5.2 Features of studying the disciplines of the cycle of safety of life activity by future specialists-builders

During the training of future construction specialists [114-118] at Vinnytsia National Technical University the following normative disciplines of the life safety cycle are taught: “Life safety” (LS), “Fundamentals of labor protection” (FLP), “Civil protection and labor protection in the field ”(CPLPF) [119-125], using computer technology training and testing [126-128], in particular during the training of construction professionals. In addition, until recently, during the working trimester in the first year, students also studied the discipline of "Occupational Safety in the Working Profession" (OSWP). While studying at the university, the student does not acquire single-subject knowledge, but in his mind is formed a system of knowledge, skills, abilities and competencies in various disciplines [129]. Therefore, the problem of establishing interdisciplinary links becomes especially relevant given the need to form in the minds of students a single general scientific picture of the world in modern conditions of continuous increase in educational information and growing shortage of time spent on its assimilation.

In the article [130] the research of interdisciplinary connections of life safety with the basic professional disciplines at preparation of bachelors of economic direction is carried out. In [131], interdisciplinary links in the training of future engineers in the engineering industry are investigated. However, no specific studies of interdisciplinary links in the process of studying the disciplines of the life cycle of future construction professionals, as a result of analysis of known publications, were found.

To study the existence of these links between the disciplines of the LS cycle and subjects such as "Higher Mathematics" (HM), "Physics", "Traffic Rules" (TR), "Ecology and Fundamentals of Biosafety and Bioethics" (EFBSBE) analyze the success students of construction profile, who studied at Vinnytsia National Technical University, when the disciplines of the LS cycle were taught in the fourth year. The research was conducted separately in two academic groups with different levels of success, where students received scores on a 100-point scale from different disciplines, which are shown in Tables 1 and 2.

Processing of research results was carried out according to the method described in [130]. Determine the sum of grades Σ, the average values of grades $\bar{a}$ and variance $\bar{S}^2$ in each discipline. To compare the variances of different samples, we use the Fisher test [132] in accordance with the calculation formula

$$F = \frac{\max\{\bar{S}_1^2, \bar{S}_2^2\}}{\min\{\bar{S}_1^2, \bar{S}_2^2\}} \le \left[F_{0.95}(n_1 - 1, n_2 - 1)\right], \tag{1}$$

where $(n_1 - 1, n_2 - 1)$ – number of degrees of freedom;

$[F_{0.95}]$ – critical value of Fisher's criterion for 95% confidence level.

These indicators are compared with the critical values of 2,820 and 2,403 [132] for the 1st and 2nd academic groups, respectively, to decide on the similarity of variances and equally successful acquisition of knowledge by students with different abilities, if they are not exceeded.

Table 1

Grades of students of the 1st academic group

Discipline	1	2	3	4	5	6	7	8	9	10	11	12	Σ	$\bar{a}$	$\bar{S}^2$
HM	60	60	60	74	74	60	60	82	60	60	60	74	784	65.3	60. 9
Physics	74	74	63	74	73	83	73	93	60	65	60	74	866	72.2	83.2
TR	60	75	75	75	88	60	88	90	60	75	65	75	886	73.8	110.1
EFBSBE	90	90	60	90	90	90	82	90	60	82	60	90	974	81.2	157.6
OSWP	90	88	80	90	74	90	74	90	76	65	60	74	951	79.25	100.5
LS	75	75	60	91	75	75	62	91	60	60	60	75	859	71.6	120.1
FLP	75	75	60	90	90	75	75	91	60	75	61	61	888	74	128
CPLPF	60	66	60	90	60	75	60	90	60	62	60	61	804	67	123.2

As can be seen from table 3, the calculated values of the Fisher test for students of both academic groups do not exceed the critical values, so the hypothesis of similar variances and equally successful knowledge acquisition by students of academic groups with different success rates can be considered correct with 95% confidence.

To determine the existence of a relationship between two series of experimental data, we use the correlation method.

Table 2

Grades of students of the 2st academic group

Discipline	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Σ	$\overline{a}$	$\overline{S}^2$
HM	64	60	82	74	64	74	60	60	74	60	74	74	87	74	74	64	1119	69.9	65.8
Physics	74	60	74	74	62	62	60	60	64	60	78	74	78	90	82	74	1126	70.4	82.1
TR	75	60	82	65	60	60	60	90	75	60	65	75	75	60	90	65	1117	69.8	107.4
EFBSBE	90	60	90	90	83	68	60	60	78	76	90	90	90	90	90	90	1295	80.9	141.2
OSWP	90	60	80	85	85	75	80	65	90	80	88	90	90	88	90	88	1324	82.75	79.4
LS	75	60	75	75	60	60	60	60	91	69	75	75	75	75	100	75	1160	72.5	121.4
FLP	76	61	82	75	64	61	60	60	90	60	75	91	92	60	93	75	1175	73.4	157.4
CPLPF	75	60	75	75	75	62	60	60	90	76	75	60	91	62	92	90	1178	73.6	137.7

Determine the calculated values of the Fisher test, entering the data in table 3.

Table 3

Estimated values of the Fisher test for students of the 1st and 2nd academic groups

Academic group	1				2			
Discipline	HM	Physics	TR	EFBSBE	HM	Physics	TR	EFBSBE
OSWP	1.651	1.209	1.096	1.568	1.207	1.034	1.352	1.777
LS	1.972	1.444	1.090	1.313	1.844	1.478	1.130	1.163
FLP	2.102	1.540	1.162	1.232	2.391	1.917	1.465	1.115
CPLPF	2.023	1.481	1.118	1.280	2.093	1.677	1.282	1.025

The linear correlation coefficient is determined by the formula

$$r = \frac{\sum_{i=1}^{n}\left[\left(a_{1i} - \overline{a_1}\right)\left(a_{2i} - \overline{a_2}\right)\right]}{n\sqrt{\overline{S}_1^2 \overline{S}_2^2}}, \tag{2}$$

where $\bar{a}_1$, $\bar{a}_2$ – average sample values of the compared values; a_{1i}, a_{2i} – partial sample values of these values; n – the total number of these values in the series of indicators; $\bar{S}_1^2$, $\bar{S}_2^2$ – variance, deviation of these values from the average values.

It is known [132] that a strong correlation can be said only if the correlation coefficient is greater than 0.7. The correlation coefficient in the range of 0.5 ... 0.7 is considered average, and if less than 0.5 – weak.

Determine the coefficients of linear correlation, entering the data in table 4.

Table 4

Estimated values of linear correlation coefficients for students of the 1st and 2nd academic groups

Academic group	1				2			
Discipline	HM	Physics	TR	EFBSBE	HM	Physics	TR	EFBSBE
OSWP	0.8017	0.7265	0.6980	0.7006	0.7548	0.7581	0.7963	0.8830
LS	0.8810	0.8155	0.6615	0.7554	0.6031	0.7543	0.8531	0.7041
FLP	0.8672	0.7270	0.6347	0.8469	0.8357	0.8775	0.8711	0.7917
CPLPF	0.9206	0.7541	0.7050	0.6680	0.7606	0.8054	0.7914	0.8157

The obtained correlation coefficients confirm the strong relationship between knowledge of these disciplines, with the exception of some interdisciplinary relationships, the cells of which in table 4 are gray and correspond to the average level of communication with the approach to strong.

To compare the homogeneity of different samples, we use the Student's test [133] with the help of the calculation formula

$$t = \frac{\left|\bar{a}_1 - \bar{a}_2\right|}{\sqrt{\frac{(n_1-1)\bar{S}_1^2 + (n_2-1)\bar{S}_2^2}{n_1+n_2-2}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \le \left[t_{0.95}(n_1+n_2-2)\right], \tag{3}$$

where $[t_{0.95}]$ – the critical value of the Student's criterion for the 95% confidence level.

Determine the calculated values of the Student's criterion, entering the data in table 5.

Table 5

Estimated values of the Student's criterion for the disciplines under study

Discipline	HM	Physics	TR	EFBSBE	OSWP	LS	FLP	CPLPF
t	1.510	0.516	1.011	0.049	0.975	0.218	0.122	1.512

The determined indicators are compared with the critical value of 2.056 [133] for deciding on the homogeneity of different samples and their belonging to one general population, if they are not exceeded. As can be seen from Table 5, the calculated values of the Student's test for each of the disciplines do not exceed the critical value, so the hypothesis of homogeneity of different samples and their belonging to one general population (future construction professionals) can be considered correct with 95% accuracy.

In different academic years, the sequence of teaching the disciplines of LS and FLP was different: until 2012/2013 academic year including these disciplines were studied in parallel in one semester, in 2013/2014 – 2016/2017 academic year first the discipline of LS was studied, and in the next semester – FLP, in 2017/2018 academic year first the discipline of FLP was studied, and the next semester – LS. Therefore, the urgent task is to determine the rational sequence of teaching life safety disciplines and the basics of labor protection during the training of construction professionals.

Determining the rational sequence of teaching the disciplines of LS and FLP during the training of construction professionals will be based on the criterion of strength of interdisciplinary links of these disciplines.

To study the existence of interdisciplinary links between the disciplines of the cycle LS and FLP, we analyze the performance of construction students who studied at Vinnytsia National Technical University in different academic years in different sequences of teaching these disciplines. The research was conducted separately in two academic groups with different levels of success, where students received scores on a 100-point scale from different disciplines.

Processing of research results was carried out according to the method described in [130, 135]. The similarity of the variances of different samples was tested by Fisher's test [132]. The comparison of the homogeneity of different samples and their belonging to one general population (future specialists in construction) was carried out according to Student's test [133].

To determine the existence of a relationship between two series of experimental data, we use the correlation method.

Comparison and generalization of the results of determining the rational sequence of teaching disciplines LS and FLP during the training of construction professionals is shown in Fig. 1.

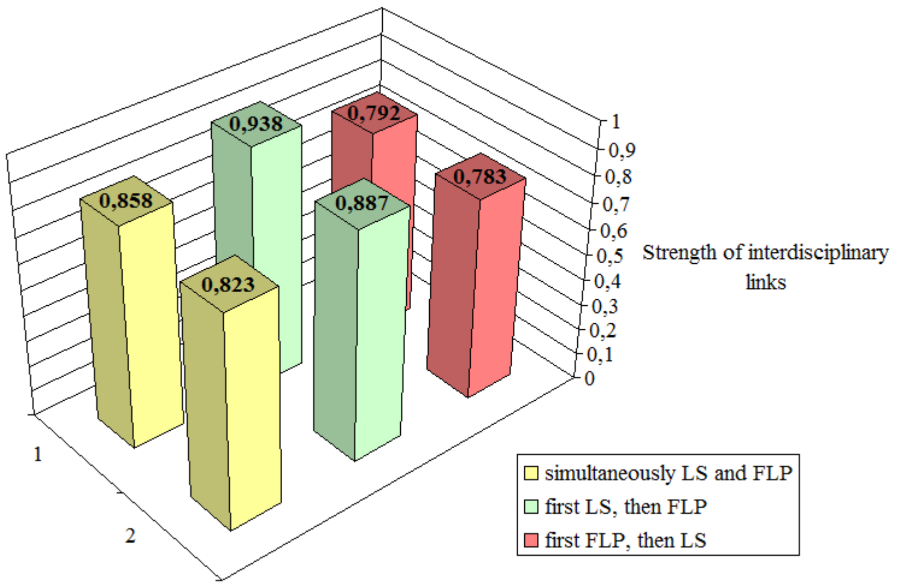

Figure 1. Graphic interpretation of the results of determining the rational sequence of teaching disciplines life safety and basics of labor protection during the training of construction professionals

Thus, based on the comparison and comparison of the data shown in Fig. 2, strong interdisciplinary links are identified in all three studied variants of the sequence of LS and FLP courses, but the greatest strength of interdisciplinary links is achieved when studying first LS course, then FLP course, and the lowest – when studying first FLP course and then LS course during the training of construction specialists in academic groups with different levels of success. The determined rational sequence of studying LS and FLP courses is confirmed by the definition of LS as a discipline: “LS is an integrated discipline of humanitarian and technical orientation, which summarizes the data of relevant scientific and practical activities labor, environmental protection, civil defense and other disciplines that study specific hazards and ways to protect against them" [134, 135].