VERIFICATION OF NEW ELECTRONIC TECHNICAL TEXTBOOKS IN THE CURRENT SCHOOL

[a]ĽUBOMÍR ŽÁČOK, [b]MILAN BERNÁT, [c]RENÁTA BERNÁTOVÁ

[a]Matej Bel University in Banská Bystrica, Faculty of Natural Sciences, Department of Technology, Tajovského 40, 974 01, Banská Bystrica, Slovakia
[b]University of Prešov in Prešov, Faculty of Humanities and Natural Sciences, Department of Technology, Ul. 17. Novembra 1, 081 16, Prešov, Slovakia
[c]University of Prešov, Faculty of Education, Department of Natural Sciences and Technological Disciplines, Ul. 17. Novembra 15, 080 01, Prešov, Slovakia

email: [a]lubomir.zacok@umb.sk, [b]milan.bernat@unipo.sk, [c]renata.bernatova@unipo.sk

The scientific study was written as a part of the project VEGA 1/0147/19 Research degree of correlation between knowledge and skills to solve technical problems in vocational and technical education.

Abstract: In the Slovak Republic, there are still no textbooks for technical education in lower secondary education. The authors work on creating modern electronic and multimedia textbooks. In the scientific study, the problem of verifying the new electronic textbook for technical subjects in primary school is being solved. Textbooks are important in the educational process. Before the introduction of the electronic textbook into practice, the authors decided to scientifically verify the electronic textbook in practice. In the first part of the article, they describe the characteristics of the textbook. Another part of the study is devoted to setting research hypotheses. Subsequently, the hypotheses were verified in practice. We have found that our electronic textbook has its meaning in practice. The pupils who worked with her achieved higher achievements. Differences between pupils in the control and experimental groups were also statistically significant. The differences were statistically significant at all three levels of learning according to Niemierkos taxonomy of educational objectives. This is an important finding in our research process. We can state that a quality and scientifically valid textbook will contribute to the effective teaching of technology in the Slovak Republic.

Keywords: electronic textbook, pupils, education, technology, school

1 Introduction

The content of the subject matter is enriched by information connected to the relation of man to work, with the need to acquire basic work skills and habits in different work areas. Education in this area is heading towards creating and developing key competencies of students by leading them to objective learning of their surroundings, to the needed self-confidence, to a new attitude and values in relation to work of man, to technology and to the environment. Goals of technical education at elementary schools include cognitive, affective and psychomotor areas which need to be developed proportionally. Teachers in the educational process manage both technical and professional facts and make students acquainted with them. To reach the goal, they use appropriate teaching aids, both traditional and modern, as necessary (Askerud, 1998). The information age has brought ICT technologies to the educational process, and they are opening new dimensions for it. Computer-aided instruction may change the traditional form of education from passive acquisition of information into an active discovery. Teachers cease to be only intermediaries of knowledge, but they become managers of the cognitive process of their students. Education using new forms with the help of ICT was relevant mainly to universities, which have a modern information infrastructure with a quick access to the Internet. Both secondary and elementary schools are beginning to use this type of education increasingly more. Literary teaching aids prepared in an electronic form represent an important element of the system of teaching aids. They represent a basic source of information which contains didactically compiled subject matter delimited by the curricula, prepared in line with didactic principles. The aim of our scientific study is to briefly characterize the process of developing an electronic textbook for the "Technology" subject for the fifth grade in lower secondary education. We have also included outcomes of the performed pedagogical experiment focused on verification of an electronic textbook named "Technology for the 5th Grade of Elementary Schools".

2 Brief characteristics of the electronic textbook and of electronic texts

The electronic textbook has its place in the system of literary teaching aids (Žáčok, 2016). Electronic text is an ordered set of understandable signs and format information capturing a string of ideas of its author. It is also very easy to transform electronic texts formally; during such transformation the sign system changes, but the content does not. Sign systems used by humans in the form of a text, image, sound and other combinations are automatically transformed into a digital system both when being saved in the computer and when exiting the computer. Data may then be transferred easily and at high speeds from one medium to another (e.g. from a hard disk to a CD-ROM or a Flash disk). Programmes enabling easy automatic content transformation are gradually developed, e.g. different kinds of text condensation with minimum information losses. Interactivity is demonstrated not only in the possibility of automatic search for text strings but also in the fact that each reader can work with a document based on the status of their knowledge basis and the choice of process alternatives and the reader has e.g. a possibility to communicate with the author. In addition, a full text method (full text, natural language processing) may be used in digitalized texts. Artificial intelligence may be used to recognize objects in digitalized images, etc.(e.g. when recognizing objects in aviation images). Electronic textbooks are characterized by easy and flexible manipulation with data and their files saved in the computer, what is demonstrated in any structuring or restructuring a text, image or a musical work (Bloor,1992). Contrary to traditional texts which worked with one type of data at a time, electronic texts enable to combine text, visual and acoustic data or video sequences and their simultaneous viewing in one device.

3 Methodology of Research

When dealing with the topic of the scientific study, the goal of the authors was to characterize the reasons for developing and the importance of textbooks in technical education at elementary schools. In the empirical part, the authors are focused on the researched topic "To what extent the developed and applied electronic textbook effects students when performing better in the cognitive and psychomotor areas". The authors have opted for corresponding methods to help them achieve the set objective. Main methods applied during review of expert and scientific studies included analysing the acquired knowledge and the development tendencies in the education system. In a pedagogic experiment we compared groups of students. In one group of students, instruction was carried out using traditional methods, and in another group of students, the instruction was carried out using a developed electronic textbook. A non-standardized didactic test was used to compare performances of the students. We have designed the didactic test according to Turek (1995). We have also discovered that the outcomes (performances of students) in the control and in the experimental groups are different and statistically significant.

We were trying to find out the extent in which the new Technology textbook will help 5th grade students or influence the degree of their acquired knowledge. Instruction in a control group (C) was carried out in a traditional manner (students did not work with the new textbook) and students in an experimental group (E) worked with the new textbook. After the end of instruction in the control and in the experimental groups we used a didactic test for both groups at the end of the natural pedagogical experiment. The didactic test was intended for 5th grade students at elementary schools. The didactic test was a non-standardized continuous NR test. We established the following hypotheses:

H_0: Results achieved in the non-standardized didactic test will be equal in the control and in the experimental groups.
H_1 : As a result of instruction with the new textbook, respondents of the experimental group will perform better in the cognitive

area compared to the control group where instruction will be carried out using traditional methods without the new electronic textbook.

$H_{1.1}$: We suppose that as a result of instruction with the new textbook, students of the experimental group will perform better in the "remembering" learning level compared to the control group students where instruction will be carried out without the new electronic textbook.

$H_{1.2}$: We suppose that as a result of instruction with the new electronic textbook, students of the experimental group will perform better in the "understanding" learning level compared to the control group students where instruction will be carried out without the new electronic textbook.

$H_{1.3}$: We suppose that as a result of instruction with the new electronic textbook, students of the experimental group will perform better in the "specific transfer" learning level compared to the control group students where instruction will be carried out without the new electronic textbook.

The researched sample was composed of 5th grade students of elementary schools. We researched 1 control group consisting of 300 students and 1 experimental group consisting of 300 students. The control and experimental groups represented a sample with 600 students. A basic set included 40 elementary schools from all eight regions in the Slovak Republic. (By drawing lots) we randomly chose 16 (two schools from each region) elementary schools where the pedagogical experiment was being carried out. Students were randomly (by drawing lots) divided into two groups - an experimental and a control group. The control and the experimental groups were equal in terms of the number and the gender of students. The pedagogical experiment was conducted in the 5th grade of elementary schools, while none of the students had repeated any previous grade and the students were of almost the same age.

We focused on the structure of a non-standardized didactic test. We used a cognitive didactic Technology test (hereinafter referred to as "DT") for the 5th grade of elementary schools.

As a second step we delimited a rough content of the DT. The rough content of our DT is as follows:

- Man and technology;
- Man an production in practice;
- Utility and gift objects.

When preparing the non-standardized didactic test we followed Turek´s principles (1995). Our aim was that the didactic test covers the inspected subject matter in an even and representative manner, i.e. to achieve the highest content validity of the DT. We analysed specific goals. In our case specific goals are subordinated to general educational goals and they respect acquisition of key competencies of 5th grade students in Technology. We prepared a specification table (Table 1). The specification table determines the content on which the tasks of the DT should focus, their numbers and levels of acquisition of knowledge according to Niemierko's taxonomy of educational goals.

Table 1: DT specification table

Sequence number	Topics	Number of tasks for:		
		remembering	understanding	specific transfer
1.	Man and technology	1	2	0
2.	Professions of craftsmen in the past and at present	1	1	0
3.	Product, creation of a simple product	1	1	1
4.	Sketch of a simple product	0	0	1
5.	Technical materials and tools for product manufacturing	1	0	0
TOTAL		4	4	2

In the step IV, we determined the form of DT tasks. We prepared both open and closed tasks for the DT. We prepared open (production and fill-in) tasks with brief answers. Closed tasks were mainly matching tasks and tasks with selection of correct answers. We proposed different tasks in our DT. When formulating them, we used the following pedagogic documents: textbook, national and school educational programme and written preparations for instruction units. We designed a bank of tasks for the DT, from which we chose 10 tasks for the DT. We opted for a 10-minute test duration. Students had the least time for tasks where correct answers were to be selected. Tasks in which students were adding (creating) answers were more time-consuming. For these tasks, we increased the necessary test time to 1-2 minutes. We prepared two variants of DT tasks with different sequences of the tasks. We assigned weights of significance to the tasks, which may be seen in the Table 2.

Table 2: Weighing DT tasks

Learning level	*Remembering*	*Understanding*	*Specific transfer*	*Non-specific transfer*
Weight of significance	1	2	3	4
Task No.	1,4,9,10	2,3,5,6	7,8	-

Since our DT contained fewer than 20 tasks, we proposed a comprehensive scoring of tasks in the DT. The Table 3 contains a detailed analysis of DT scoring.

Table 3: DT scoring

Task	Number of /scored/ points	Description
1	0.5	0.5 point for the correct answer.
2	1	1 point for the correct answer.
3	1	1 point for the correct answer.
4	0.5	0.5 point for the correct answer.
5	4	0.5 point for each correct answer, max: 4 points.
6	2	1 point for correctly matching the answer, max: 2 points.
7	3	1 point for each correct answer, max: 3 points.

8	3	Max. 3 points for drawing a correct sketch.
9	0.5	0.5 point for the correct answer.
10	0.5	0.5 point for the correct answer.

DT tasks are assigned weights of significance because not all tasks are always equal. It is always more valuable to understand something than only to remember it, and it is even more valuable to be able to apply what has been learnt than to understand it. We consider such differences when allocating the weights of significance. Tasks in the DT, in our case prepared based on 3 levels of acquisition of subject matter, which are solved only by remembering something, have been assigned the weight of significance 1, tasks with understanding have received the weight 2, and tasks focused on a specific transfer have been given the weight 3.

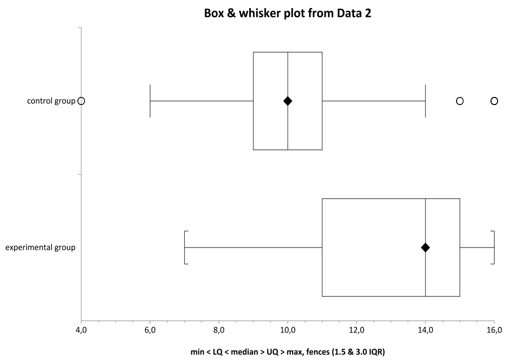
4 Statistical Verification of Research Hypotheses and Results of Research

We wished to know the performances of students in the didactic test. If they filled in the 5th grade didactic test correctly, 5th grade students could be awarded the highest gross score (GS) of 16 points. It is obvious from the descriptive statistics (Table 4) that 5th grade students of the experimental group mastered the subject matter more successfully than students of the control group. The calculated arithmetic average and the standard deviation were calculated in the reliability interval: lower interval: -95%, upper interval +95%. We may conclude from the average acquired from the measured researched sample that the calculated arithmetic mean for the experimental group is from the measurement reliability interval of 12.41 to 13.00, and for the control group, it is from the measurement reliability interval of 9.85 to 10.36. We have also found out that deviations of values from means are not so high, so we may state that the arithmetic means are more valid. The variation range is from 4 (minimum value) to 16 (maximum value). The Table 4 shows that the minimum score awarded in the didactic tests for the 5th grade was 4 points and the maximum score was 16 points. The median calculated for the control group was 10 and for the experimental group 14. That is to say, half of students in the control group scored ≤ 10 points in the DT, and the other half of students scored ≥ 10 points in the DT. In the experimental group, a half of students scored ≤ 14 points in the DT, and the other half of students scored ≥ 14 points in the DT. Based on the descriptive statistics, we may also state that the sharpness coefficient is not equal to zero, and we therefore conclude that the distribution of values is sharper (asymmetric) than the standard distribution of values.

Table 4: Basic (descriptive) statistics

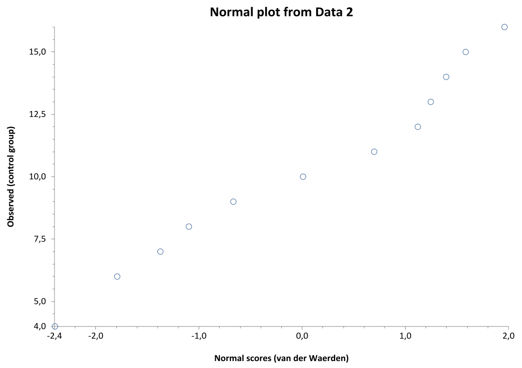
Variables	control group	experimental group
Valid data	300	300
Missing data	0	0
Sum	3,032	3,812
Mean	10.106667	12.706667
Variance	5.145775	6.789922
Standard deviation	2.26843	2.605748
Variance coefficient	0.224449	0.205069
Standard error of mean	0.130968	0.150443
Upper 95% CL of mean	10.364402	13.002728
Lower 95% CL of mean	9.848931	12.410606
Geometric mean	9.847348	12.413884
Skewness	0.506633	-0.396087
Kurtosis	4.27024	2.092984
Maximum	16	16
Upper quartile	11	15
Median	10	14
Lower quartile	9	11
Interquartile range	2	4
Minimum	4	7
Range	12	9
Centile 95	15	16

We may also see in graph 1 that the results achieved in the experimental group were better than in the control group. It is obvious from Fig. 1 that the mean value of the set is equal to 10 in the control group and to 14 in the experimental group. The median is the mean value which divides a relevant sequence of values into two approximately identical halves. In the case of systemic division of values, the median is equal to the mean. In our case, we have found out that the calculated arithmetic mean and the median are not equal. We have measured a higher deviation of the median from the mean in the experimental group. The quartile range represents the area of mean 50% of values of the variables, i.e. from 6 to 14 in the control group and from 7 to 16 in the experimental group. That is to say, it represents a difference between the third and the first quartile (75th and 25th percentile). The quartile range is important for determining the so-called outliers. In our case, we have found out that there are few outliers beyond the (quartile range) interval in the researched set.

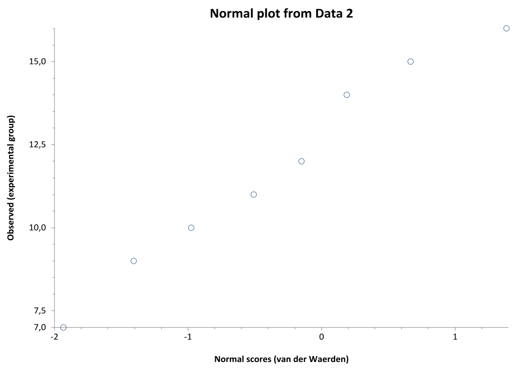


Graph 1: Median, quartile and variation range of the variables from the exit test in the 5th grade

We analysed the values to find out if such outcomes are statistically significant. To be able to choose a correct analysis of values, we had to examine the assumption of standard distribution of likelihood of random errors first. We examined the assumption of standard distribution of likelihood of random errors using normality charts (Graph 2, Graph 3) and also by comparing variances of basic sets. The charts (Graph 2, Fig. 3) are not clearly symmetric, and the calculated variances are not equal either. The residuum is the difference between an actual and an estimated value. In our case, residua have no standard distribution because the residua normality chart did *not form a line*, or, in other words, the form of standard likelihood charts is not acceptable (Graph 2, Graph 3). Graph 2 and graph 3 indicate that the assumption of standard distribution of the basic set was not correct.



Graph. 2 Assessing the normality of accidental errors – chart of normality of residues in the control group



Graph 3: Assessing the normality of accidental errors – chart of normality of residues in the experimental group

Based on the discovered facts we decided to use a non-parametric Kruskal–Wallis test to find out the existence of statistically significant differences between the control and the experimental groups (Chajdiak & Rublíková, 1994).

Since we compared the results of students from the control and the experimental groups, we are verifying the validity of the zero hypothesis by analysing the variance (using a non-parametric test, more particularly). We compared the results on the significance level of $\alpha=0.05$. The significance level is an expected likelihood of rejecting the zero hypothesis which we have determined before. In our case, the p value (calculated value) is the lowest likelihood for rejecting the zero hypothesis determined based on results of selective finding. Therefore, we identify the two values with different symbols. The way how we may decide about the test result is to compare the p value and the α significance level. The following rule applies (Chajdiak, 1994):

For the particular α significance level:

1. we are rejecting the zero hypothesis if $\alpha \geq$ p value.
2. we are accepting the zero hypothesis if $\alpha <$ p value.

This form of testing is the fastest and the most comfortable if we have a computer available because most statistical programme systems calculate the p value. In this case, it is enough if we compare the p value with the α significance level which we have determined, and we may decide about the test result very quickly and simply (Meyer & Seaman, 2014).

The below-stated text contains a calculation and a finding if there are statistically significant differences in performances of students of the control and the experimental groups and also in performances of students of the control and the experimental groups at the remembering, understanding and specific transfer learning levels.

Table 5: Kruskal–Wallis test (total performances of students)

Variables: control group, experimental group
Groups=2
df=1
total observations = 600
T = 135.169201
P<0.0001
Adjusted for ties:
T = 135.111137
P < 0.0001

In our case, the measured p value is the lowest likelihood for rejecting the zero hypothesis determined based on results of selective finding. In our case, the calculated p value (Table 5) is lower than the α value (0.05). The test statistics is in the area of rejecting the zero hypothesis. We are therefore rejecting the zero hypothesis and concluding that the achieved results are statistically significant in favour of the experimental group. Such finding is significant at the α significance level of 0.05 (95%). To conclude, we may express significance of the H_1 hypothesis, i.e. the H_1 hypothesis has been proved correct with the significance level α of 0.05 (95%).

Table 6: Kruskal–Wallis test (performances of students at the "remembering" learning level)

Variables: control group, experimental group (understanding)
Groups=2
df=1
total observations = 600
T = 36.473363
P<0.0001
Adjusted for ties:
T = 37.802138
P < 0.0001

We were also finding out if there are statistically significant differences between the control and the experimental groups at the remembering learning level. The calculated p value (Tables 6) is smaller than the α value. We may state that the achieved results are statistically significant in favour of the experimental group at the remembering learning level. Such finding is significant at the α significance level of 0.05 (95%). The $H_{1.1}$ hypotheses have been proved correct.

Table 7: Kruskal–Wallis test (performances of students at the "understanding" learning level)

Variables: control group, experimental group (remembering)
Groups=2
df=1
total observations = 600
T = 34.756023
P<0.0001
T = 37.040276
P < 0.0001

We were also finding out if there are statistically significant differences between the control and the experimental groups at the understanding learning level. The calculated p value (Tables 7) is smaller than the α value. We may state that the achieved results are statistically significant in favour of the experimental group at the understanding learning level. Such finding is significant at the α significance level of 0.05 (95%). The $H_{1.2}$ hypotheses have been proved correct.

Table 8: Kruskal–Wallis test (performances of students at the "specific transfer" learning level)

Variables: control group, experimental group (spec. transfer)
Groups=2
df=1
total observations = 600
T = 92.974445
P<0.0001
Adjusted for ties:
T = 96.583817
P < 0.0001

We were also finding out if there are statistically significant differences between the control and the experimental groups at the specific transfer learning levels. The calculated p value (Tables 8) is smaller than the α value. We may state that the achieved results are statistically significant in favour of the experimental group at the specific transfer learning level. Such finding is significant at the α significance level of 0.05 (95%). The $H_{1.3}$ hypotheses have been proved correct.

5 Discussion

From 1 September 2015, innovated state educational programmes started to apply in the regional school system in lower secondary education. The "Technology" subject was also affected by the changes. Since textbooks for the "Technology" subject are still in short supply at elementary schools, we have decided to write an electronic textbook for students of the 5th grade at elementary schools as a part of the project. The electronic textbook named "Technology for the 5th Grade of Elementary Schools" is divided into three areas. The content of each area is composed of basic and extended subject matter. There are revision tasks at the end of each area. The textbook contains also projects which students deal with directly during school lessons or as a part of the assigned homework (Němec & Krišťák, 2017). A correctly developed electronic textbook gives students a free and easy access to information they need. When developing the electronic textbook, we met the below-stated requirements:

- understandability – the didactic text must be comprehensible;
- language correctness – all texts written by us are clear, professional, grammatically and stylistically correct and apposite;
- high creative and graphic level – from the creative and graphic point of view, our texts are appealing and they enhance the aesthetic sense of students;
- ergonomic requirements – the text and illustrations are designed in such a way that students find their bearings easily in the electronic textbook.

6 Conclusion

In general, we may state that textbooks or literary teaching aids have had their justified place in technical education in the current school system. Literary teaching aids are intended for students. Teachers use different sources of information to prepare for lessons, e.g. technical literature. Nowadays electronic textbooks and other electronic texts used in the educational process are very important, particularly thanks to several above-mentioned advantages. In our scientific study we have pointed out to the options of developing and preparing an electronic textbook for the "Technology" subject. Technology has its future in the educational process. The "Technology" subject included in lower secondary education develops not only students' knowledge but also skills which are very important and needed for young people to find jobs in the modern information society.

Literature:

1. ASKERUD, P.: *A Guide to Sustainable Book Provision*.Paris,1998 UNESCO.
2. BLOOR et al.: A hypertext systememployment related language to hearing – impaired school leavers. *Computer & Education, 18(1),1992, p.* 201–208.
3. CROPLAY, A. J.: *Creativity in Education and Learning.* London, Kogan Page, 2001, 15(2), 123-126.
3. CHAJDIAK, J., RUBLÍKOVÁ, E., GUDÁBA, M.: *Štatistické metódy v praxi*. Bratislava: STATIS, 1994, 18(3), p. 152-155.
4. HOCKICKO, P., KRIŠŤÁK, Ľ., NĚMEC, M.: Development of student´sconceptual thinking by means of video analysisandinteractive simulations at technical universities. *European Journal of Engineering Education, 2015, 40(2*), p. 145-166.
5. KRIŠŤÁK, Ľ., NĚMEC, M., Danihelová, Z.: Interactive methods of teaching physics at technical universities. *Informatics in Education,2014, 13(1)*, 51-71.
6. NĚMEC, M., KRIŠŤÁK, Ľ., HOCKICKO, P., DANIHELOVÁ, Z., VELMOVSKÁ, K.: Application of innovative P&E method at technical universities in Slovakia. *EURASIA Journal of Mathematics, Science and Technology Education, 2017, 13(6)*, 131-136.
7. MEYER, J. P., SEMAN, M. A.: A comparison of the exact Kruskal-Wallis distribution to asymptotic approximations for all sample sizes up to 1. *Journal of Experimental Education, 2014, 81(2)*, 139–156.
8. TUREK, I.: Kapitoly z didaktiky. Bratislava: Metodické centrum Bratislava, 1995, 12(1), 158-161.
9. ŽÁČOK, Ľ.: *Technika a pracovný zošit pre 5. ročník základnej školy*. Banská Bystrica:2016, Belianum.

Primary Paper Section: A

Secondary Paper Section: AM