kitų mokomųjų dalykų turinio žinias, bendruosius pažintinius gebėjimus, asmeninę patirtį, todėl yra bendroji pradinio ugdymo problema.
3. Pedagoginio eksperimento rezultatai atskleidė, kad statistinių gebėjimų ugdymo sėkmę nulemia mokymo turinio sistemingumas, nuoseklus žinių sistemos gilinimas tolesniame procese tiek mokant matematikos, tiek ir visų kitų mokomųjų dalykų, laikantis tarpdalykinių ryšių principo ir vykdant pažintinę veiklą (renkant duomenis, keliant hipotezes, jas tikrinant, darant išvadas, interpretuojant), ir tinkamos pedagogų kompetencijos.
4. Pradinėje mokykloje ugdant statistinius gebėjimus, ugdomi ne tik specialieji gebėjimai, bet ir visapusiška asmenybė. Statistikos ir tikimybių teorijos elementų mokymas atlieka pažintinę, lavinamąją, tiriamąją, pragmatinę, informacinę, socializacijos funkcijas. Statistikos kursas atveria plačias eksperimentavimo, aplinkotyros tyrinėjimo, komunikacijos panaudojimo mokymo procese galimybes.
5. Pradinių klasių mokinių statistinių gebėjimų ugdymas sėkmingas, jei yra parengtos mokymo priemonės, kurių turinio absoliučiosios ir santykinės apimtys atitinka tarptautinius standartus.
6. Tyrimas atskleidė statistinių gebėjimų ugdymo perimamumo tarp pradinės ir pagrindinės mokyklos klasių dvipusį pobūdį: pradinių klasių mokiniai parengiami įsisavinti aukštesniųjų klasių matematikos mokymo turinį, o pastarasis sudaromas remiantis tuo, ko išmokstama pradinėse mokykloje.
7. Tyrimas parodė, kad kai kurie statistikos ir tikimybių teorijos elementai yra prieinami trečios klasės mokiniams, tačiau tik ketvirtoje klasėje susiformuoja prielaidos įsisavinti statistikos ir tikimybių teorijos elementų mokymo turinį.

8. Pradinių klasių mokinių teigiamą požiūrį į statistikos ir tikimybių teorijos elementų mokymąsi lemia: užduočių turinio ryšys su mokinių artimąja aplinka; galimybė savarankiškai atlikti tyrimus ir gauti mokinių interesus atitinkančius rezultatus; papildomai įgytos įvairių sričių žinios ir gebėjimai; mokytojų naudojami metodai, aktyvinantys individualią ir grupinę veiklą.
9. Tyrimas atskleidė, kad mokytojai, neįgiję statistinių gebėjimų studijų metais, patiria nemažų sunkumų realizuodami statistikos ir tikimybių teorijos elementų mokymo turinį; jų statistinių gebėjimų ugdymas tęstinių studijų institucijose yra esminė sėkmingo statistikos ir tikimybių teorijos elementų mokymo prielaida.
10. Įvairių šalių mokslinių publikacijų analizė ir atliktas empirinis tyrimas liudija, kad pradinių klasių matematikos mokymo turinys turi būti nacionalinės kultūrinės erdvės komponentas, funkcionuojantis paritetiniais pagrindais.

REKOMENDACIJOS

Bendrųjų programų rengėjams: sudarant naują ugdymo turinį, pradinių klasių matematikos skyriuje tikslinga mokyti braižyti stulpelinę, skritulinę, ploto diagramą, grafiką, piktogramas, kurios naudojamos mokant kitų dalykų, informacijos šaltiniuose, ir iš jų skaityti duomenis; skaičiuoti vidurkį, apvalinti skaičius, nustatyti skaičiaus procentus, supažindinti su vienodo ir nevienodo tikėtinumo įvykiais, paprasčiausiais atvejais nustatyti įvykių tikimybę.

Pradinio ugdymo didaktams: a) Nagrinėjant įvairias mokymo temas, tikslinga supažindinti mokinius su vienodo ir nevienodo tikėtinumo įvykiais, mokyti nustatyti baigties tikėtinumo įvertį išreiškiant jį žodžiu ir raštu. Sudaryti sąlygas mokiniams eksperimentuoti, diskutuoti, kad jie praktiškai įsitikintų, jog bandymų baigtys gali būti tiek vienodai, tiek nevienodai tikėtinos; b) Atsižvelgti į aprobuotą statistinių gebėjimų turinį formuluojant mokomąsias užduotis ir sudarant matematikos ir kitų dalykų pratybų sąvadus.

Pradinių klasių mokytojus rengiančioms institucijoms: daugiau dėmesio skirti statistikos ir tikimybių teorijos pradmenims mokyti, jų pateikimo metodikai, mokomiesiems tikslams ir principams suprasti. Ypatingas dėmesys turėtų būti skiriamas mokytojų kompetencijai suvokti statistiką ir tikimybių teoriją.

Tęstinio profesinio mokymo institucijoms: kvalifikacijos tobulinimo programose numatyti mokytojų kvalifikavimą statistikos ir tikimybių teorijos srityje.

Tolimesnių mokslinių tyrimų vykdytojams siūloma nagrinėti:

- statistiniai gebėjimai panaudojami kitų mokomųjų dalykų pamokose;
- statistinis mąstymas ugdomas įvairių mokomųjų dalykų pamokose;
- mokytojai rengiami ugdyti mokinių statistinius gebėjimus.

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