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FORMATION OF RESEARCH COMPETENCIES IN STUDENTS BASED ON AN INTEGRATIVE APPROACH

Egamberganov I. Sh.
Chirchik State Pedagogical University, Republic of Uzbekistan

Abstract
The article considers that the integrative approach is an effective technology for the formation of research competencies among students on the example of processing experimental data obtained as a result of a physical experiment (mathematical and statistical analysis). The formation of research competencies among students was assessed on the basis of reproductive, productive and creative criteria.

Keywords: physical experiment, mathematical-statistical analysis, research competence, reproductive level, productive level, creative level.

Introduction

According to the Decree of the President of the Republic of Uzbekistan and the Concept for the development of the higher education system in the Republic of Uzbekistan until 2030, they specifically address issues such as improving the quality of education in the field of physics and developing research work in higher educational institutions, increasing their efficiency, broad involvement of youth in scientific activities, formation of innovative infrastructure of science [1-2].

In the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan dated August 27, 2021 No. 545 "On measures to organize a management system for scientific innovation activities" provides for the creation of the Ministry of Innovative Development of the Republic of Uzbekistan, among its functions, the tasks of taking measures to support talented youth striving to conduct scientific research in our country and create for them necessary conditions for using the laboratory facilities of higher educational institutions and scientific organizations [3].

MATERIALS AND RESEARCH METHODOLOGY

Research work on the modernization of the education sector, especially higher education of scientists from the countries of the Commonwealth of Independent States and our republic, was carried out by V.I. Baidenko, V.M. Zueva, U. Begimkulova, the problems of applying the competency-based approach in education have been studied by such researchers as I.A. Zimnyaya, A.V. Khutorskaya, N.Muslimov, Sh.N.Turdiev, B.Khodzhaev, issues of research competence - S.V. Abakumova, I.A. Kovalenko and others.

In recent years, research work carried out in the field of pedagogy in our republic, including the work of F.Kh. Baychaev, Zh.Z. Madaminova, M.M. Parpieva, M.M. Usanova and others are devoted to the problems of developing professional competence in future specialists, but the problems of developing research competence in students have not been sufficiently studied [5-7].

RESEARCH RESULTS

As you know, physics is an experimental science. Any physical experiment encourages the student to work independently, teaches him to analyze, think about and observe the data obtained as a result of the experiment. Therefore, setting up an experiment and conducting it is not a process of passive observation for the student, but is considered useful for motivating him to active activity.

In fact, although the qualification requirements developed for a bachelor characterize research activities, in practice we see the student not as an active participant in this process, but simply as a performer (when writing an essay, coursework, final qualifying work, etc.). From them it becomes clear that we need to engage in the comprehensive development of research competence continuously, throughout the entire process of studying at a university, which requires new approaches in developing the content and implementing the fundamental training of bachelors.

During physics classes in specialized areas of pedagogical higher educational institutions, a student sometimes has a need to turn to mathematical tools in the process of processing the results obtained in a physical experiment. At the moment, in the process of working with mathematical tools, students are gradually developing mathematical literacy and research skills. In most cases, the level of development of research abilities is assessed at the reproductive, productive and creative levels [4].

In order to develop the student's research ability, it is recommended to carry out a mathematical and statistical analysis of the results obtained in a physical experiment (Table 1 shows the flight distance of a horizontally thrown object), and their activity is assessed based on the criteria mentioned above.

Table 1. Measured values l flight length in centimeters (cm)

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
38.5	39	37.5	39.8	39.6	39.3	39	40	37	40
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
39.5	39.3	38.5	38.7	40.5	39	38.5	38.9	40.7	38.6

Reproduction level. Knows the average value of the expressions in this table and the expression for the standard deviation and makes calculations. To assess the best value of the distances (N = 20) of the body flight based on the values given in Table 1, their average value is determined, that is $L = \bar{l} = \frac{\sum_{i=1}^{N} l_i}{N} = 39.095$ cm.

Based on the number N of the body's flight range and the average value, the standard deviation is calculated, that is $\sigma = \sqrt{\frac{\sum_{i=1}^{N}(l_i-\bar{l})^2}{N-1}} = 0.9076$ cm.

Based on the average value of discrete quantities and standard deviation obtained in the experiment, the flight range is written as follows:

$$L_y = L \rightleftarrows \pm\sigma = (39.095 \pm 0.9076)\text{cm}.$$

Productivity level. Calculates the average value and standard deviation of the values in a given table, determines the limits of change in values. Uses the laws of mathematical statistics. You can also use information and communication technologies to find the average value and standard deviation in this table.

The actual distribution of the obtained results must be checked whether these results can satisfy or not the hypothesis l_1, l_2, l_3,.. . l_N, according to the normal distribution (Gaussian), estimated by the values of L and σ. Having defined four measurement areas $L - \sigma$, L, $L + \sigma$, as shown in Table 2, determines their boundaries.

Table 2. Possible choice of bins for the data in Table 1.

Bin number k	1	2	3	4
Values of l in bin (cm)	$l < L - \sigma$	$L - \sigma < l < L$	$L < l < L + \sigma$	$L + \sigma < l$
	l <38.1874	38.1874 < l < 39.095	39.095 <l< 40.0026	40.0026 < l
Number of observations in bin Q_k	2	9	7	2

Creativity level.Works with scientific and additional literature (probability theories). Converts data into graphical form. Mastered research methods. Uses electronic programs during research work.

By dividing the range of all measured values into sections, we can describe the problem in detail; first, the number of measurement results falling on each segment k is calculated (if the measurement result falls on the boundary between two segments, then we can write half of the result in one interval, and the second half in another interval). Let us note this number Q_k. In our example, the observed numbers Q_1,Q_2, Q_3, Q_4 are shown in the last row of Table 2. Now, assuming that our results are normally distributed (as we estimated the expected number E_k), we can calculate the measurement results for each segment k. Then, several times the observed number Q corresponds to the expected number E_k.

The calculation of the expected number E_k is known. The probability of an arbitrary measurement result falling into the interval $a < l < b$ is equal to the area under the Goass function between $l = a$ end $l = b$ [8]. In our example, the probability of the measurement results falling into each of the four segments P_1, P_2, P_3, P_4, the corresponding Gaussian function, is equal to four areas (Figure 1). Two equal surfaces P_2 and P_3 together give a value of 68%. In this case, the probability of falling into one of the two central intervals is 34%, that is, $P_2 = P_3 = 0.34$. The two external fields account for the remaining 32%, that is, $P_1 = P_4 = 0.16$.

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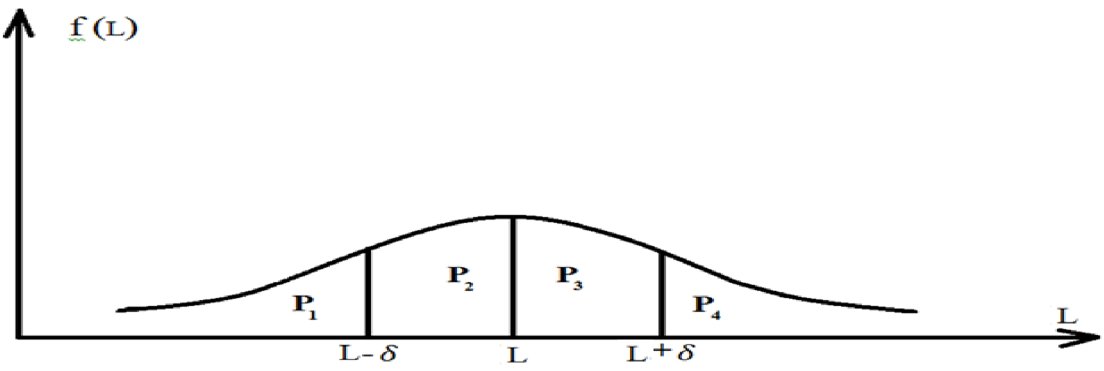

Fig.1. The probabilities P_1, P_2, P_3 and P_4 of the results falling into each of the four bins are equal to the corresponding four areas shown under the Gaussian function.

To find the expected number E_k, we multiply these probabilities by the number of total measurements $N = 20$. These expected numbers are shown in Table 3. The fact that E_k is not an integer reminds us that the expected number is not the number we actually expected in an arbitrary individual experiment, but rather the average expected number obtained by repeating our measurements many times.

Table 3. Calculation of χ^2 for the data in Table 1.

Bins	1	2	3	4
l values in bin	$L < L - \sigma$	$L - \sigma < l < L$	$L < l < L + \sigma$	$L + \sigma < l$
Probability P_k	16	34	34	16
Expected number Ek = NPk	3.2	6.8	6.8	3.2
Observed number *Qk*	2	9	7	2
$Q_k - E_k$	– 1.2	2.2	0.2	– 1.2

The smaller the difference between the observed number (*Q*) and the expected number (*E*), the more normally the measurement results in the experiment will be distributed. The last row of Table 3 shows the difference between the expected number and the observed number, and their algebraic sum is zero, that is

$$\sum_{k=1}^{4}(Q_k - E_k) = 0.$$

When assessing how well an observed number satisfies the expected number, the χ^2 criterion is considered important and is expressed as follows:

$$\chi^2 = \sum_{k=1}^{n}\frac{(Q_k - E_k)^2}{E_k}$$

If the condition is met $\chi^2 \leq n,$ then the observed number satisfies the expected number if the condition is satisfied $\chi^2 \geq n,$ then the observed number is significantly different from the expected number. The difference between the observed and expected numbers (Qk - Ek) of our example is four, that is, $n = 4$.

Let's calculate the number χ^2:

$$\chi^2 = \sum_{k=1}^{4} \frac{(Q_k - E_k)^2}{E_k} = 1.565$$

Since the value of 1.565 for χ^2 is less than the difference between the observed and expected numbers (namely n = 4) $\chi^2 \leq n$. Hence, we have no reason to doubt the hypothesis that the results of our measurements are normally distributed.Table 4 shows the results of educational and research activities recommended for 45 students.

Table 4. Results level of development of research abilities

Quantity of students	Reproductive	Productive	Creative
45	31	11	3

Conclusion

Observation of students completing this task shows that the research activity of most of them is reproductive in nature. In our opinion, in order to develop students' research activities, it is necessary to pay more attention to the connection between disciplines, that is, an integrative approach.

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