Research of the Adequacy of the Conceptual Model of Non-Traditional Education to the Traditional Educational Process

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Abstract: This article covers the issues of improving the methodology for researching the adequacy of the conceptual model of non–traditional education to the traditional educational process through mathematical modeling of the educational process.

Keywords: Conceptual, innovation, adequacy, competence, empirical research, approximation, interpolation.

Introduction

The transition from traditional educational process observation to non–traditional educational process observation and substantiation of the effectiveness of the methodology used in non–traditional education to work out the issue of modeling this process, which requires the processes of assessing the quality of Education based on the results obtained, that is, checking the correspondence (adequacy) of the conceptual model of non–traditional. In general, since the non-traditional educational conceptual model cannot be considered fully compatible with the traditional educational process in all its characteristics, it will be possible to construct different models of the educational process depending on the different observations made during the study.

To assess the level of adequacy of the non–traditional educational conceptual model and the traditional educational process, the same methodology is applied to the traditional educational process and its non–traditional educational conceptual model, which can be determined by comparing the results obtained from it.

Figure 1 presents a structural scheme for identifying errors in assessing the adequacy of the conceptual model of traditional education and non–traditional education.

Hence, the field of possible values belongs to the $D_x$ methodological effects of different levels results of the traditional educational process by directing $\bar{x}_j = (x_{1j}, x_{2j}, \ldots, x_{nj})$ and the results of the unconventional educational process $\bar{y}^M_j = (y_{1j}^M, y_{2j}^M, \ldots, y_{nj}^M), (j=1,l)$ let $l$ be obtained by passing the experiment [1].
To assess the adequacy of the conceptual model of this educational process to the traditional educational process, its error \( \Delta = (\Delta_1, \Delta_2, \ldots, \Delta_m) \) and \( \delta = (\delta_1, \delta_2, \ldots, \delta_m) \) are determined by the following formulas:

\[
\Delta_i = \max \left| y_{ij} - y^M_{ij} \right|, \quad (i=1,m)
\]

\[
\delta_i = \frac{\Delta_i}{\Delta y_i}, \quad (i=1,m)
\]

\[
\sigma_i = \sqrt{\frac{1}{t} \sum_{j=1}^{i} \left( y_{ij} - y^M_{ij} \right)^2}, \quad (i=1,m)
\]

Here: absolute, quoted, and averaged quoted errors of the conceptual model of non-traditional learning on the result obtained from \( \Delta_i, \delta_i, \sigma_i - i \) \((i=1,m) \) \( y_{ij}, y^M_{ij} - j \) – the value of the traditional educational process in experience and the non-traditional educational model in the result \( i \), \((i=1,m, j=1,l) \). The methodology that can be applied in the field of \( \Delta y_i - D_k \) is the maximum change in the values of \( x_k \) \((k=1,n) \) in the result \( i \) of the traditional educational process.

If the magnitude of these errors is greater than some of the given positive values, then the conceptual model of non-traditional education will be suitable (adequate) for the traditional educational process.

So, now let's consider an assessment of the model of the process of active traditional education and the process of non-traditional education. Suppose, when creating a mathematical model of this process, an unconventional educational model in the form of a Linear Differential Equation of the traditional educational process was obtained [2].

\[
\sum_{k=0}^{n} a_k \frac{d^k y^M(t)}{dt^k} = \sum_{k=0}^{m} b_k \frac{d^k x_M(t)}{dt^k}
\]

here: \( x_M(t) \) – the methodology used in the concept model of non-traditional education;

\( y^M_M(t) \) – the result of the model of the non-traditional educational process;

\( n, m \) – high – order \([0, T]\) methodology applied in time intervals \( x(t) \) and \( y(t) \) whether the results were obtained, where \( T \) is the time to perform the observation.

Now the quality of the non-traditional educational model can be determined by comparing \( y^M_M(t) \) and \( y(t) \), or by introducing certain variables between these factors.

The results of the traditional educational process and the non-traditional educational model will differ in the methodology used at the same level since this is because their differential equations...
and initial situations are not the same [4]. To assess the adequacy of the non-traditional educational model and the traditional educational process, we introduce a criterion of their mutual proximity to the difference in the results of the study, that is, for the same \( x(t) \) methodology reaction, the expression of the following form is used:

\[
I_x = \int_0^T F\left(y(t) - y_M(t)\right) dt
\]

In particular

\[
F\left(y(t) - y_M(t)\right)\left(y(t) - y_M(t)\right)^2
\]

In general, the assessment of adequacy is carried out for the methodology in which \( x(t) \) of various forms is applied. In the process, the mathematical expectation of the \( I_x \) assessment is introduced.

\[
I = M[I_x] = M\left[ \int_0^T F\left(y(t) - y_M(t)\right) dt \right]
\]

The expression of the results of the study has a complex appearance, which complicates the analytical observation of \( I \) dependence on the coefficients of the conceptual model of non-traditional education. For this reason, additional criteria are also included. In private, if the conceptual model equation of nontraditional education is as follows,

\[
\sum_{k=0}^n a_k \frac{d^k y_M(t)}{dt^k} = y_M(t)
\]

in this case, it is important to determine from \( (y_M(t) - x(t)) \) the difference between this model of education and the methodology used in assessing the adequacy of the traditional educational process.

\[
I = M\left[ \int_0^T F(y_M(t) - x(t)) dt \right]
\]

\[ y_M(t) = y(t) \]

started. In this case, we define the conceptual model of non-traditional education and the results of the traditional educational process with \( y(t) \).

\[
I = M\left[ \int_0^T F\left(\sum_{k=0}^n a_k \frac{d^k y(t)}{dt^k} - x(t)\right) dt \right]
\]

the functionality of the non-traditional educational model, which is convenient for the overall result, can be expressed as follows:

\[
I = M\left[ \int_0^T F\left(\sum_{k=0}^n a_k \frac{d^k y_M(t)}{dt^k} - \sum_{k=0}^m b_k \frac{d^k x_M(t)}{dt^k}\right) dt \right]
\]

\[
\Delta = \sum_{k=0}^n a_k \frac{d^k y_M(t)}{dt^k} - \sum_{k=0}^m b_k \frac{d^k x_M(t)}{dt^k}
\]

This expression is a generalized error of the non-traditional educational model. Hence, according to the requirements of the established norm, a square of a generalized error is obtained as a function \( F(\bullet) \).
The advantage of this function is that it depends on the parameters of the non-traditional educational conceptual model, its methodology, as well as the parameters by which its results can be determined [5]. However, when calculating this function, some difficulties arise that are associated with the differentiation of expectations $x(t)$ and $y(t)$, and are also associated with the presence of the need to determine mathematical expectations. Figure 2 presents a determination structure scheme when evaluating a generalized error and Criterion $I$, where $p=d/dt$ is the differentiating operator [3]. However, on the conditions for the implementation of this process, only a sketchy development can be formed, in which the order of the image will be smaller than that of the denominator, i.e.

$$\sum_{k=0}^{n} a_k p^k / D(p)$$

or

$$\sum_{k=0}^{m} b_k p^k / D(p)$$

here: $D(p) - n, m \leq n$ level multihead.

![Figure 2. Structure scheme for determining the evaluation of the generalized error and Criterion $I$](image)

In that case, $\tilde{A}(t)$ is a generalized error and $\tilde{I}$ am a criterion assessment determination structure scheme expressed as shown in Figure 3.

![Figure 3. $\tilde{A}(t)$ generalized error and $\tilde{I}$ criterion assessment determination structure scheme](image)
\[ \Delta(t) = \left( \sum_{k=0}^{n} a_k p^k / D(p) \right) y(t) - \left( \sum_{k=0}^{m} b_k p^k / D(p) \right) x(t) \]

\[ I = M \int_{0}^{T} \Delta_2 dt \]

The structure scheme in Figure 4 will be equivalent to the scheme presented in Figure 3.

**Figure 4.** $\Delta(t)$ is a generalized error and $I$ is a criterion assessment determination structure equivalent scheme

Checking the concept model of non–traditional education for adequacy means studying how much it characterizes the processes taking place in this system and how qualitatively it describes the improvement of information in the process [6]. Verification of adequacy is carried out based on some experimental data.

Checking the adequacy of the concept model of non–traditional education with the traditional educational process is understood as an analysis of its compatibility with the educational system under study in this process, as well as the effectiveness of its results in terms of indicators. However, it should be taken into account that the conceptual model of non-traditional education cannot reflect the traditional educational system in one aspect of itself; otherwise, there will be no point in implementing the non–traditional educational model.

**Research Methodology**

Adequacy changes as a result of the idealization of external conditions and modes of operation of the system, which we can cite as an example: ignoring one or another parameter; ignoring some random factors.

Hence, the methodological implications used in the educational process, as well as the lack of specific information about certain nuances in the structure of the educational system, and at the same time, the approximations, interpolations, assumptions, and hypotheses carried out, also cause the passivity between the conceptual model and the educational process.

The aforementioned and other factors can cause an imbalance that arises between the non–traditional educational model and the real education system.

As a simple attitude that determines the adequacy of the traditional educational process with an unconventional educational model, the following expression can be considered:

\[ \Delta y = |y_0 - y_m| \text{ or } \Delta y = \frac{|y_0 - y_m|}{y_0} \]

or here $y_0$ is the characteristic of the result of the traditional educational process, and $y_m$ is the value that characterizes the result of the non–traditional educational model corresponding to the
characteristic of this result of the educational system.

Based on the above relationship, we consider the traditional educational process with the developed conceptual model to be adequate if this value does not exceed some limit value.

But the use of this criterion in practical matters is considered ineffective in some situations for the following reasons.

First, there will be no information about the value of $y_0$ for the educational process being planned or modernized, while this educational process is modeled, such educational processes are usually considered. Course, in such situations, the values of an analog of the traditional educational process with the value of an unconventional educational model can be checked, but in this situation, distrust of both results may arise.

Secondly, the traditional educational process can be assessed not by a single characteristic, but by a complex of characteristics, and the norm requirements of their constituent characteristics may differ.

Thirdly, the characteristics can be a random quantity or function, most often, a nostalgic function. Statistical characteristics obtained in conceptual models with a high level of adequacy for stochastic processes can also remain more accurate about the corresponding values obtained with the help of experiments in the process of real education. This thing can be explained as follows. If there is a model of non–traditional education, the resulting value in this process is deduced based on the results of a huge number of Applied (realizations), while in real traditional education, the possibility of conducting experiments in such a number is limited.

Fourth, at the beginning of the process, the possibility of achieving a permissible limit value does not always exist.

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**Figure 5. Checking the adequacy of the concept model of non–traditional education with the traditional educational process**

So, regardless of these processes, it will still be necessary to check the adequacy of the conceptual model of non–traditional education with the traditional educational process, which is because the wrong decision can be made according to the result of the error of the non–traditional educational model. Adequacy in practice is determined, that is, by analyzing the effectiveness of the results obtained using an unconventional educational model based on research. We can see the observations in the form below in Figure 5 above:
examination of elements of an unconventional educational model (detailing elements in discussion situations or conducting additional analysis);

checking the model of non–traditional education for external influences (accepted hypothesis, it is necessary to evaluate approximations through mathematical methods);

checking the conceptual model of non–traditional education (errors in the design of the problem are identified);

examination of the methods of research of the characteristics of the results of the non–traditional educational model (the error of the solution is determined);

verification of the software model of non–traditional learning (the correspondence of operation (Operation) and operation of algorithms in software and mathematical models is analyzed, experiments are carried out at the limit and sample values of their variables, and motor programming errors are determined), etc.

Correction (correction) of an unconventional educational model. If during the examination of the adequacy of the non–traditional educational model, unauthorized imbalances between the traditional educational process and the non-traditional educational model are identified, then there is a need to make additional changes to the non-traditional educational model.

When the model of non–traditional education is corrected, changes in the following manifestations can be made:

- change in the general education process;
- change of negotiation aspects based on the needs of a certain area, in the form of;
- parametric of the form.

If there is a methodological error in the conceptual or mathematical model of non-traditional education, then the need arises to make general changes to the model of this educational process. As a result of the loss of such errors, a new educational model is formed.

Based on the needs of a certain area, while in changes to the discussed aspects, some parameters or algorithms are clarified. They are carried out as follows, for example, by replacing the components of the educational process and other non–traditional educational methodology that better characterizes external influences. Based on the needs of a certain area, it is recommended to detail and modernize this process to a greater extent, although changes in the discussed aspects partially change this educational model, in some situations, it is necessary not to apply changes to this appearance as much as possible so that the need to update the software model does not arise.

Parametric changes include changes in special parameters to eliminate unexpected unusual situations that arise in the organization of some educational process.

The stage of checking the adequacy of the concept model of non–traditional education and its correction ends with the identification and fixation of the effective aspects of this educational model. The effectiveness of the concept model of non–traditional education is taken into account by such a set of conditions that if these conditions are appropriate, then the result of this process will satisfy the research.

Materials and methods

Assessment of the adequacy of the conceptual model of non–traditional education is to check whether this educational model corresponds to the real educational process. The process of assessing the adequacy of the concept model of non–traditional education to the real educational process is assessed by its proximity to the results of experimental data.

When substantiating the adequacy of the concept model of unconventional education, one or another criteria are used, among which the Stuydent criterion was selected.
This criterion gives the probability of finding that every two average values in the selection are corresponding to one set. Checking the hypothesis that the data of the criterion refers to the same set is used in many situations.

Criteria can be applied in two ways:
- when the Equality hypothesis of the two independent main mediums of the first, non–interrelated equations is examined (two selected criteria). Control and experience groups will be present in this process;
- in the second, middle, the same groups themselves to check the hypothesis, the choice on the scale of the data will be interconnected.

When independent selections are not interconnected, the criterion statistics will be equal to:

\[ t_{emp} = \frac{\bar{a} - \bar{b}}{\sigma_{a-b}} \]

here: \( \bar{a} - \bar{b} \) average value in experience and control groups; \( \sigma_{a-b} \) the standard error of the subtraction of the arithmetic mean.

\( \sigma_{a-b} \) it is found in the following formula:

\[ \sigma_{a-b} = \sqrt{\frac{\sum (a_i - \bar{a})^2 + \sum (b_i - \bar{b})^2}{n+m-2} \cdot \left( \frac{1}{n} + \frac{1}{m} \right)} \]

where \( n \) and \( m \) is the value of the first and second selections.

If the number of selections was the same as \( n=m \), then the standard error of the arithmetic mean is determined using a simpler formula:

\[ \sigma_{a-b} = \frac{1}{\sqrt{n+m-2}} \]

here is the \( t_{emp} \) – the size of the selection.

The calculation of the number of free hands is carried out by the following formula:

\[ k = n+m-2 \]

When the number value of the selections is equal to \( k = 2n - 2 \).

The value obtained in the next step will have to be compared with the theoretical value of the \( t_{emp} \) Student criterion. If \( t_{emp} < t_{krit} \), then the \( N_0 \) hypothesis is accepted, whereas if the result shows zero hypotheses are rejected, an analog hypothesis is accepted instead.

The success of the research work is determined by determining the degree of effectiveness in the practical activities of pedagogical hepatizes. In the above empirical research work, Student criteria were used to determine the effectiveness of the results obtained and to prove hepatizes, as well as to process the results of the experiment. To compare the appropriations of experience and control groups, the average value of the appropriation assessment in groups was taken as follows:

\[ \bar{X} = \frac{\sum X_i}{n} \]

The following were used in the analysis of experimental – test work in four stages:

**The first stage.** Average values Determination indicators.

\[ \bar{X}_i = \frac{\sum X_i m_i}{n} \]

\[ \bar{X}_c = \frac{\sum X_i m_i}{n} \]
Here $X_i$ is the mastering indicator (value), which accepts values 3 (satisfactory), 4 (good), and 5 (excellent). $m_i$ – The number of repetitions of assessments, $n$ – the number of respondents participating in the experiment.

The selection in the experimental – test work represents the variance as follows:

$$S_t^2 = \frac{1}{n} \sum_{i} m_i (X_i - \bar{X}_t)^2$$

$$S_\sigma^2 = \frac{1}{n} \sum_{i} m_i (X_i - \bar{X}_\sigma)^2$$

**Second stage.** The average value that evaluates the effectiveness of the educational process is the ratio of the average arithmetic values of the assessment of experience and control groups, that is, the coefficient of efficiency.

$$\eta = \frac{\bar{X}_t}{\bar{X}_\sigma}$$

Here $\bar{X}_t$ is the average arithmetic value of the experimental group estimates. $\bar{X}_\sigma$ the average arithmetic value of the assessment of mastering in the control group.

**Third stage.** Unknown middle values of the set are confidence intervals for $a_t$ and $a_\sigma$:

$$a_t = \left[ \bar{X}_t - \frac{t \cdot S_t}{\sqrt{n_t}}, \bar{X}_t + \frac{t \cdot S_t}{\sqrt{n_t}} \right]$$

$$a_\sigma = \left[ \bar{X}_\sigma - \frac{t \cdot S_\sigma}{\sqrt{n_\sigma}}, \bar{X}_\sigma + \frac{t \cdot S_\sigma}{\sqrt{n_\sigma}} \right]$$

Here the probability of confidence in $t$ – normalized deviation is determined based on $\beta$. For example, if we take $\beta = 0.95$, $t = 1.96$.

**Stage four.** The hypothesis about the equality of intermediate values is obtained by the hypothesis opposite to it.

$H_0: a_t = a_\sigma$

$H: a_t \neq a_\sigma$

About the above hypothesis, we check through the Student criteria.

$$t = \frac{\bar{X}_t - \bar{X}_\sigma}{\sqrt{S_t^2/n_t + S_\sigma^2/n_\sigma}}$$

if we adapt the ideas to the criterion of Student $t > t_{0.05}(k)$, $H$ is accepted, and if on the contrary, $H_0$ is accepted. Here is the level of freedom of the Student criterion. To calculate it, the following formula was used:

$$k = \left( \frac{S_t^2/n_t + S_\sigma^2/n_\sigma}{n_t - 1 + n_\sigma - 1} \right)^2$$

Hence, comparing the above results with the results of the traditional educational process and the results of the traditional educational conceptual model shows the average results of the training session on the development of students’ competencies to improve the methodology for organizing independent education using electronic educational resources, and, according to it,
the results of experimental and control groups.

References


