МАТЕМАТИКАНЫ ОҚЫТУ ӘДІСТЕМЕСІ

МЕТОДИКА ПРЕПОДАВАНИЯ МАТЕМАТИКИ

METHODS OF TEACHING MATHEMATICS

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USE OF EXCEL IN TEACHING ELEMENTS OF STATISTICS IN SCHOOL MATHEMATICS COURSE

Abstract

This study examined using Excel spreadsheets to teach statistics elements in a school mathematics course. Compared to other software packages, the advantages of using Excel in school mathematics have been determined. Basic information about Excel was shown, and information was given about its current use in teaching statistics. The school mathematics course determined the kind of statistical calculations that can be made. Statistics have a special place in school mathematics. It is covered in the mathematics textbooks of grades 5-11 of the general education school. In grades 5-6, they are given subtopics as an introduction to statistics; in grades 7-11, they are considered a separate section. The issue of digital technologies in teaching statistics is often discussed in textbooks. The digital tool MS Excel is used in mathematics textbooks for the 7th grade, 8th grade, and 11th grade of general education schools in the Republic of Kazakhstan to make statistical reports. 11th grade in elementary schools of algebra and analysis in the subject: main and sample sets, basic statistical means (sample mean, arithmetic mean, median, mode), discrete and interval frequency tables, statistical diagrams (frequency polygon, histogram), and discrete get acquainted with the concepts of quantitative characteristics of the selection of random variables. In this article, we have given tasks and instructions for making calculations using the Excel spreadsheet for the topics mentioned in the 11th-grade Algebra and Analysis Beginnings textbook. It has been shown that all statistical reports at the school level can be produced using Excel. MS Excel was used to create a frequency table, calculate fundamental statistical mean values, and create a frequency polygon, and a histogram was shown with concrete examples.

Keywords: school mathematics, elements of statistics, MS Excel, digital program.

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МЕКТЕП МАТЕМАТИКА КУРСЫНДА СТАТИСТИКА ЭЛЕМЕНТТЕРІН ОҚЫТУДА EXCEL БАҒДАРЛАМАСЫН ПАЙДАЛАНУ

Аңдатпа

Бұл зерттеуде мектеп математика курсында статистика элементтерін оқытуда Excel кестелік процессорын қолдану жағдайы қарастырылды. Басқа программалық пакеттермен салыстырғанда Excel программалық жасақтамасының мектеп математикасында пайдаланудың артықшылықтары анықталды. Excel жайлы негізгі ақпарат көрсетіліп, қазіргі уақытта оның статистика элементтерін оқытуда пайдаланылуы туралы ақпарат берілді. Мектеп математика курсында статистиканың қандай есептерін шығаруға болатыны анықталды. Мектеп математикасында статистиканың алатын орны ерекше. Ол жалпы білім беретін мектептің 5-11 сыныптарының математика оқулықтарының

әрқайсысында қамтылған. 5-6-сыныптарда олар статистикаға кіріспе ретінде ішкі тақырыптар ретінде берілсе, 7-11 сыныптарда жеке тарау ретінде қарастырылады. Оқулықтарда статистиканы оқытудағы цифрлық технологиялар мәселесі жиі айтылады. MS Excel цифрлық құралы Қазақстан Республикасы жалпы білім беретін мектептердің 7-сынып, 8-сынып және 11-сыныбына арналған математика оқулықтарында статистикалық есептерді шығаруда қолданылады. Жалпы білім беретін мектептерінде 11-сынып алгебра және анализ бастамалары пәнінде: басты және таңдалым жиынтықтарын, негізгі статистикалық орта мәндер (таңдалым құлашы, арифметикалық орта, медиана, мода), дискретті және интервалдық жиілік кестелері, статистикалық диаграммалар (жиілік полигоны, гистограмма) және дискретті кездейсоқ шамалар таңдалымының сандық сипаттамалары түсініктерімен танысады. Осы мақаламызда 11-сынып алгебра және анализ бастамалары оқулығында аталған тақырыптарға Excel кестелік процессорын пайдаланып, есептер шығаруға тапсырмалар және нұсқаулықтар бердік. Мектеп деңгейіндегі статистикалық есептердің барлығын Excel көмегімен шығаруға болатыны көрсетілді. MS Excel көмегімен жиілік кестесін құруға, негізгі статистикалық орта мәндерді есептеуге, жиіліктер полигонын және гистограммасын құруға нақты мысалдармен көрсетілді.

Түйін сөздер: мектеп математикасы, статистика элементтері, MS Excel, цифрлық бағдарлама.

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ИСПОЛЬЗОВАНИЕ ПРОГРАММЫ EXCEL ПРИ ОБУЧЕНИИ ЭЛЕМЕНТАМ СТАТИСТИКИ В ШКОЛЬНОМ КУРСЕ МАТЕМАТИКИ

Аннотация

В этом исследовании изучалось использование электронной таблицы Excel при обучении элементам статистики в школьном курсе математики. Определены преимущества использования программ Excel в школьной математике по сравнению с другими пакетами программ. Была показана основная информация об Excel и дана информация о его текущем использовании в обучении статистике. В школьном курсе математики было определено, какие статистические расчеты можно производить. Статистика занимает особое место в школьной математике. Ей посвящен каждый из учебников математики для 5-11 классов общеобразовательной школы. В 5-6 классах они даются как подтемы как введение в статистику, а в 7-11 классах рассматриваются как отдельный раздел. Вопрос о цифровых технологиях в обучении статистике часто обсуждается в учебниках. MS Excel используется как цифровой инструмент в учебниках по математике для 7, 8 и 11 классов общеобразовательных школ Республики Казахстан при решении статистических задач. В общеобразовательных школах в 11 классе по предмету алгебра и начало анализа проходят темы: главные и выборочные совокупности, основные статистические средства (выборочное среднее, среднее арифметическое, медиана, мода), дискретные и интервальные таблицы частот, статистические диаграммы (полигон частот, гистограмма) и дискретный прием. Ознакомятся с понятиями о количественных характеристиках выборки случайных величин. В этой статье мы дали задания и инструкции по проведению расчетов с использованием электронной таблицы Excel по темам, упомянутым в учебнике «Алгебра и начало анализа» для 11 класса. Почти все статистические расчеты школьной программы могут быть составлены с использованием Excel. Использование MS Excel для создания таблицы частот, расчета основных статистических средних значений, построения полигона частот и гистограммы было показано на конкретных примерах.

Ключевые слова: школьная математика, элементы статистики, MS Excel, цифровая программа.

Main provisions

Statistics is a branch of mathematics that describes the general problems of collecting, measuring, and analyzing quantitative or qualitative data. Thanks to these data, it is possible to analyze the activities and work of any economic sector. In the current development of society, interest in statistics as a science and its widespread use in practical activities has grown significantly.

Introduction

Statistical data can give a clear picture of the current state of production and economy. Thanks to this, any deviations or inconsistencies can be detected, several corrective measures can be taken in time, and the situation can be significantly improved [1].

As the importance of statistics increased, the demand for statisticians increased. Also, in today's society, everyone should be competent in statistics because statistical data (average, median, mode, etc.) can be found in every activity of everyday life. This means that the teaching of statistics has become an actual issue in the field of education, that is, in the methodology of teaching mathematics.

Using digital technologies in teaching statistics is advisable because applied statistical analyses are performed on large amounts of data. When performing statistical analysis of big data on paper, you can face problems such as data confusion and calculation duration. Digital technologies can solve such a gap in statistics education. Excel is the most widely used statistical software package in production. The issue of using digital technologies such as Excel in teaching statistics has not been fully explored, and collecting information on this issue is becoming urgent.

Research methodology

The purpose of the study is to review the use of the Excel program in teaching statistics in school mathematics courses and determine its differences from other software packages [2].

Research methods: theoretical review, comparison, induction.

The study's objectives are to determine the use of digital technologies in teaching statistics elements in a general education school and the extent to which teachers master them.

Hypotheses

H1: enables students to use knowledge through digital technologies effectively;

H2: helps students to be sociable;

H3: Helps students make quick and correct decisions [3].

Results of the study

Literature review. MS Excel. Excel, the leading spreadsheet program, is a vital tool for professionals across various fields [4]. Business people, scientists, accountants, and journalists rely on its versatile capabilities. They use it to manage lists, create catalogs and tables, generate financial and statistical reports, analyze survey data and trade enterprise status, process scientific experiment results, and prepare presentation materials. Excel can calculate sums across table columns and rows, calculate percentages, and calculate the arithmetic mean, bank rate, or variance. The Excel software package has many financial, mathematical, logical, and statistical standard functions [5].

In the Excel spreadsheet, you can change the design of the cells in different ways. As in powerful word processors, Excel can change fonts, letters' color, background, etc., and functions. In addition, it allows you to create graphs and charts and insert pictures into the table. The Excel software package can perform about 400 standard functions of mathematical, logical, accounting, and statistical functions. Therefore, using Excel to teach mathematics is very effective and provides many opportunities for the subject teacher. In the process of teaching mathematics, Excel can be used to study many topics: solving equations; solve the system of equations; function study; draw a graph of the function; solving statistical problems.

Comparison of Excel with other statistical software packages. In addition to the Excel table processor, powerful software packages, such as Minitab, STATISTICA, COMSOL, Matlab, and SPSS Statistics, generate statistical reports (*https://www.minitab.com/*).

Using the Minitab software package, you can visualize, analyze, and compare data to implement business tasks (https://www.statistica.com/en). The program offers all the possibilities for creating reports, has many tools for statistical analysis, and allows you to format tables and graphs conveniently for a report or a scientific article. The Minitab package includes a large selection of statistical tools. The program will be helpful for specialists in various fields of activity. For example, accountants, financiers, and analysts use large data sets for analysis, macros for process automation,

and graphical elements for reports. This program is often used during scientific research among teachers, students, and research workers in higher educational institutions.

StatSoft manufacturer STATISTICA is known for creating robust programs for statistical and graphic analysis (*https://www.statistica.com/en/*). This software package's set of tools allows prediction and data mining. This program enables users to create applications, install integrations, and organize Internet access. The user can customize the STATISTICA interface according to their tasks and needs. The analysis process proceeds interactively by gradually opening dialog windows. The first tab always contains the most used functions, while the others contain specialized methods and functions. Therefore, it will be convenient for both beginners and advanced users. The graphics block contains a set of tools for visualization and graphic design. You have over 10,000 graph types to edit, interactively rotate, zoom, and control transparency. The main advantages of the STATISTICA package are its high speed and accuracy of calculations. All calculations are fast, although applications are massive and database requests are frequent. The program uses proprietary performance improvement technologies. Initially, StatSoft products were designed with maximum optimization in mind when working with complex predictive models. In STATISTICA programs, you can perform exploratory data analysis, determine correlation, create scatter diagrams, calculate the T-criterion, create frequency tables, and create themes. The program also allows you to define probability distributions in an interactive calculator. The programs are intended for both private and corporate users.

COMSOL software products are tools for creating numerical models in various design fields (*https://www.comsol.com/*). COMSOL Multiphysics is a universal platform used in production, scientific research, and engineering. This software environment allows us to analyze physical processes and manage models and applications. The program has tools for creating geometric models, assigning properties to materials, and visualizing the final modeling project. All developed models are stored in the database. The COMSOL software package has extension modules. COMSOL Multiphysics includes core functionality such as model creation, application development, and model management. You can group geometric models into patterns by creating geometric models. The appendix contains interfaces for forming characteristics of models based on mathematical equations. The COMSOL component is also an application development environment based on computational models.

Matrix Laboratory, or Matlab for short, is a set of tools for programming, mathematical calculations, and computer modeling (*https://www.mathworks.com/*). With the help of this software, data processing is carried out quickly and qualitatively. Matlab products are represented as functions or scripts. Modeling for data analysis allows the use of matrices, linear equations, and vectors. The program has a built-in graph gallery for monitoring patterns. All graphical visualizations can be annotated, and graphs can be manipulated. The application allows you to perform tasks of various levels, from executing simple interactive commands to building large-scale programs. Differential equations, partial derivatives, and linear and non-linear equations can be created.

IBM SPSS Statistics is a software package for complex statistical analysis, planning, and business accounting (*https://www.ibm.com/products/spss-statistics*) [6]. SPSS Statistics has a convenient user interface that does not require programming. There are various management functions, statistical commands, and reporting tools. All IBM SPSS products are integrated into a single system, so switching from one program to another will not be difficult. Built-in Modules increase analytical capabilities. IBM SPSS works on all operating systems – Windows, MacOS, Linux, Android, and iOS. Often, this software is used in medicine, marketing, government, and educational institutions. The software package includes a metadata dictionary, which makes it easier to work with the documentation. With SPSS, you can measure frequencies, correlations, regressions, and other statistical products.

Most of the powerful statistical software packages are industrial. There is no specific statistical software product aimed at education. However, the teacher can use the abovementioned programs to teach statistics depending on his skills. Besides these, Excel spreadsheets have several advantages.

Almost all statistical calculations in other software products can be performed in Excel [7]. Students are familiar with the Excel spreadsheet as it is a component of Microsoft Office. Excel is accessible, and its interface is intuitive. In many works, Excel has been used in mathematics courses in higher educational institutions and schools [8].

MS Excel in teaching elements of statistics. The Excel digital tool can be a powerful learning tool for elementary and middle school students. Excel provides concrete ways to explore abstract concepts in math and other subjects. This program contains various formulas that can be used in teaching mathematics. In addition to using ready-made formulas, students can create formulas to work with quantities. This paper proposes the use of MS Excel in the teaching and learning of statistics in secondary schools. This document demonstrates the ability of MS Excel to teach almost all high school statistics topics. Using Microsoft Excel, you can generate the following types of statistical elements in a school mathematics course: Creating diagrams and tables; Calculation of central tendency values (mode, median, arithmetic mean, geometric mean); Construction of frequency range and polygon; Creating a graphic image of a random variable; Calculation of variance and standard deviation. Because Microsoft Windows is the standard operating system in many countries worldwide, most teachers already own Microsoft Office, including Excel. Thus, when using the Excel software package, an important criterion should be that it is widely available. Despite these advantages, some scholars recommend the appropriate use of Excel in teaching statistics for several reasons. For example, they consider some Excel functions complicated, inappropriate, or inaccurate [9]. For example, in the general education schools of the Republic of Kazakhstan, students of the 11th grade, within the subject of beginning algebra and analysis, pass the chapter on basic concepts of mathematical statistics. In this chapter, the main and sample sets, the main statistical average values (sample interval, arithmetic mean, median, mode), discrete and interval frequency tables, statistical diagrams (frequency polygon, histogram), and numerical characteristics of discrete random variables are introduced in the chapter. The 11th-grade Algebra and Analysis Beginnings textbook has tasks and instructions for calculating these topics using the Excel spreadsheet [10, 11]. The following report is given in the textbook. The number of grains in a wheat ear obtained from a field without fertilizer application is given.

Based on these data, create a frequency table, calculate the slope, mode, median, and arithmetic mean, and create a frequency polygon and a histogram. First, we enter the data into a table (Figure 1) and create a frequency table (Figure 2).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2	**The number of grains in a wheat ear obtained from an unfertilized field**														
3	4	6	5	6	5	6	4	6	4	9	5	3	6	8	5
4	4	6	8	6	5	6	7	4	6	5	2	8	6	5	6
5	5	5	5	4	4	4	6	7	5	6	7	5	5	6	4
6	8	5	3	7	5	3	6	4	7	5	6	5	7	5	7
7	6	7	5	4	7	5	5	5	6	6	5	6	7	5	8
8	6	8	6	7	6	6	3	7	6	8	3	3	4	4	7
9	6	5	6	4	5	7	3	7	7	6	7	7	4	6	6
10	5	6	7	6	3	4	6	6	3	7	6	7	6	8	6
11	6	6	6	4	7	6	6	5	3	8	6	7	6	8	6
12	7	6	6	6	8	4	4	8	6	6	2	6	5	7	3

Figure 1. Entering data into an Excel spreadsheet

When creating a frequency table, you need functions to count and find the maximum and minimum values. Fundamental statistical mean values can be calculated using standard functions or formulas (Figure 2). To create a polygon of frequencies, we select a table of frequencies and draw a graph (Figure 3). To create a histogram, you must determine the number and length of intervals. After deciding these, we determine the frequency of each interval. Then, select intervals and frequencies and create a histogram (Figure 4).

15		**Frequency table of the number of grains in a wheat ear obtained from an unfertilized field**									
16	X	2	3	4	5	6	7	8	9		
17	n	2	11	19	29	51	25	12	1	Σ	150
18	w, %	1,3	7,3	12,7	19,3	34	16,7	8	0,7	Σ	100
19											
20											
21	**Basic statistical characteristics**										
22	Min	2									
23	Max	9									
24	Change	7									
25	AVG	5,627									
26	Mode	6									
27	Median	6									

Figure 2. Calculation of the table of frequencies and basic statistical values using Excel

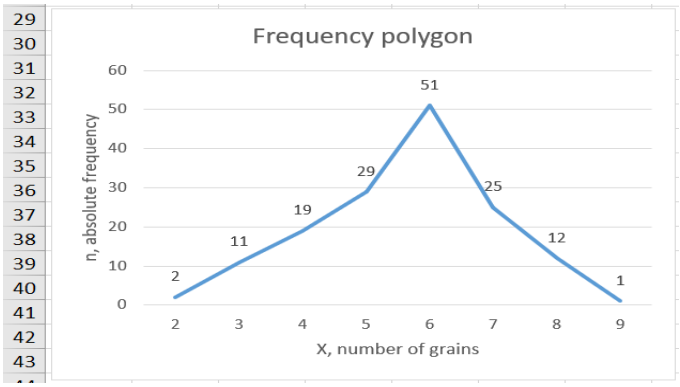

Figure 3. Building a frequency polygon using Excel

48	**Number of intervals**	≈	8						
49	**Interval length**		0,875						
50									
51	**Interval**	**[2;2,875)**	**[2,875;3,75)**	**[3,75;4,625)**	**[4,625;5,5)**	**[5,5;6,375)**	**[6,375;7,25)**	**[7,25;8,125)**	**[8,125;9)**
52	**Frequency**	2	11	19	29	51	25	12	1

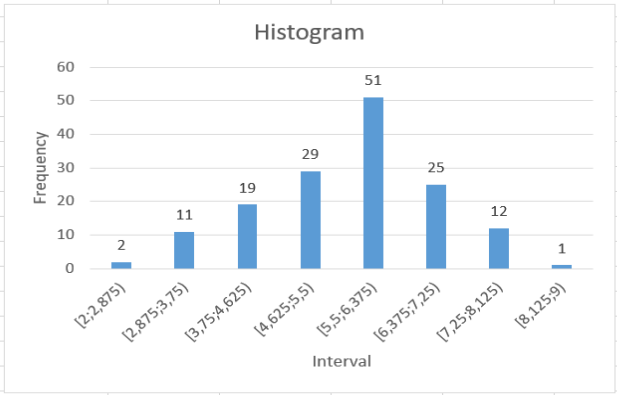

Figure 4. Building a histogram using Excel

Discussion

Within the framework of the study, basic information about Excel was provided. Details on using the Excel table processor in teaching statistics elements in the school mathematics course were presented. The advantages of using Excel over other statistical software packages have been identified. Most statistical software packages are not intended for educational use. Because of its popularity, accessibility, and simplicity, Excel helps teach statistics. Excel is used to teach statistics in school mathematics courses in many countries. It has been shown that all statistical problems at the school level can be solved using Excel.

An example of creating a frequency table, calculating fundamental statistical mean values, and creating a frequency polygon and histogram was shown using MS Excel. This study will help mathematics teachers teach the elements of statistics.

Conclusion

This work showed that the Excel software package can teach statistics elements in school mathematics courses. Researchers agree that using Excel spreadsheets to teach statistics elements helps students learn the subject easily. MS Excel has advantages over other digital tools in that it is affordable and relatively easy to use. The importance of using digital technologies such as Excel to teach the elements of statistics in school mathematics has been revealed.

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