Analysis of the Students' E-Test Data for Verification of Some Hypotheses

Zlatan Iliev, Todor Todorov, Adriana Borodzhieva, Irina Zheliazkova

Analysis of the Students' E-Test Data for Verification of Some Hypotheses: *The paper uses the collected students' e-test results for verification of five hypotheses about the normal distribution of correct, missing and wrong knowledge, performance time, and students' marks respectively.*

Key words: *Analysis, E-test Results, Normal Distribution, Hypotheses.*

INTRODUCTION

This paper continues the experimental study described in the previous paper [1]. The goal of the statistical analysis is to check if the collected students' sets, e.g. *CK* (correct knowledge), *MK* (missing knowledge), *WK* (wrong knowledge), Time, and *Mark* have normal distribution, as some educational researchers stated or expected. For this purpose the raw data set was brought in a table (Table 1).

Table 1 – Raw data set

Name and Family	Fac. N.	Time	CK	MK	W	Mark	Name and Family	Fac. N.	Time	CK	MK	WK	Mark
Pavel Ivanov	113222	00:51:40	**181**	60	46	5,64	Denitza Tzolovska	113299	01:55:57	**124**	117	79	3,90
Martin Aleksandrov	113189	00:27:09	**178**	63	55	5,59	Plamen Tzvetkov	113277	01:57:48	**123**	118	100	3,87
Ahmed Ahmedov	113230	01:09:58	**175**	66	44	5,55	Nesibe Isak	113288	01:47:22	**120**	121	59	3,77
Ivan Kirilov	113190	01:16:28	**174**	67	65	5,53	Dzihan Daud	113207	01:52:26	**118**	123	67	3,70
Vasil Kozov	113182	01:37:55	**172**	69	51	5,50	Vladimir Grigorov	113284	01:40:23	**117**	124	79	3,67
Svetoslav	113240	01:43:34	**169**	72	49	5,40	Benay Basriev	113269	01:59:14	**113**	128	85	3,53
Svetoslav	113191	01:27:44	**168**	73	74	5,37	Rolanda	113286	01:58:21	**112**	129	70	3,50
Verginiya Ivanova	093232	01:37:14	**164**	77	22	5,23	Cuneyt Kadir	113260	01:19:12	**110**	131	73	3,43
Ivan Todorov	113204	01:42:13	**164**	77	61	5,23	Marina Ivanova	113235	01:44:46	**110**	131	94	3,43
Svetoslav Angelov	113239	01:08:27	**162**	79	58	5,17	Liubomir Petrov	113231	01:25:12	**108**	133	122	3,37
Zeliha Hasanova	093222	01:28:02	**162**	79	19	5,17	Ilmaz Halmi	113281	01:53:54	**108**	133	112	3,37
Angel Atanasov	113203	01:41:15	**159**	82	67	5,07	Pavlin Peshkov	113221	01:31:38	**106**	135	37	3,30
Vasil Ivanov	113212	01:55:08	**159**	82	81	5,07	Samet Onur	113901	01:41:43	**105**	136	62	3,27
Georgi Georgiev	113186	00:47:19	**159**	82	33	5,07	Guleyman	113295	01:21:56	**102**	139	61	3,17
Petar Petrov	113184	00:31:38	**158**	83	89	5,03	Gabriela Marinova	113291	00:57:27	**100**	141	92	3,10
Konstantin	113187	00:52:26	**158**	83	90	5,03	Milcho Hekimov	113215	01:19:08	**100**	141	110	3,10
Borislav Mutev	113201	01:00:50	**154**	87	65	4,90	Martin Kaloev	113218	01:34:09	**100**	141	71	3,10
Ivan Ivanov	113252	01:40:07	**153**	89	56	4,87	Yashar Halil	113271	01:37:21	**100**	141	84	3,10
Ivan Koev	113205	01:34:27	**150**	91	67	4,77	Monika Moysova	113244	01:06:14	**97**	144	73	3,00
Zlatan Iliev	113234	01:45:36	**147**	94	73	4,67	Vladimir Voinov	113279	00:56:10	**84**	157	110	2,57
Gordan Petrov	113258	01:54:54	**147**	94	76	4,67	Georgi Nachev	113251	00:52:37	**83**	158	77	2,53
Martin Velikov	113219	01:31:53	**147**	94	74	4,67	Peter Krumov	113199	01:36:25	**134**	107	84	4,23
Nikolay Slavov	113253	01:29:58	**144**	97	53	4,57	Neli Liubenova	113246	01:21:22	**131**	110	67	4,13
Kaloyan	113202	01:09:56	**138**	10	74	4,37	Nikolay Najdenov	113225	01:19:30	**130**	111	78	4,10
Hristo Nikolov	113229	02:08:09	**138**	10	69	4,37	Yuliyan Dechev	113232	01:35:29	**130**	111	71	4,10
Ivo Yankov	113275	01:54:55	**138**	10	82	4,37	Tzvetoslav Tzakov	113233	02:09:02	**130**	111	76	4,10
Tzvetan Tzvetanov	113268	01:58:27	**137**	10	92	4,33	Margarit Georgiev	113195	01:42:08	**129**	112	79	4,07
Martin Dochev	113226	02:08:42	**137**	10	70	4,33	Victor Vladov	113259	01:36:44	**126**	115	73	3,97
Milan Pavlinov	113180	01:32:35	**134**	10	94	4,23							

STATGRAPHICS [5] was used as a tool for verification of hypotheses about normal distribution of students' data set. This commercial tool is powerful; it serves for statistical modeling, data analysis and visualization through tables, formulas, and graphics. In addition it has an intuitive user interface.

VERIFICATION OF HYPOTESES ABOUT THE NORMAL DISTRIBUTION

Students' correct knowledge: The values of input parameters for *STATGRAPHICS* are: 57 values of the students' *CK* ranging from 83,0 to181,0; number of intervals 11, and fitted normal distribution. The values of the calculated parameters of the dispersion analysis are: *mean* = 134,667; *standard deviation* = 25,9087. The values calculated for checking the hypothesis of *CK* normal distribution are: *Chi-Square* = 9,43585; *degree of freedom* = 9, and maximum degree of variability *P-Value* = 0,398052. Having in mind the range of the variable and the standard deviation value it can be concluded that the scatter will be small and the maximum of the values will occur symmetrically at the central tendency. The histogram together with the normal distribution for the students' *CK* is shown in Fig. 1. It is clearly seen that the histogram is close to the normal distribution. The values of output parameters (*Chi-Square* and *P-value*) confirm this null hypothesis.

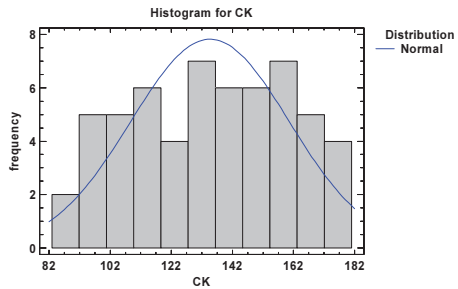

Fig. 1 – Histogram and normal distribution of the students' CK

Students' missing knowledge: The values of the input parameters for *STATGRAPHICS* are: 57 values of the students' *MK* ranging from 60,0 to 158,0; number of intervals – 11, and fitted distribution normal. The values of the calculated parameters of the dispersion analysis are: *mean* = 106,351; *standard deviation* = 25,8964. The values calculated for checking the hypothesis of *MK* normal distribution are: *Chi-Square* = 9,44451; *degree of freedom* = 9, and maximum degree of variability *P-Value* = 0,397242. Having in mind the range of the variable and the standard deviation value it can be concluded that the scatter will be small and the maximum of the values will occur symmetrically at the central tendency. The histogram together with the normal distribution of the students' *MK* is shown on Fig. 2. It is clearly seen that the histogram is close to the normal distribution. The values of output parameters (*Chi-Square* and *P-value*) confirm this null hypothesis.

Students' wrong knowledge: The values of the input parameters for *STATGRAPHICS* are: 57 values of the students' *WK* ranging from 19,0 to 122,0; number of intervals = 11. The values of the calculated parameters of the dispersion analysis are: *mean* = 71,8246; *standard deviation* = 20,4242. The values calculated for checking the hypothesis of *WK* normal distribution are: *Chi-Square* = 6,76705; *degree of freedom* = 6; maximum degree of variability *P-Value* = 0,342929. Having in mind the range of the variable and the standard deviation value it can be concluded that the scatter will be small and the maximum of the values will occur symmetrically at the central tendency. The histogram together with the normal distribution of the student's *WK* is shown in Fig. 3. As the value of *Chi-Square* and degree of freedom are smaller in comparison with the same

parameters for *CK* and *MK* the approximation of the students' *WK* to the normal distribution is better.

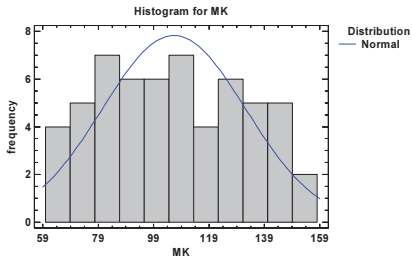

Fig. 2 – Histogram and normal distribution of the students' MK

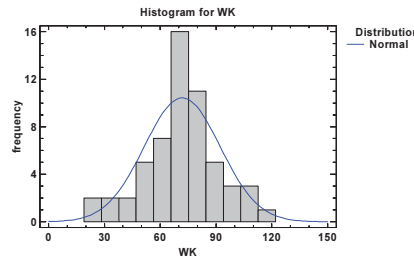

Fig. 3 – Histogram and normal distribution of the students' WK

Time of students' performance: The histogram together with the normal distribution of the students' time of performance is shown in Fig. 4. The values of the input parameters for *STATGRAPHICS* are: 57 values of the students' time of performance ranging from 27,15 to 129,033 (in minutes); number of intervals = 10. The values of the calculated parameters of the dispersion analysis are: *mean* = 90,3909; *standard deviation* = 24,2006. The values calculated for checking the hypothesis of the students' time of performance normal distribution are: *Chi-Square* = 9,18859; *degree of freedom* = 6; maximum degree of variability *P-Value* = 0,163247. The null hypothesis is confirmed, i.e. time of performance is close to the normal distribution and its maximal value of this parameter close to the time planned by the test author.

Students' marks: The histogram together with the normal distribution of the students' marks is shown in Fig. 5. The values of the input parameters for *STATGRAPHICS* are: 57 values of the students' marks ranging from 2,53 to 5,64; number of intervals = 14. The values of the calculated parameters of the dispersion analysis are: *mean* = 4,25; *standard deviation* = 0,8533. The values calculated for checking the hypothesis of the students' marks' normal distribution are: *Chi-Square* = 15,8643; *degree of freedom* = 10; maximum degree of variability *P-Value* = 0,103585.

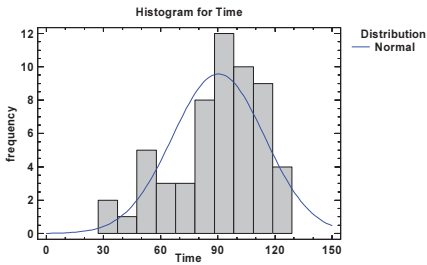

Fig. 4 – Histogram and normal distribution of the time of students' performance

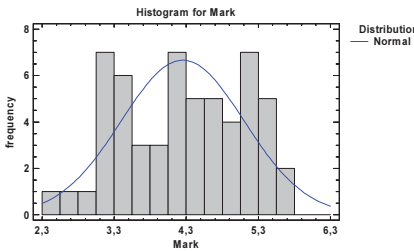

Fig. 5 – Histogram and normal distribution of the students' marks

As the value of *Chi-Square* and degree of freedom are bigger in comparison to the same parameters for *CK*, *MK* and *WK* the approximation of the students' marks to the normal distribution is not so close. This inference can be explained at least with three reasons: (1) The linear one-factor model, accepted for the students' *Mark*, takes into account only *CK*. A good human teacher considers also some additional factors, for

example *MK*, *WK* and Time. (2) The coefficients 4.0; 0.55; 0.70; 0.85; 1.00 of the non-linear assessment scale are determinated experimentally. (3) A traditional course also includes other students' activities, e.g. practical exercises, course work, workshops, and projects, each with a separate mark. The final course mark presents a weighted model of all these marks [3, 4].

Representative sample size: Under the desired 95% level of confidence, level of precision equal to ±5% the calculated value of $n = 49{,}89 \approx 50$. Therefore, 57 > 50 students were enough for the representative sample size.

CONCLUSION

Through a natural experiment the students' correct, missing, and wrong knowledge, performance time, and marks were measured by means of a non-commercial intelligent and adaptive e-testing environment. As it is expected the five hypotheses about the normal distribution of the above-mentioned variables are close to the normal distribution. In increasing order of χ^2, (e.g close to the normal distribution) are: *WK*, *CK*, *MK*, *Time*, and *Mark*. The approximation of *WK* to the normal distribution is the best, while of the *Mark* is not so normal. This comparison confirms some results obtained from previous experimental studies of Zheliazkova's research group, as well as of other researchers [2]. It is important for the classical didactic test theory often considered only multi choice test questions.

To improve the mark distribution the author's team is intended to embed new multi-factors models in the testing environment, including also the students' *MK*, *WK*, and *Time* or to differ their combinations. On one hand, that will increase the degree of adaptation the testing environment to the teachers' preferences. On the other hand, the belief and reliable work of the users, e.g. teachers and students in the testing environment will increase the number of subjects too.

ЛИТЕРАТУРА

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The paper has been reviewed.