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THE STATE OF TEACHING STATISTICS TOPICS IN HIGH SCHOOL TEXTBOOKS IN VARIOUS PROGRAMS

Abstract

In Kazakhstan, the statistics curriculum is a component of the mathematics curriculum at the high school level. The way statistics is taught will be evolved as a result of changes in secondary school mathematics instruction. The probability theory is not given effectively in the mathematics curriculum in schools. Most students have little problem with the basic concepts, but many have a lot of trouble understanding how to organize increasingly complicated issues. The article discusses the current state of teaching statistics elements and the meaning of the curriculum plan. Our study's primary objective is to define the main benefits of each program by comparing various programs taught throughout in the country. In this article, the authors analyze algebra textbooks in grades 9-11. As a result of the analysis of the topics, the main features of the three programs involved in the study were identified, the results of which we will apply in the future to the systematization of the topics of secondary statistics. Systematization of Statistics topics helps to supplement the tasks and theoretical knowledge found in the textbook in accordance with the class level.

Ключевые слова: education in mathematics; secondary education; statistics curriculum; systematization; probability

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ТҮРЛІ БАҒДАРЛАМАЛАРДАҒЫ ЖОҒАРҒЫ СЫНЫП ОҚУЛЫҚТАРЫНДАҒЫ СТАТИСТИКА ТАҚЫРЫПТАРЫНЫҢ ОҚЫТЫЛУ ЖАҒДАЙЫ

Аңдатпа

Қазақстанда статистиканы оқыту бағдарламасы орта мектеп деңгейіндегі математиканы оқыту бағдарламасының құрамдас бөлігі болып табылады. Статистиканы оқыту әдістерін өзгертуге орта мектепте математиканы оқыту әдістеріне түзетулер енгізу нәтижесінде қол жеткізуге болады. Статистикадағы ықтималдық теориясын оқыту әдісі мектеп математикасы бағдарламасында тиімді қарастырылмайды. Білім алушылардың көпшілігінде негізгі ұғымдарда айтарлықтай қиындықтар жоқ, бірақ күрделі есептерді шешуде көптеген қиындықтар бар. Мақалада статистика элементтерін оқытудың қазіргі жағдайы және оқу жоспарының маңызы талқыланады. Біздің зерттеуіміздің негізгі мақсаты-елімізде оқытылатын әртүрлі бағдарламаларды салыстыру арқылы әр бағдарламаның негізгі артықшылықтарын анықтау. Бұл мақалада авторлар 9-11 сыныптарға арналған Алгебра оқулықтарын талдайды. Тақырыптарды талдау нәтижесінде зерттеуге қатысқан үш бағдарламаның негізгі ерекшеліктері анықталды, оларды біз болашақта орта мектептегі статистика тақырыптарын жүйелеу үшін қолданамыз. Статистика тақырыптарын жүйелеу оқулықтағы тапсырмалар мен теориялық білімді сынып деңгейіне сәйкес толықтыруға көмектеседі.

Түйін сөздер: математикалық білім; орта білім; статистика бойынша оқу бағдарламасы; жүйелеу; Кембридж бағдарламасы

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СОСТОЯНИЕ ПРЕПОДАВАНИЯ СТАТИСТИЧЕСКИХ ТЕМ В ШКОЛЬНЫХ УЧЕБНИКАХ ПО РАЗЛИЧНЫМ ПРОГРАММАМ

Аннотоция

В Казахстане учебная программа по статистике является компонентом учебной программы по математике на уровне средней школы. Методы преподавания статистики могут быть изменены в результате изменений в преподавании математики в средней школе. Теория вероятностей в статистике недостаточно эффективно рассматривается в школьной программе по математике. У большинства студентов нет особых проблем с основными понятиями, но у многих возникают проблемы с решением сложных задач. В статье обсуждается текущее состояние преподавания элементов статистики и значение учебного плана. Основная цель нашего исследования – определить основные преимущества каждой программы, сравнивая различные программы, преподаваемые по всей стране. В данной статье авторы анализируют учебники алгебры для 9-11 классов. В результате анализа тем были выявлены основные особенности трех программ, участвующих в исследовании, которые мы будем применять в будущем для систематизации тем по статистике в средней школе. Систематизация тем статистики помогает дополнить задания и теоретические знания, содержащиеся в учебнике, в соответствии с уровнем класса.

Ключевые слова: математическое образование; среднее образование; учебная программа по статистике; систематизация; кембриджская программа

Introduction. There is a rising effort to include statistics and probability as a component of fundamental math literacy in secondary and even elementary school curricula. It is increasingly common to anticipate that students will learn various measures of central tendency and spread, come across theoretical and real distributions, and engage in discussions about subjects like randomness, statistical tests, and statistical significance that were previously introduced at various academic levels in foreign countries education. In addition to a reevaluation of its connections to mathematics, statistics should be taught across the curriculum due to its growing importance and its connections to daily literacy, science, health, and the social sciences. According to research, the probability is included in many scientific curriculum as well as the majority of secondary school mathematics curricula [1]. But, due to the fact that there are many changes and additions in the education system of Kazakhstan, the teaching of mathematics has not yet become a systematic form. As a result, the necessary elements of Statistics in the modern world are not mastered by students of the country. Since statistics are widely used in all fields of science, it is advisable to start teaching the elements of Statistics in

Kazakhstan. However, it takes a considerable time to develop strong statistical thinking abilities. For these reason, other research shows that starting the systematically teaching process

in the elementary grades and continuing to build and reinforce these abilities throughout the middle and high school years is the best method to ensure statistical literacy [1]. An ever-more-positive public attitude reflects the widespread recognition of the field of statistics' contribution to scientific understanding [2. P 259-265]. Nowadays, there is no question that every professional should be able to conduct an inquiry, collect data with advance planning, and analyze the findings. Such learning should be done sooner. As the research shows, the use of Statistics is changing rapidly because science is developing rapidly, so leaving its teaching to higher education is not an effective solution [3]. The traditional statistics curriculum's mathematical underpinnings fall short of the pressing need for pupils who can work with data [3]. It is necessary to systematize the teaching of Statistics, taking into account foreign experience, and it is better to study the curriculum of statistics in school education. There is no doubt that, with regard to the underlying presumptions and objectives, the subject boundaries, the content, the teaching methodology, and the methods of assessment, the introduction of a new curriculum presents a variety of obstacles to instructors [4]. Many studies have done researches on the teaching of Statistics, which can prove that there are still

difficulties in teaching it. The study found that there are not enough qualified teachers, there is no statistical framework, teachers are unable to connect statistical ideas to practical applications, students lack basic math skills, there are not enough required textbooks [5]. The results of the assessment of the central trend indicators in the frequency table have not yet been mastered when evaluating the central trend measurement technique, particularly for the average and median [6.P73-86]. Since statistics is one of the most important lessons in the modern century, it is necessary to pay special attention to the methodology of teaching it. Students ' statistical literacy would increase if they taught statistics on the basis of interdisciplinary links in order to be able to work with data found in all fields of science

In this age of technology, the lesson taught in every school should be taught to use a computer competently. Students may have an increased interest in learning because they are educated with the resources they are interested in. Some studies already got positive aspects of using computer based learning, pupils demonstrate success in their ability to solve their mathematical issues when learning geometry with Geogebra [7]. In comparison to learning geometry without studying geography, GeoGebra also aids pupils in grasping geometric ideas [7]. This study proves that teaching statistics must meet modern requirements, that the basis of interdisciplinary communication can be implemented through computer science. At the same time, teaching students by project learning methods has recently shown positive results [8.P 197].

In our study, as one of the first steps to systematize the teaching of Statistics elements in mathematics, we will analyze the topics of various programs taught in our country. The results of the analysis will help us develop an effective statistician curriculum and identify the advantages and disadvantages of different programs.

Methods and materials. The primary informational materials in the various educational systems is the program- related textbooks which is taught in the three different programs. We made our analytical research work by comparing the topics and tasks assigned to the textbooks with each other. The study used a total of 7 algebra textbooks taught in grades 9-11 in each program itself as State, BIL schools and Cambridge and a statistics textbook taught in grades 11 for the Cambridge program [9].

Methodology which is used to collect our data for analysis was document review which is qualitative data. In our case primary type of document was textbooks. In order to develop an effective program for statistics, it was necessary, first of all, to determine how they are taught in a different program. We were selected State ,BIL school and Cambridge programs in our research. Topics and tasks and the interpretation of topics were considered individually for each grades.

Results and discussion. We used a tabulation (Table 1) as a representation tool in order to process our data to analyze easily the given information in textbooks on the topic.

Table 1**Analysis of the topic "elements of Statistics" in programs**

	State	BIL schools	Cambridge
9th grade	Basic concepts and principles of combinations (addition and multiplication rules)	Basic concepts and principles of combinations (addition and multiplication rules)	The probability. The probability of an event.
9th grade	Factorial of a number, permutation and combination.	Factorial of a number, permutation and combination.	Mutually exclusive events
9th grade	The combination formulas	The combination formulas	Relative frequency
9th grade	Newton's binomial theorem and its properties	Newton's binomial theorem and its properties	Venn diagram

9th grade	Fundamentals of probability theory	Fundamentals of probability theory	Probability diagram
9th grade	The main definition of probability	The main definition of probability	The types representation of data
9th grade	Using probability in geometry	The main definition of probability	Surveys (hypothesis ,analyze)
9th grade			Averages (mean,mode,median)
9th grade			Frequency polygons
10th grade	Elements of combinatorics and their application for finding the probability of events. Newton binomial (with a natural exponent) for approximate calculations	Elements of combinatorics and their application for finding the probability of events. Newton binomial (with a natural exponent) for approximate calculations	The representation of data
10th grade	Probability of an event and its properties	Probability of an event and its properties	Averages(mean, mode, median)
10th grade	Conditional probability. The rules of addition and multiplication of probabilities	Conditional probability. The rules of addition and multiplication of probabilities	Types of correlation
10th grade	The formula of total probability and Bayes' formula	The formula of total probability and Bayes' formula	Box- whisker plot
10th grade	Bernoulli's formula and its consequences	Bernoulli's formula and its consequences	Cumulative Frequency
10th grade	Probabilistic models of real phenomena and processes	Probabilistic models of real phenomena and processes	Comparison of data
10th grade	Random variables	Random variables	Probability
10th grade	Discrete Random Variables	Discrete Random Variables	Relative frequency
10th grade	The concept of continuous random variable	The concept of continuous random variable	Mutually exclusive and independent events
10th grade	Numerical characteristics of discrete random variables	Numerical characteristics of discrete random variables	Probability by using Tree and Venn diagram
10th grade	Types of distribution of discrete random variables. The law of large numbers	Types of distribution of discrete random variables. The law of large numbers	The conditional probability
11th grade	Population and sample	Elements of combination and probability theory	Representation of data (Types of data, Discrete data,steam and leaf diagram, Continuous data, histograms, Cumulative frequency)

11th grade	Discrete and continuous variation series	Population and sample	Measure of central tendency (Mode and modal class, Median, Mean)
11th grade	Estimation of the quantitative characteristics of a random variable by sample	Discrete and continuous variation series	Variation (The measure of variation, Range, IQR, Variance and standard deviation)
11th grade		Estimation of the quantitative characteristics of a random variable by sample	Probability (Experiments, events and results, Mutually exclusive events and addition rule, Independent events and multiplication rule, Conditional probability, Dependent events and conditional probability)
11th grade			Permuatation and Combination
11th grade			The probability distribution
11th grade			The binomial and geometric distribution
11th grade			The normal distribution

9th grade: In the three education systems, statistics are presented as two chapters:

BIL schools cover the topics of combinations and probability [12], as they run through a state program, and in the Cambridge system, probability and data representation are supplemented [11]. Although there is a probability section in all three systems, the topics are different. For example, in the Cambridge system, if the types of events are considered in the previous grades, it takes place at 9th grade in the state system [10]. At the same time, the introduction to probability theory under the state system is carried out only in the 9th grade. In the Cambridge system, the topic of probability is supplemented by the tree diagram and the Venn diagram. However, there are very few new topics presented in the Cambridge system, the level of tasks is easy. BIL and government textbooks consider the Venn diagram in the combination chapter. These topics are considered in the 11th grade in the Cambridge system [11]. In the state system, the topic of combination is used to solve Newton's binomial problems, while in the Cambridge system, this topic is not represented in the discipline of Statistics, although it is expressed in algebra. The topic of probability in the 9th grade of the state system is given as an interdisciplinary theme, that is, through topics for calculating geometric probability. This increases the importance and complexity of the topic of probability in public schools.

10th grade: At the level of this class, common to all three programs, the topic of probability is considered. State and BIL textbooks complement the topics of combination and random variables [14],[15]. In the Cambridge system, the representation of data found in past classes is carried out by repeating the topics of average values, cumulative frequency, and the probability topic for this class is supplemented with calculations of probability from the conditional probability, tree diagram and Venn diagram [13]. There are significant differences in the other two programs. First of all, in the combination chapter, the considered topics are permutation and all their common states and conditions. In addition, the search for probabilities through combinations elements is is also included. In both textbooks, the

topics are given with a clear definition and an example, but the BIL textbook does not explain all possible cases of combinations, the number of tasks assigned to combinations is limited, and the priority tasks are unvaried. The transmission of the probability subject in the systems is different, and the Cambridge system is greatly simplified when compared with the other two systems. In the state system, there is a complete probability formula, the Bayer's formula, which gives the 10th grade level an advantage over other systems [14]. There are many common themes in BIL and government textbooks than in the Cambridge system. One of the most important probabilities topics in teaching statistics is the Bernoulli formula, which is found in the textbooks of the BIL and the state system [14], [15]. The Cambridge system textbooks, although they do not cover complex topics, perfectly explain the ways of mutually exclusive events, addition and multiplication rules. In the second part of the school textbook, BIL considers random variables and their numerical characteristics of the elements of Statistics as a new chapter in the textbook. Cambridge textbooks cover this topic and related discrete and continuous variables in all topics starting from the 7th grade [13]. However, BIL and public school textbooks have precisely explained discrete variable and supplemented them with binomial and geometric distribution laws. The great disadvantage of these systems, however, is that they do not cover the scope of their application, although they have been mentioned in the title and definition of the continuous variable. We can see that the Cambridge system has become very important in the application of discrete, continuous variables in other topics of Statistics and has shown it in all topics of textbooks between grades 7-10. The topic of expected value is considered by the state and BIL schools in discrete variable, and the subject of variance is studied to this class level. And in the Cambridge system, all complex subjects are taught in the 11th grade as separate disciplines of Statistics and Probability.

11th grade: Most of the schools taught by the education system of the Republic of Kazakhstan are 11 - year, and Cambridge is taught using the 12-year education system, so statistics are taught in the last two classes as a separate subject, in addition to mathematics. However, this discipline is not mandatory for all students, but is taught as an elective. That is, until the 11th grade, all students are equally familiar with the main common elements of [9]. In the 11th grade, students are taught in depth in order to be able to study and pass exams in mathematics and statistics in their chosen specialties. The state educational system teaches algebra to students in the natural sciences and humanities. Therefore, very few statistical topics are found in state and BIL textbooks. In both directions, the topics of the same population and sample, discrete and continuous variation series, estimation of quantitative characteristics of a discrete variable by sample are considered, and no significant number of problems are given. As for the discipline of Statistics and Probabilities in the Cambridge system, the differences in topics encountered before these classes from the state and BIL systems are supplemented in this textbook.We can look at the normal distribution as a special topic that we have not encountered in other systems. The Cambridge textbook consists of eight chapters with general details. They are: Data representation (data types, stem-leaf diagram, histogram, cumulative frequency, comparison of representations), measurement of mean values (mode, arithmetic mean, median), series of variations (scale, IQR, variance and standard deviation), probability , probability distribution (discrete random variables, probability distribution,expected value and variance of discrete random variables), geometric and binomial distributions, normal combinations (continuous random variables, normal distributions, modeling with normal distributions, binomial distributions) [9]. All topics in the textbook are fully covered and examples with definitions are provided, and the levels of the report are significantly modified and complicated. I think that individual teaching of Statistics as a subject will increase the statistical literacy of students and will be able to better understand the importance of topics.

Conclusion. In conclusion, an analysis of the provided elements of Statistics in Mathematics textbooks in grades 9-11 was carried out. It was found that the subjects taught in most classes coincide with general secondary school textbooks, since the schools of the BIL are subject to the state system. However, there were differences in the problems and definitions given, and the information that should be explained within the same topic, although the topics corresponded. In the course of studying the textbooks of the Cambridge system, it became clear that through the spiral system, all topics become more complex annually at the level of 6-10 grades within the framework of basic data representation and probabilities. However, it should be noted that one of the disadvantages is

that these tasks are simplified even for the high school students. However, thanks to this system, students will be able to fully master the main topics of Statistics. Moreover, if he wants to complete his knowledge of statistics, he can get an opportunity to study in depth in the last two years as a separate subject. As for the teachings of Statistics in the BIL and state textbooks , children may not be able to see the relationship between the topics passed in each class, each year the topic is presented in a more complex and scattered form. As another disadvantage, we can see that the information in the reports has too little connection with real life.This can prevent children from understanding the importance of studying statistics. Another shortcoming is that many topics are not covered in detail. Thus, in the three systems, the general topics of statistics at the level of grades 9-11 coincide, but their distribution to classes is different.Some of the topics of statistics used by the Cambridge system are, in particular, the whisker box diagram, the tree diagram,determining the average values from the continuous variable table. We can see that the normal distribution law is not found in the state system at all.

In the analysis, we were able to identify the advantages and disadvantages of each system. In the research, the points that need to be changes were identified. This study will help us prepare curriculum that can provide students with effective knowledge by combining three important systems.

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