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COEFFICIENTS OF LEARNING IN MATHEMATICAL AND NONMATHEMATICAL SUBJECT MATTER

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Abstract. Ćoefficient to remember something"was introduced in cybernetic pedagogy. This coefficient expresses what part of information (from group of letters arranged without meaning) a learner is able to remember after one repetition. He can remember about 1/23 (4,34%) received information. We have derived ćoefficient of learning". Its values are greater, because understandable learning (we mean it) is more effectively than memory learning. We used this coefficient as expression of improvement of soft motive hand. Its value was about 6%. We found out it in ten pictures arranged chronologically during 4 months. We valued subject matter pretension by ćoefficient of understanding". We found out what children could understand subject matter with one repetition. Similarly ćoefficient of disclosing"was introduced for revealing of coherence reading of picture. It was 38% after the first experiment. It means that this number of children revealed coherence in the picture. It is possible to value subject matter pretension effectively and briefly according to introduced coefficients in standard class. On the other hand it is possible to value knowledge level of pupils by using standard subject matter.

1. Introduction

Many of appreciated sciences at present have become sciences due to mathematics and its tools, which enable us to express values of observed phenomena by numbers and according it to formulate law. A law is a valid statement in generally according exactly determined conditions. Even measurement and quantity of conditions is important, too. It enables us to express a law in form of function. All input conditions occur on its admission and result is represented by number as an output. It is consequence of admissible conditions.

These laws are taught incorrectly sometimes. Maybe the reason is that they have been already expressed incorrectly in textbooks or they have been taught incorrectly from time immemorial. I remember one school experiment. We warmed water in a vessel and measured time. We found out temperature of water equably grew above constant flame in dependence on time. It was a law, so our different measured values were żounded offąnd it was in harmony.

Really it was not true. Water had certain temperature in the beginning of measurement, for example 12^0 C and value was near 100^0 C later. If we take into consideration law about lead of warm, we find out that amount of warm led away from one body into other body depends on difference between temperatures of warmer and cooler. We neglected this difference of temperatures. Amount of warm delivered to water (for unit of time) in the beginning of warm was higher than at the end of warm, because exchange was made during higher difference of temperatures. Theoretical line of warm becomes a curve. It comes near to temperature of warm very slowly at small difference of temperatures. Then line and curve becomes tangents. Getting cool is similar process.

2. Comparison curve of forgetfulness and getting cool, warm and learning

A curve of getting cool passes very similarly as known curve of forgetfulness. A curve of warm resembles to curve of memory learning [1, 2005] very much. It seems that reason of the shapes of these curves causes diminution of differences between "temperature of mediumąnd "finish temperature". On the other hand difference between "mastering of subject matterąnd śubject matter that should be learnt"(aimed subject matter) makes smaller.

Value of learning coefficient $k = 0,043$ ($K = 4,3\%$) was measured during memory learning. It means a pupil could remember about 1/23 of subject matter after one repetition.

If amount of unlearnt subject matter became smaller, the respondents remembered about 1/23 from smaller amount of subject matter. Research was carried out the way that the respondents learnt about groups of letters without their meaning by heart [2, 1996]. If we draw "ignorance"in graph, the curve declines gentle to axis x - there is zero ignorance on it. When the respondents learnt the groups of letters with meaning, the coefficient of learning (memory) was much higher. Analogy thinking and episodic memory had there own part.

3. Coefficient and graph of understanding subject matter – ideal graph

If pupil understands subject matter, it is a manifestation of intelligibility and subject matter convenience to age. All pupils do not understand the whole subject matter for the first time. The process of understanding - ideal graph marks that every other repeating (explaining) of subject matter was understood approximately by equal proportionate part of pupils who did not understand to subject matter yet. We introduce 128 pupils and coefficient of understanding $k = 0,5$ as an example of ideal graph. Numbers of pupils who did not understand subject matter after every other explaining make a sequence {128; 64; 32; 16; 8; 4; 2; 1}. It is a geometrical sequence $a_{i+1} = k \cdot a_i$ with coefficient $k = 0,5$. Its graph declines to axis x and becomes tangent of graph for large ones. Steepness of curve depends on greatness of coefficient k.

4. Understanding subject matter – research

Research sample was created by 126 pre-schoolers (from kindergartens and zero classes at elementary school). We chose subject matter: explaining of notions "bigąnd śmall". Numbers of pupils and coefficients of understanding created next sequence {126; 75; 32; 13; 3; 2} after every repeating during learning. We counted coefficient of understanding k after every repeating. The values were {0,60; 0,63; 0,68; 0,50; 0,33}.

Investigated sample of pupils - pre-schoolers is characteristic by higher value about understanding of subject matter than "idealśtate with coefficient $k = 0,5$. We regard subject matter easy understandable according shape of curve and weight average of coefficient about understanding. Curve shape about understanding of notions approaches "idealśhape of learning curve. (Average deviation is 15,7%, weighted average deviation is 4,1%.)

5. Improvement of soft motive hand

We chose research sample of 30 pupils - pre-schoolers and 10 pictures which were painted by pupils chronologically during 4 months and we measured the third longest óverstep"**P** in millimetres. The children painted outlined pictures in workbook for pre-schoolers "Bude škola 1"(watering-can, frog, high boot, ..., hare). We counted values of the third longest óverstepóf all children. Then we found out sequence which uncovered improvement of soft motive hand focused on its punctuality. The sequence was {120; 108; 104; 93; 89; 84; 79; 80; 78; 70}.

Average punctuality P was improved about (120–70). 100/120 = **41,7%** during experiment in 4 months. Improvement between two next pictures had

average value $k = 0,046$, it is only a little better than coefficient of memory learning. Anomaly in graph was created during painting of the 8^{th} picture and its surroundings. We awaited equable improvement here, but results made worse. The coefficient of learning had negative value there. Value of coefficient "k- improvement between two neighbouring pictures had following values {0,10; 0,037; 0,106; 0,044; 0,056; 0,059; -0,01; 0,025; 0,1025}. Shape of graph is not linear so we can expect smaller absolute value of improvement of soft motive hand at equal average coefficient of improvement in next four months.

6. Disclosure of situation in the picture

219 children took part in experiment. They had two pictures with educational situation. They were to uncover "Why is a figure (coloured pencil) sad?ón the 1^{st} picture. They disclosed that the coloured pencil hurt its finger. The car stopped rapidly in front of the pedestrian crossing on the 2^{nd} picture. The children were to uncover what happened and why. They disclosed snake's right of way. The teachers and parents who investigated these picture situations with children were instructed about to must not betray true answer. The number of pupils changed during 3 possibilities of disclosure of notions as follows {all pupils 219; rest after 1^{st} disclosure 135; rest after 2^{nd} disclosure 87; rest after 3^{rd} disclosure 60}. Coefficient values of disclosure were $k \in \{0,38; 0,36; 0,31\}$. Average coefficient value of disclosure was approximately $k = 0,35$. It means that wanted notion was disclosed by approximately 35% of children from the group of children who did not uncover this notion yet during one observation of picture. (Average deviation is 7,6%, weighted average deviation is 6,9%).

7. Summary

According observation of shape about physical processes the hypothesis was created about similar shape of learning process, too. It was attested reliably at memory learning. The expectation of similar shape of other mental processes was (approximately) attested (in small sample) during measurement of improvement of soft motive hand in week intervals. Shape of curve with other coefficient was attested during investigation of understanding subject matter, too.

According achieved coefficient $k = 0,046$ we can regard improvement of soft motive hand as a very pretentious educational activity. It can be compared with memory subject matter, when coefficient was $k = 0,043$.

Coefficient of understanding of notions "bigąnd śmall" was $k = 0,61$. So we can say, that subject matter is not pretentious. Only two children did not understand subject matter in the group of 126 children during lesson.

Ideal state is coefficient $k = 1$. It is a desire of teachers. In this case all pupils will master subject matter after the 1^{st} explaining.

The coefficient of disclosure of situation on the picture (hurt finger and snake's right of way) was $k = 0,35$. We can say that pretension of subject matter determined by pictures is appropriate to age and abilities of pre-schoolers.

The students at Fakulty of Education in Banská Bystrica solved more pretentious problems for pupils of the 4^{th} class at elementary school. Gerová - Klenovčan [3, 2004] indicate how students and pupils understood the text of problems. Problem 1: pupils 41,3%, students 41,3 - 88%; problem 4: pupils 65,2%, students 69–94%; problem 5: pupils 84,8%, students 91,3–100%. If we do not regard investigated problems for pupils as test but learning subject matter, we can say that it is adequately pretentious. We can regard it this way in weaker groups of students, too.

The results can be used in practice by two ways.

- If it is standard sample of pupils, we can state pretension of subject matter from gained coefficient values of learning.
- If subject matter has standard pretension, we can find out knowledge and abilities of pupils from gained coefficients.

It is evident that teaching style, skills of teacher and didactical abilities influence "pretension of subject matter"without regard to text of problem of subject matter.

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