The Role of Computer Modeling and Experiment in Pedagogical Researches

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Summary
In the given article questions on directions of the theory and practice of computer modeling and the organization of computing experiment are considered at carrying out of pedagogical researches. Its condition for today is analyzed and the mathematical model of processes of testing is offered. Now pedagogical researches are directed on that search and application of the developed methods in one area of methodical researches to extend to another. Undertaken separate attempts of generalizations also are not basic. From this point of view computer modeling and computing experiment are necessary for research of educational process as a whole, and also possibilities of a technique of teaching of separate disciplines.
Key words:
computer modeling, mathematical model, computing experiment, testing.

1. Introduction

Nowadays, the theory of training and methods of pedagogical researches are basically descriptive and teachers individually possess the technique of any subject. Therefore, the transition of the theory of training from the empirical form to the demonstrative is an important question which raised today.

2. The theory of computer modeling and computing experiment

As one of means of such transition can act, in our opinion, the theory of computer modeling and computing experiment. Analyzing scientific works on this question, it is possible to allocate some directions[3].
The first direction - gynecological in which the computer model acts as intermediate object in the course of material knowledge, that allows to reveal communication between the quantitative and qualitative parties of the phenomena.
Models of this direction express not only that general, that there is between the individual phenomena in the given area, but also that unites various areas.

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The second direction - use of computer model instead of the original. This direction allows to receive data on studied object which do not manage to be received in nature, to reveal the original nature, to carry out forecasting of development of object of studying.
The third direction - modeling-information, designed taking into account likelihood character of process of training, with use of statistical data of process that allows to reveal certain laws of object of studying.
The fourth direction -analytical. By means of such computer model the analytical or graphic description of a certain part of process of preparation of the pupil on the basis of corresponding qualitative and quantitative characteristics is given. It is possible to carry block diagram's and the models reflecting an information transfer, its comprehension, training, inculcation of skills, the control over mastering to this direction etc.
The fifth direction - general-methodological, allowing to estimate communications in training between subjects and the disciplines forming outlook of trainees.
The sixth direction - psychological. These are attempts of modeling by means of information technique of the person of the trainee, behavior of student's collectives for studying of their biological, psychological, social properties and features. Such modeling should be spent taking into account adaptation of people to various external conditions and is stimulating factor and in the course of perception of new data.
As an example computer training which was investigated practically by each private technique can serve it, but at the same time basic features and possibilities of training with personal computer use up to the end are not opened.
One of the vivid examples in respect of introduction of methodology of computer modeling and computing experiment in training is the subject «the Computer drawing and design».
First of all it is connected with character of the studied material supposing construction of computer models and research of the phenomena by a method of computer imitating modeling. Models are taken as a principle demonstration and training programs, programs of training apparatus and numerical experiment.

Besides it on employment "traditional" forms of use of the personal computer -the computer control of knowledge, generation of individual tasks for the decision of problems, carrying out of calculations are possible also.
Besides, transition was outlined in subject teaching «the Computer drawing and design» from use of training programs on separate sections of a course to creation and practical introduction of complexes educational-methodical and the software.
Therefore for teachers-experts, methodologists and developers of applied software rather important the information on that what productivity, that is adequacy of those or other elements of computer technologies of training and concrete program systems in comparison by traditional technologies is represented. Such information can be received under the scheme or on the basis of methods of mathematical modeling and computing experiment.
Thus the received information, undoubtedly, would allow to allocate the most effective and rational forms of the organization of educational process in the conditions of information of formation and to formulate recommendations about kinds and the maintenance of curriculums.

3. The analysis of test tasks

As an example of use of mathematical modeling we will consider process of testing of trainees by results of training the realized on the personal computer.

Let we have some set of test tasks $\{T_k\}, k=\overline{1,n}$, where n - the general number of tasks. For each task Tk, we will have some set of accessible variants of answers $\{A_{k,j}\}, j=\overline{1,m_k}$, where mk - quantity of variants of the answer for task Tk. We will present set of true answers to problem Tk in the form of indistinct set Rk with function of accessory $\omega_л(A_{k,j})$ and universal set $\{A_{k,j}\}, j=\overline{1,m_k}$. Let accessory function is limited and $\omega^{k,\max}=\max\limits_j\left(\omega^k(A_{k,j})\right)$ - height of set Rk. In a case when $\omega^k=\{0,1\}$, we will deal with the "usual" test task with two types of answers: true and incorrect.
The elementary analysis of tests begins with calculation of true answers to the concrete task [1]. Let Sk - the variant of answer Ak, j on problem Tk, which tested has considered true, or Sk =Z in case the tested has considered, that any variant of the answer is not correct. Having designated for Pk total of attempts of the answer to problem Tk, we can calculate two sizes:

$$x_{k,1}=\sum_{i=1}^{P_k}\begin{cases}\dfrac{\omega_i^k}{\omega_i^{k,\max}};\omega_i^{k,\max}\neq 0;\\ 0;\omega_i^{k,\max}=0,S_{k,i}\neq Z\\ 1;\omega_i^{k,\max}=0,S_{k,i}=Z\end{cases} \quad (1)$$

$$x_{k,2}=\sum_{i=1}^{P_k}\begin{cases}\dfrac{\omega_i^{k,\max}-\omega_i^k}{\omega_i^{k,\max}};\omega_i^{k,\max}\neq 0;\\ 1;\omega_i^{k,\max}=0,S_{k,i}\neq Z\\ 0;\omega_i^{k,\max}=0,S_{k,i}=Z\end{cases} \quad (2)$$

We name $x_{k,1}$ - factor of the given true answers to problem T_k, $x_{k,2}$ - factor of the given incorrect answers. In case $\omega^{k,j}=\{0,1\}$ these sizes will designate quantity truly and incorrectly given answers accordingly. For simplification of the further calculations it is normalized R_k. It is possible according to an assumption about limitation of function of accessory ω^k. We will make replacement $\tilde{\omega}^k=\dfrac{\omega^k}{\omega^{k,\max}}$, and we will not consider in (1) and (2) variant when among the offered answers there is no true. In this case calculation of factors $x_{k,1}$ and $x_{k,2}$ will be reduced to two simple formulas:

$$x_{k,1}=\sum_{i=1}^{P_k}\tilde{\omega}_i^k, \quad (3)$$

$$x_{k,2}=\sum_{i=1}^{P_k}(1-\tilde{\omega}_i^k) \quad (4)$$

Having designated $N_k = x_{k,1} + x_{k,2}$, we can calculate two important characteristics - a measure of right answers $y_{k,1} = x_{k,1} / N_k$ and a measure of wrong answers $y_{k,2} = x_{k,2} / N_k$[2].

4. Testing model

But the analysis of concrete test tasks is not end in itself, more often us the analysis of some set of the test tasks represented as something whole interests. So, we come to test definition. We will name test Qi - a set of test tasks {Tk │ψ i (Tk) =1}, where ψi (Tk) - function of an accessory of the test task to test Qi, having a range of definition set {Tk} and accepting two value: 1 - in case task Tk is included into test Qi and 0 - otherwise.

Being based on the given formal scheme of representation of tests, we will draw some conclusions concerning a way of storage of the information in systems of an estimation of knowledge.

Accessory function ψZ can be realized in the form of the table with two fields, first of which - identifier Qi, and the second - identifier Tk. Having divided the table containing information on set of tests {Qi}, the table of test tasks and the table of communications (accessories) of test tasks to concrete tests, we get possibility any way to change the size of the test (quantity of test tasks entering into it), and also not increasing it is essential to use the sizes of base one test task in various tests.

Let's give an example calculation of factor of correlation Pirsons for two "parallel" tests for sample of examinees $\{X_l\}, l = \overline{1,h},$ where h - number tested. Let Qi = {Tk │ψ i (Tk) =1} and Qj = {Tk │ψ j (Tk) =1} - two "parallel" tests, $x_{k,1}^l$ - the size calculated under the formula (1) or (3) on concrete examinee Xl (thus Pk ≡1). Then calculation of factor of correlation will look as follows:

$$r_{ij} = \frac{SP_{ij}}{\sqrt{SS_i * SS_j}},$$

where:

$$SS_i = \sum_{l=1}^{h}\left(\left(\sum_{\forall k|\psi^i(T_k)=1} x_{k,1}^l\right)^2\right) - \left(\frac{\left(\sum_{l=1}^{h}\left(\sum_{\forall k|\psi^i(T_k)=1} x_{k,1}^l\right)\right)^2}{h}\right),$$

$$SS_j = \sum_{l=1}^{h}\left(\left(\sum_{\forall k|\psi^j(T_k)=1} x_{k,1}^l\right)^2\right) - \left(\frac{\left(\sum_{l=1}^{h}\left(\sum_{\forall k|\psi^j(T_k)=1} x_{k,1}^l\right)\right)^2}{h}\right),$$

$$SP_{ij} = \sum_{l=1}^{h}\left(\left(\sum_{\forall k|\psi^i(T_k)=1} x_{k,1}^l\right) * \left(\sum_{\forall k|\psi^j(T_k)=1} x_{k,1}^l\right)\right) - \left(\left(\sum_{l=1}^{h}\left(\sum_{\forall k|\psi^i(T_k)=1} x_{k,1}^l\right)\right) * \left(\sum_{l=1}^{h}\left(\sum_{\forall k|\psi^j(T_k)=1} x_{k,1}^l\right)\right) / h\right).$$

The given scheme gives more flexible system of realization of exhibiting of a total point for the test. Let $B_k^{\max}$ - a point which the examinee can receive, having chosen as the answer to task Tk such variant of answer Ak, s, that $\omega^k(A_{k,s}) = \omega^{k,\max}$. Then begins possible to count a point received at a choice of answer Ak, i on task Tk, under the formula:

$$B_k^i = B_k^{\max} * \frac{\omega^k(A_{k,i})}{\omega^{k,\max}}$$

However it not a unique method of calculation of a point which can be realized within the limits of the given model.

Conclusion

Within the limits of the given scheme wide enough class of test tasks with the closed variants of answers is realized. The system is flexible, that does its universal.

Calculation of numerical characteristics of tests, despite seeming bulkiness, it is easy to be algorithmic. On the basis of the given model the computer system of examination on discipline «the Computer drawing and design» is under construction.

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