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THE TRAINING PATHS INDIVIDUALIZATION OF STUDENTS FROM TECHNOLOGICAL ROUTE AT THE CONFLUENCE OF AGRICULTURE AND CHEMISTRY DISCIPLINES

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One of the major concerns of the contemporary school is to adapt the teaching approach in accordance with the students' particularities, their academic aptitude for learning and practice both the cognitive acquisitions and psychomotor skills necessary for the social and professional integration. In the spirit of current Romanian educational legislation, the entire teaching staff is determined to implement individualized learning pathways.

This paper analyses the influence of laboratory experiment and student's learning style on the remarkable transfer of the interdisciplinary knowledge between Agriculture and Chemistry. The student's self-assessment and the teacher's observation and assessment were used to interpreting student's performance. Participants in the study were the 9th-grade (school year 2022-2023) and 10th (school year 2023-2024) students of "H. Vasiliu" Technological High School, Podu Iloaiei, Iasi County. The learning performances and expectations of the students, the realities, trends and influence of the society on the formation of secondary education were assessed, monitored and predicted, based on the student's answers to the applied questionnaires, with using SPSS (Statistical Package for the Social Sciences) statistical software. The laboratory experiments have a direct impact on the learning outcomes, unlike the others learning styles

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which have different influences on grades in the two subjects, but not statistically significant.

***Keywords*:** interdisciplinary experiment, assessment, non-parametric tests, professional training

Introduction

One of the main concerns of contemporary education is to adjust teaching approaches to student's age-specific characteristics and academic learning skills and practicing both cognitive acquisitions and psychomotor skills necessary for personal development and socio-professional integration. According to current educational legislation[1] there is a need to introduce individualized learning pathways. This mission is obviously a hard and utopian one in the case of formal classroom settings.

Learning is a complex process that should consider unavoidable differences among students and should start from the paradigm of a teacher (school) -student-family partnership. The teaching experiment involved in such pedagogical research develop in two directions: active, projected experiments, in which the teacher's intervention is intentional and planned, as well as passive observational experiments, in which the teacher is required to interpret a sudden change in students' development; such a change is unintentional.[2] On the other hand, assessment is recognized as a key factor in improving teaching and learning in the classroom. The selection of the assessment items enables teachers to gather information about students' content learning, to identify ways of maintaining that learning, and to use this information to be involve in responsive instruction.[3] In this way, the assessment has the potential to strengthen the relationship between teaching and learning.[4] However, teachers tend to adopt broader working approaches, from critical perspectives, such as student-centered learning, laboratory experiments, multilingual and multimodal meaningmaking contents, etc.[5] These accommodations seek to compensate for what students are perceived as lack and to cultivate the students' assets.[6]

For an accurate understanding of the present study, several concepts need to be defined: *curriculum, content and interdisciplinarity*, viewed as efficient means of structuring educational content. Two approaches are possible: in a narrow sense, *curriculum* refers to the content of activities related to education and training. In a broad sense, curriculum encompasses the entire education and training system, including all its components and interactions among them. V. De Landsheere proposes the following definition: "A curriculum is an ensemble of actions planned to stimulate education: it includes the definition of learning aims, contents, methods (including those related to evaluation), materials (including school textbooks) and devices pertaining to the appropriate training of teachers".[7] Therefore, the curriculum can be seen as wider in range, from the detailed planning of educational actions and the formulation of objectives to their implementation through delivery to students and the evaluation of content by specific means within a particular educational environment, carried out by appropriately trained teachers. Consequently, the *contents* of the educational and training process represent important components of the curriculum. In other words, knowledge is linked to values transmitted to students during a lesson while the capacities and skills targeted through learning, as curricular content, also have an informative role. Certainly, educational content needs to be established in accordance with educational aims, available human and methodological resources, regulatory curriculum documents (curriculum plans, subject curricula, etc.), but also based on the specific culture of each school. Put differently, content represents "a body of knowledge, values and attitudes reflected in curriculum plans with different purposes and objectives set by society by means of school" [8]

Interdisciplinarity is an organizational form of educational content which has become very popular lately; it is an integral part of educational policies and it also applies on a broader scale at the level of content design and the actual implementation of teaching activities. Interdisciplinarity aims to establish connections among disciplines where appropriate, facilitating their integration without strict disciplinary boundaries, in order to ensure closer links to real-world contexts. The bridge between these disciplines facilitates the understanding of several phenomena and the development of a broader perception of reality.

Interdisciplinarity can be addressed during the design of curriculum plans and school textbooks; however, it may also be possible when addressing content that requires similar assessment methods. Interdisciplinary connections can be achieved either by the same teacher with solid subject-matter training, sufficient knowledge of related fields and excellent general knowledge (as minimal correlations are required) or through collaboration between two teachers working on specific content sequences. In the latter case, appropriate professional training and agreement on the design and the implementation of interdisciplinary educational content delivery. Ideally, in this case the teachers with different specialties should teach the same class, and the disciplines involved should have common or similar aims.

In recent years, an interdisciplinary trend can be observed in non-formal extracurricular activities, particularly as non-formal learning has increasingly been integrated into formal education (see the educational sequences in "Scoala altfel"/ "Non-formal Education Week"). The data presented above are relevant to the usefulness of the present study, as both fields - Chemistry and Agriculture - require interdisciplinary approaches.

The present paper aims to monitor the influence of a series of individual factors, focusing generally on students' learning styles and, in particular, on the acquisition of knowledge and skills in view of an interdisciplinary knowledge transfer (ex. Chemistry vs. Agriculture).

The main goal of the paper is to assess realities, tendencies and influences affecting a segment of the school population that often receives limited attention from society, yet whose formation addresses a strong need, not only in Romania, but also in European society nowadays – the proper training of future workers as a medium-skilled workforce, resulting from education acquired during secondary schooling. Based on a set of Chemistry questionnaires administered to the same groups of students over two consecutive school years (9^{th} grade, 2022 - 2023 and 10^{th} grade, 2023 - 2024) at "H. Vasiliu" Technological High School of Podu-Iloaiei, Iasi County, as well as on Chemistry laboratory experiments included in the C2 common core School Curriculum for the respective grades, the authors monitor learning outcomes and conduct predictive analyses using inferential statistics processed with SPSS software.[9] Moreover, the study applies several inferential statistical techniques, both parametric and non-parametric, to correlate teachers' formal evaluations with students' self-evaluation, which is not formalized and often full of surprises for the teacher in mundane school practice. This is true even for those entrenched in routine practices for whom a flat, monotonous, predictable and uninspiring approach has become an unfortunate reality.

Experimental

The sample consisted of 46 9th-grade students from two classes of agricultural specialization at “H. Vasiliu” Technological High School in Podu-Iloaiei, Iasi County, who participated in a complex experiment during the 2022-2023 school year under the guidance of teachers for the disciplines required by the project. The teacher’s task was to highlight aspects of school learning at the borderline of the two curriculum areas: Mathematics and Sciences (represented by the discipline of Chemistry) and Technologies (represented by a package of disciplines from the curriculum plan specific to the field, profile and specialization of the students). This was followed by the implementation of a “borderline” formal experimental activity in Chemistry-Agriculture, organized in work teams and involving students from both classes. The activity was carried out within the time frame allocated to a learning unit for the Technologies discipline. Separately, a self-evaluation questionnaire was also considered and also applied after the experiment.

In what follows we render the topics of the progress text (in Chemistry):

Progress assay - Chemistry

10 points are awarded ex officio,

Total 100 points

1. (5p.) Choose the series which consists only of cations:

   a) Na, Mg, Al   b) Cl^{-}, S^{2-}, O^{2-} c) Na^{+}, Mg^{+2}, Al^{+3}

2. (5p.) The solution is:

   a) a liquid chemical compound;

   b) a homogeneous mixture of two or more substances;

   c) a heterogeneous mixture.

3. (10p.) Correlates the compounds of column A with the appropriate type of column B.

A	B
1. $Ca(OH)_2$	a) salt
2. HNO_3	b) oxide
3. Na_2CO_3	c) acid
4. CaO	d) base

4. (5p.) The solubility of sugar in water increases if:

   a) temperature increases;

   b) pressure increases;

   c) temperature decreases.

5. (5p.) The neutralization is the reaction between:

   a) a metal and a strong acid;

   b) an acid and a base;

   c) a metal and water.

6. (5p.) The hydration process of ionic compound in water takes place with:

   a) heat absorption, b) heat release.

7. (5p.) The dissolution is a phenomenon:

   a) physical;

   b) chemical;

   c) physico-chemical.

8. (5p.) The source of minerals for plants is the:

   a) air; b) soil; c) water.

9. (5p.) Flora represents all:

   a) live forms; b) animals; c) plants.

10. (5p.) The main sourse of heat for plants is the:

    a) soil; b) atmosphere; c) sun.

11. (5p.) The air is a mixture of:

    a) liquid components; b) gases; c) organic compounds.

12. (10p.) Read carefully the following statements and underline the letter A if the statement is true and F if it is false:

A/F In photosynthesis process the plants synthesize organic substances;

A/F The humus is formed from the decomposition of organic matter by microorganisms;

A/F In the respiration process the plants take the CO_2 from the air;

A/F The soil was formed on the land surface from rocks.

13. (20p.) Fill the blank spaces:

a) In the photosynthesis process the plants need of mineral salts,...............and water;

b) The components of environment that affect plant life are: water, soil,............., heat and...................;

c) Inorganic salts may be absorbed by plants if they are ....in water;

d) The soil fertility can be improved by applying ....

The Chemical- Agriculture interdisciplinary teaching experiment “Influence of climatic factors and soil type on plants” was conducting in few logical steps:

a) Experiment organization

The students purchased soil samples from four different locations. Each sample was subsequently divided into two parts to be subjected to different lighting conditions: one exposed to natural daylight and other maintained under dark condition. The two classes were organized into groups of four to five students, with each group receiving eight pots (two pots for each soil type). The soil types used in experiment (marshy, alluvial-clay chernozem, cambric chernozem and earth celery) were collected from three different areas in Iasi County. Before the experiment the earth celery was mixt with peat (Agro CS (J. Zimcik, Czech Republic) purchased from Dedeman) in 2:1 ratio. Each pot was filled with 100 g of ground soil and planted with two bean seeds. For a rapid identification of sample, the pots were labeled according to soil type and lightning conditions. Throughout the experiment, each group systematically monitored soil moisture content, seed germination and plant height.

The main purpose of the experiment was to observe different factors that influence the germination, sprouting, and growth of bean plants. The analyzed factors were:

- **a** factor: **a1**-light with variables $\mathbf{a1_1}$-light and $\mathbf{a1_2}$ –dark; **a2**-temperature; **a3**- moisture;
- **b** factor: soil type (texture and permeability) with variants: **b1** – marshy, fine texture, low permeability; **b2** – alluvial-clay chernozem (black earth), medium texture and permeability; **b3 –** cambric chernozem, medium texture and permeability; **b4** – mixture of peat and earth celery without texture, very high permeability;
- **c** factor: soil reactivity with variants: **c1-** pH = 6.97, neutral reactivity (6.8 - 7.2); **c2 –** pH = 7.54, weak alkaline reactivity (7.2 – 8.4); **c3** - pH = 6.89, neutral reactivity (6, 8 – 7,2); **c4** -pH = 7.28, weak alkaline reactivity (7.2 – 8.4).

b) Assessment post-experiment

Qualitative and quantitative evaluation of knowledge was performed by applying a post – experiment self-assessment questionnaire based on Likert scale with 5 steps:

Identification data of the respondents:

Item “Gender”: 1 - male; 2 - female;

Item “Age”: 3 - class age; 4 - a year older than class age;

Item “Residence” (aria of residence): 5 - a commuter;

6 - resident; 7 - boarding school.

Structural items:

Item I: Summer do you work in agriculture?

1 - barely; 2 - a bit; 3 - so-so; 4 - long time; 5 - very long time.

Item II: Do you find attractive the experiment carried out?

1 - not at all attractive; 2 - less attractive; 3 - I don’t know;

4 - quite attractive; 5-very attractive.

Item III: Set the difficulty of teaching experiment that you conducted.

1 - very easy; 2 - easy; 3-medium; 4- difficult;

5 - very difficult.

Item IV: How do you evaluate the oral assessment to the written one applied during the development of experiment?

1 - very good; 2 - good; 3 - indifferent; 4 - less attractive;

5 - unattractive.

Item V: How do you evaluate the way of team work versus individual one?

1 - totally agree; 2 - agree; 3 - indifferent; 4 - disagree;

5 - totally disagree.

Item VI: How useful do you find a role play during this experiment?

1 - very useful; 2 - useful; 3 - I don’t know; 4 – less useful;

5 – useless.

Item VII: How useful do you find completing a diary of the group in carrying out of experiment?

1 - very useful; 2 - useful; 3 - I don’t know; 4 - less useful;

5 - useless.

Item VIII: How much did help you your team colleagues to conduct a such experiment?

1 - very much; 2 - much; 3 - I don’t know; 4 - little;

5 - not at all.

Item IX: How well trained do you think you are in the field after this experiment?

1 - very well trained; 2 - well trained; 3 - average;

4 - less trained; 5 - untrained.

Item X: How often do you think you will use the knowledge’s learned during this experiment?

1 - very often; 2 - often; 3 - I don’t know; 4 - seldom;

5 - scarcely ever.

Item XI: Would you be interested to follow a carrier in agriculture area?

1 - very much; 2 - much; 3 - I don’t know; 4 - little;

5 - not at all.

Item XII: Do you think that the concepts learned at the chemistry discipline will help you in future agriculture experiments?

1 - very much; 2 - much; 3 - I don’t know; 4 - little;

5 - not at all.

c) Persistence of information

During the first two weeks of the 2023-2024 school year, students from two classes (subsequently became 10^{th}-grade classes) were assigned the task of writing–an essay of maximum 10 lines on the topic: “The climatic and soil factors influence on plants”. The topic was the same as that of the experiment undertaken in the previous year. A selection of ideas extracted from the essays is presented in the final section of this paper, entitled “Persistence of information – opinions one year after the interdisciplinary experiment.”

For an adequate interpretation of obtained data, non-parametric statistical techniques[9] required by the sample size and the nature of the independent variable, were applied.

Results and discussions

a. Students’ conclusions after the interdisciplinary experiment (for the 9^{th} grade)

After conducted the lab experiment, the student concluded:

- In the dark, plants benefited from a more favorable and constant microclimate (humidity and temperature); however, they grew longer in search of light, and finally some of them broke and dried because the process of photosynthesis no longer occurred.
- Under light conditions, plants grew more slowly due to thermal stress (the room heated only for a few hours in the morning and even less during the weekend, not to mention the significant temperature differences between day and night), but they were green and vigorous.
- They did not break because photosynthesis, a process that lies at the basis of plant growth and development, occurred.

- Clay soils were watered every three days, whereas the other soils were watered daily.

- Sample 4 (peat and earth celery), with very permeable soil, required watering every day, while the other samples were watered every two days. Sample 1, with low permeability was watered every three days.

- The time frame for receiving water was established based on soil permeability.

- Medium texture soils have average permeability and water-retention capacity, whereas fine texture soils have low permeability and high water-retention capacity, which led to remaining quantities of water.

- Peat soil (turbah), with very high permeability, did not retain water but provided excellent fertility conditions; however, it posed problems as far as water was concerned. When not watered daily, the soil dried, and plants suffered from water deficiency, which explains the watering program differed for each soil type.

- Bean loves heat (to germinate it needs a minimal temperature of 8-10^{0}C) and enough humidity, otherwise there is a delay in the rising time.

- Based on our experience, we can observe delays in germination and growth due to thermal stress (in plants grown under light condition) and water stress (towards the end of the week, some samples suffered from the lack of water).

- In conclusion, in order to ensure good yields, beans require warmth, light and medium-texture soils with average permeability, adequate fertility, and neutral reaction (pH = 6,8 – 7,5).

- Cold soils do not provide favorable conditions because of their low permeability and their excess of moisture (marshy soils).

Based on above students' observations, the teachers could be able to determine the students' thoughts, feelings and actions for academic evaluation purposes: developing competence, demonstrating competence and performance avoidance. Consequently, students often pursue multiple goals simultaneously, and the ways in which they achieve them have strong implications for their outcomes.

Compared to teacher-led instruction, active instructional methods enable students to work independently or in small groups, which enhances students' autonomy in competence acquisition. Laboratory experiments revealed that students involved in structured inquiry activities reported higher task-specific abilities than when they receiving direct instruction.

b) *Influence of students' perception on the team or individual activity vs. perception of the experimental activity*

The statistical dependence of the experimental activity on gender, age and area of residence is presented in Table 1.

Table 1. Dependence of responses to items I–VII on gender, age, and area of residence. (Experiment attractiveness variables).

	Dependence of the Experiment attractiveness variable by the gender, age and residence predictors: R=0.47155819; R^2=0.22236; R^2 adjusted= 0.15756439; F(3,36)=3,4314					
N=40	**b***	**Standard error of b***	**b**	**Standard error of b**	**t(36)**	**Asymptotic significancy p**
Intercept			161.2417	98.79045	1.63216	0.111364
Gendre	-0.264	0.148	-0.843	0.47112	-1.78990	0.081885
Age	**0.306**	**0.147**	**0.888**	**0.42744**	**2.07742**	**0.044955**
Residence	-0.239328	0.148068	-0.4227	0.26149	-1.61634	0.114751

where: R - correlation coefficient, F – Fisher factor, N - sample size, b* - variables correlation slope obtained from Fisher' test (F test), b – variables correlation slope obtained from statistics technique, t - t test value.

Based on the Table 1 data, age is the only independent factor that influences the perception on experimental activity. These data indicate that age, implicitly life experience, can modify students’ goal dispositions, contributing to the situational variability of achievement goals. On the other hand, it is important to establish the impact of experimental classroom activities - such as teacher-led instruction, individual work, and group work - on students' instruction.[10] Compared to teacher-led instruction, where students play a more passive role, active instructional methods that enable students to work independently or in small groups may enhance task autonomy and mastery goal adoption. In support of this hypothesis, the dependence of students’ perceptions of teamwork or individual work versus laboratory experiment attractiveness was tested (Figure 1).

The option “quite attractive” was found to be the most frequently selected response regarding students’ perceptions of experimental activity. The question of the extent to which the study of Chemistry becomes (item XII) a prerequisite for a profession in the agricultural domain was addressed (item XI). The students’ responses are summarized in Figure 2. It is observed that there is a discontinuity in the discussion regarding the role and influence of the support provided by Chemistry concepts for a profession in agriculture: the high frequency of the answer “I don't know” coincides with the perceived usefulness of Chemistry concepts, for which the answer option „much” was selected. Based on these findings, it is hypothesized that engagement in active learning activities applied in interdisciplinary experiments is not entirely associated with students’ future professional choices.

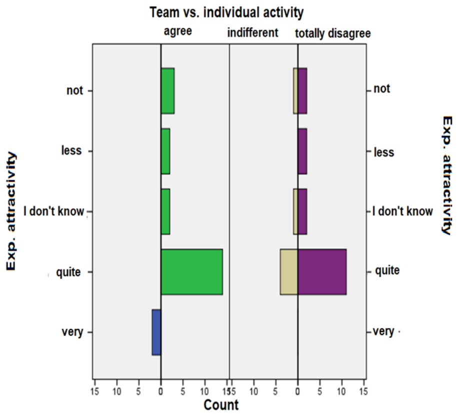

Figure 1. The link between the perception of the activity in the team/individual vs. the perception of the experimental activity.

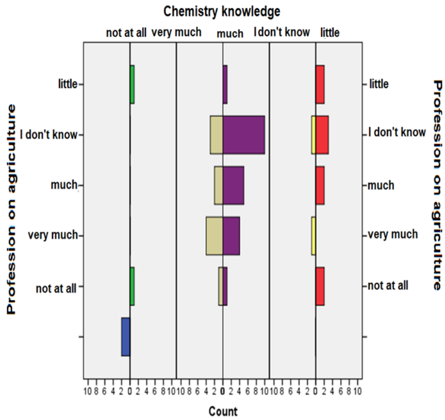

Figure 2. The link between the perception of the necessity of the chemistry knowledge in agriculture activity in the perception of 9th grade students.

The connection between students' goal and affective experiences revealed that this relationship may be the key to fostering their interest, in which case performance may lead to professional success.

c. Influence of commuting phenomenon and "learning style" on the marks obtained at Chemistry assessment

"Residence" was considered the independent variable (*IV*) and item "*V*" the dependent variable (*DV*). The coding of the *VI* was intentionally established because school practice over several years has revealed that students from boarding school are less disturbed by the commuting phenomenon in contrast to commuter students who make this trip daily. For an appropriate interpretation of results, the Jonckheere-Terpstra test (named J test) was applied (Table 2).[11] This test is specific to directional analysis. The investigated hypothesis (H^1) was that an intensification of the commuting phenomenon would lead to lower test scores in disciplines perceived as difficult by students (in this case, Chemistry). The relatively small sample size (N = 46) and the nature of the data (qualitative variables resulted from the answers to questionnaire of the Likert type) required the application of a test of this kind (Table 3). Additionally, a bidirectional Kruskal-Wallis test was applied (Table 4), contrary to the directional assumption of the J test, in order to detect any statistically significant influence on the initial *IV* hierarchy (Was it incorrect from the beginning?).

Table 2. Values of Jonckheere-Terpstra test (grouping variable: Residence).

Case	**TI experiment***
Number of Levels in Residence	3
N	46
Observed J-T Statistic	430.500
Mean J-T Statistic	350.000
Standard Deviation of J-T Statistic	47.208
Standard J-T Statistic	1.705
Asymp. Sig. (2-tailed), p	0.088

*****TI experiment - progress test scores during the laboratory experiment

Table 3. Median test-Test Statistics (grouping variable: Residence).

Case	**TI experiment**
N	46
Median	6.00
Chi-Square, χ^2	2.469[a]
Degree of freedom, Df	2
Standard J-T Statistic	1.705
Asymp. Sig. (2-tailed), p	0.291

[a] 3 cells (50.0%) have expected frequencies less than 5.
The minimum expected cell frequency is 2.4.

The J test value is 430.5. The standardized J test statistic (“Std J-T Statistic”) (z = 1.705) corresponds to a significance level higher than conventional threshold of 0.05 ($p > 0.05$), as shown in Table 2.

Therefore, the J test is not statistically significant in this context. In the investigated case, it cannot be stated that commuting has an influence on students' Chemistry test scores. Also, the median test was not statistically significant (Table 3): $\chi^2 = 2.469$ at $p > 0.05$. For sample of 46 cases, values above the median compensate for lower values. In Table 4 are shown the distribution of values according to "Residence" for each subgroup of the sample and Table 5 reports the Kruskal Wallis test statistics. The Kruskal Wallis test was also not statistically significant because KW = 2.869 at $p > 0.05$ (Table 5). In terms of non-parametric technique, it can be concluded that the commuting phenomenon does not influence the students' grades in Chemistry.

Table 4. Kruskal-Wallis-ranks test.

Case	**Residence**	**N**	**Mean rank**
TI experiment	3	14	19.43
	6	14	22.93
	7	18	27.11
	Total	46	

Table 5. Test Kruskal-Wallis-test statistics.

Case	**TI experiment**
Chi-Square, χ^2	2.869
Degree of freedom, Df	2
Asymp. Sig. (2-tailed), p	0.238

Further, it was studied the influence of "Residence" and "Learning Style" variables on students' grades in Chemistry tests (Figure 3).

In approaching the analysis of learning styles, we started from the observation that the auditory learning style shows the highest frequency in students' responses, followed - very similar levels-by the other two styles. The highest frequency was found in case of “hearing” learning style among both local and boarding school students. A frequency of three cases (commuting students) was found for both the “practical” and “visual” learning styles.

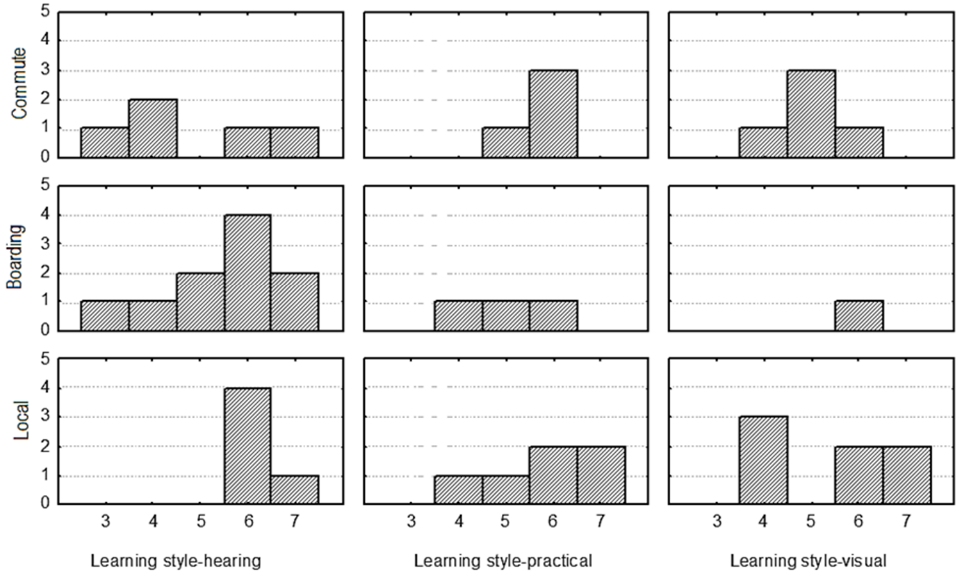

Figure 3. The reciprocal influence of “Learning style” variable (horizontal axis) and “Residence” variable (vertical axis) on the students marks at initial Chemistry test.

Repeating the J test for “Learning style” variable (item *VI*), also indicated a lack of statistically significant influence of this variable on Chemistry test scores (Table 6) and Agriculture post-experimental test grades, respectively (Table 7). However, there is a difference between the two situations: the negative sign of *z* value of J test (Table 7). In this case, it can be stated that the grades obtained by the students in their preferred specialty (Agriculture) indicate-a tendency toward reverse variation between

"Learning style" and "Agriculture test grades". In contrast, in the case of Chemistry – a discipline perceived as more difficult - there is a tendency toward direct variation between "Learning style" and "Chemistry test grades". Overall, learning style shows different patterns of influence–on grades in the two disciplines; however, these differences are not statistically significant.

Table 6. Values of Jonckheere-Terpstra test (grouping variable: Learning style on Chemistry test grades).

Case	**TI experiment**
Number of Levels in Learning style	3
N	46
Observed J-T Statistic	374.500
Mean J-T Statistic	344.500
Standard Deviation of J-T Statistic	46.912
Standard J-T Statistic	0.639
Asymp. Sig. (2-tailed), p	0.522

Table 7. Jonckheere-Terpstra test (grouping variable: Learning style on Agriculture post-experimental test grades).

Case	**TI experiment**
Number of Levels in Learning style	3
N	46
Observed J-T Statistic	311.000
Mean J-T Statistic	344.500
Standard Deviation of J-T Statistic	47.915
Standard J-T Statistic	-0.699
Asymp. Sig. (2-tailed), p	0.484

d) *Reciprocal influences between variables resulting from self-assessment test*

Figure 4 show the results of interaction between the frequencies of items *VIII*, *XI* and *XII*. The selection of these three items was based on the purpose of training students at the secondary school level, as well as on the circumstances in which this training take place. The interest concern both the Chemistry teacher, who has a "diagnosis" of the outcomes of teaching approaches distinct from the traditional curriculum, and the student, who needs knowledge, a climate of cooperation with peers, and a potential employer (i.e., the job market) for whom these students may become future employees.

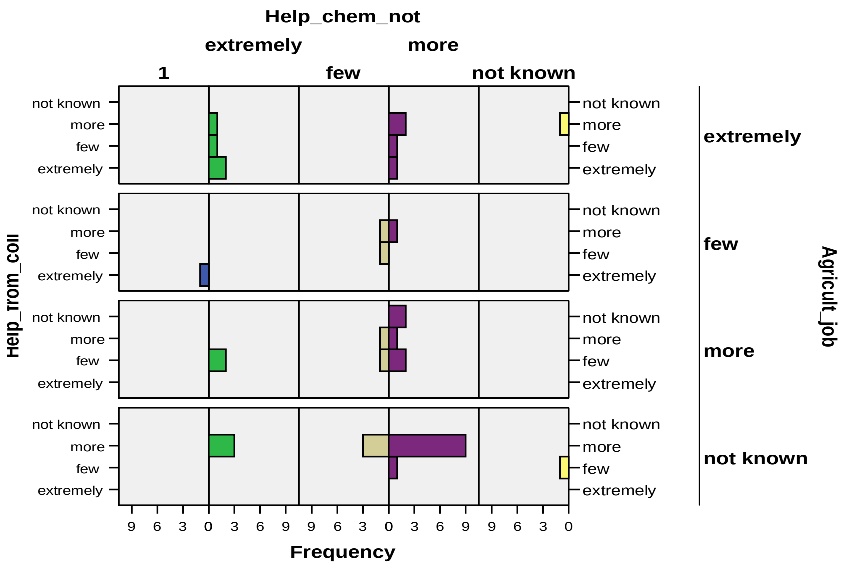

Figure 4. Interaction between VIII-XI- XII items from self- assessment questionnaire.

From point of view of frequency distribution corresponding to variable *VIII*, the option "much " prevailing over those in the "least " category. The categories "very much" and "I don’t know" occur sporadically or do not appear at all. This provides evidence of the cooperation demonstrated by the students involved in this project. The frequency values corresponding to the same variable (*VIII*) are consistent with response options close to the "much" category of variable *XI*. It is an encouraging aspect for employers in a field that is often overlooked, yet vital to the country's economy-Agriculture.

Additionally, from the point of view of frequencies corresponding to the variable *XII*, it can be noted that, although the frequencies are relatively small in number, they are concentrated in "very much" and "more" categories which coincide with the "more" option of variable *XI*.

The investigation result of interaction between the frequencies of variables corresponding to items *VIII*, *XI* and *XII* are presented in Figure 5. The selection of these items was based on the continuity of students' training in the domestic environment. Different household responsibilities and agricultural purposes may enhance students' interest in school and intellectual development. In general, this is also of interest to the technology teacher that has a realistic image of the effectiveness of their efforts in a desirable direction. Students are encouraged by the cooperation and competition, at least in the initial stage of training. From perspective of the frequency distribution corresponding to the variable *I*, the options ranging from "very long time" (5) and "long time" (4) to "so-so" (3) prevail over the other two response categories.

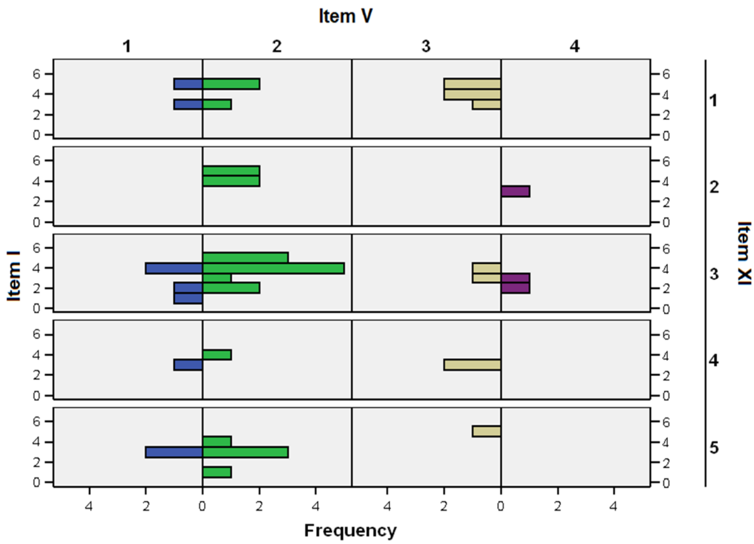

Figure 5. Interaction between I-V- XI items from self- assessment questionnaire.

The frequency values corresponding to variable *V* show a high proportion of the "agree" (2) and “indifferent” (3) categories (Figure 5). The diagram result call into question the usefulness of the approaches of student-centered knowledge approaches in encouraging his integration into the class team.

e. The information persistence – opinions after a year of interdisciplinary experiment (school year 2023-2024)

In this paragraph are presented some answer given by the students involved in inter-disciplinary experiment.

Landmark question 1: What do you remember from last year's experiment?

Answer 1.1: Since the last year’s experiment, I learned that if I want to cultivate a plant, I must take into account its requirements from heat, light, water and soil, as these factors determine whether the plant grows more or less.

Answer 1.2: For example, I remember that in soil with an alkaline reaction nothing germinated, compared with soils with acidic reactivity on which some plants have grown. Also, I observed the stages of plant growth.

Answer 1.3: I observed that certain soil types must be watered more frequently because the plants dried out and began to suffer from a lack of water. Also, I measured rainfall, temperature, air pressure, humidity, wind speed, as well as soil texture, structure and pH.

Answer 1.4: I did not see the connection between disciplines before this experiment. I could not believe that what I learned in Chemistry can be use in the field for which I am preparing.

Landmark question 2: What mistakes did you often make last year and which ones you corrected this year?

Answer 2.1: I always confused cations with anions, soil properties, fine texture with the specific coarse texture, and the organic part of the soil with the mineral part. I did not understand what aggregated soil is or the pH values specific acidic and alkaline reactivity of soil.

Landmark question 3: What can you do now as a result of participation in this experiment?

Answer 3.1: Now, I know how to determine soil texture and pH and, depending on these factors, apply measures of soil tillage and plant care, to asses soil fertility and humus content based on soil color.

Answer 3.2: I know that it is important for the soil to be well structured in order to provide a good aeration and adequate moisture conditions for plants. Dusty soil has a damaged structure, easily forms a crust, and hinders plant growth.

Answer 3.3: I can say that I learned how to work as part of a team with my colleagues. At the beginning, we were very individualistic and mischievous, as some of us destroyed plants and others were rather slack. During the experiment, we realized that we could not escape our duties and, in the end, I regretted that the experiment had finished.

Landmark question 4: Have you applied the knowledge gained so far?

Answer 4.1: Yes, I showed my mom that I know how to cultivate some plants and even now I do not forget to water the flowers on time.

After one year, students' knowledge has consolidated, and from an affective and behavioral point of view, a change in the importance attributed to the subjects studied in high school in relation to future professional activity has been observed. Also, teamwork was associated with students' goals and individual responsibilities and performances; thus, it has the potential to serve as an effective motivational intervention and to support the development of interest.[12]

Conclusions

The idea of "permeabilization" of formal delimitations between disciplines is not a new and has been imposed by new socio-economic realities. The approach of professional reconversion is often necessary due to the excessive amount of information specific of knowledge society, the dynamics of professions and reality according to which an initial training no longer guarantees long-term professional stability (in term of preserving specific tasks or a workplace)

The teaching experiment focused on the Chemistry-Agriculture area, emphasizing notions that might appear unattractive or inappropriate for professional practice or for developing a passion for a particular field. The idea of curriculum complementarity between two disciplines within curriculum areas is essential and interest studying a given discipline can also be through a related field. Checking the persistence of information over an extended time frame highlighted the cognitive acquisitions and skills acquired by students, obviously, not only because of the two disciplines that this paper focused on.

The influence of variables such as the distance by a student to attend school (the commuting phenomenon), learning style, gender and age of respondents was not statistically significant with respect to grades in a discipline often considered difficult or even unattractive (Chemistry) for this segment of the school population. Among the causes, the following are worth mentioning: teaching style and content accessibility via experiment, achieved by the gradual and natural “erasure” of formal delimitations between contents. With regard to gender and age, there are no psycho-pedagogical arguments supporting such influences in the case of the first variable and, as far as age is concerned, the presence of students one year older than the standard age did not significantly influence grades. It is also worth noting that Chemistry concepts were valued as having clear professional usefulness do to the effort of teachers in these disciplines, which may explain the limited occurrence of the researched influences. We conclude that the interdisciplinary approach to educational content in the two fields, Chemistry and Agriculture, proved useful and necessary for developing an overall phenomenological vision and for establishing an appropriate relationship with technological evolution in the knowledge society and the surrounding reality. Among the main challenges, we can identify the impediments created by a mainly traditional educational system, which emphasizes the informative dimension and relies on teachers trained in mono- or bi-disciplinary frameworks.

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