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Original article

Diagnosis of the initial state of professionalization of the chemical content specialty Agronomy

Diagnóstico del estado inicial de la profesionalización del contenido químico especialidad Agronomía

Diagnóstico do estado inicial de profissionalização da especialidade de conteúdo químico Agronomia

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ABSTRACT

The new task posed by Cuban society, regarding the improvement of new economic actors, demands the training of Middle Technicians in Agronomy as a priority of the policy of the Cuban state. The above requires a professional vision of the chemical contents applied to Agronomy; while updating the country's economic model requires a qualified workforce to transform agriculture and bring it to high rates of productive efficiency. In this direction, as the objective of the article, the state of the professionalization of the chemical contents of the Agronomy specialty in pedagogical praxis was diagnosed. For this, empirical methods were applied: document review; surveys of teachers, tutors from labor and students entities; observation of the teaching-learning process of Chemistry and pedagogical test. Likewise, the following were used as materials: the study plans for the training of middle technicians in the Agronomy specialty (Ministerial Resolutions 109/2009, 106/2020), the programs for the subjects Chemistry and Basic and specific vocational training. The results obtained confirmed the manifestation of insufficiencies in the professional training of the student of the Agronomy specialty, from the limited possibilities to establish essential relationships between chemical and professional content, for the solution of agrochemical problems. These allowed us to confirm the main causes that gave rise to the problem in question. Furthermore, they justify the need for a new proposal that allows the solution of agrochemical problems in the essential contexts of Technical and Professional Education.

Palabras clave: diagnosis; professionalization; chemical content; teaching-learning process.

RESUMEN

El nuevo encargo que plantea la sociedad cubana, en cuanto al perfeccionamiento de los nuevos actores económicos, demanda la formación de Técnicos Medios en Agronomía como una prioridad de la política del estado cubano. Lo anterior, necesita una visión profesionalizada de los contenidos químicos aplicados a la Agronomía; en tanto, la actualización del modelo económico del país requiere de la fuerza de trabajo calificada para transformar la agricultura y llevarla a altos índices de eficiencia productiva. En esta dirección, como objetivo del artículo, se diagnosticó el estado en el que se encuentra la profesionalización de los contenidos químicos de la especialidad Agronomía, en la praxis pedagógica. Para ello se aplicaron los métodos empíricos: revisión de documentos; encuestas a profesores, tutores de las entidades laborales y estudiantes; observación al proceso de enseñanza-aprendizaje de Química y prueba pedagógica. De igual manera, fueron empleados como materiales: los planes de estudio para la formación de técnicos medios en la especialidad Agronomía (Resoluciones Ministeriales 109/2009, 106/2020), los programas de las asignaturas Química y Formación profesional básica y específica. Los resultados obtenidos constataron la manifestación de insuficiencias en la formación profesional del estudiante de la especialidad Agronomía, desde las limitadas posibilidades para establecer relaciones esenciales entre los contenidos químicos y profesionales, para la solución de problemas agroquímicos. Estos permitieron confirmar las principales causas que dieron origen al problema en cuestión. Además, justifican la necesidad de una nueva propuesta que permita la solución de problemas agroquímicos en los contextos esenciales de la Educación Técnica y Profesional.

Palabras clave: diagnóstico; profesionalización; contenido químico; proceso de enseñanza-aprendizaje.

RESUMO

A nova tarefa colocada pela sociedade cubana, no que diz respeito ao aperfeiçoamento de novos actores económicos, exige a formação de Técnicos Médios em Agronomia como prioridade da política do Estado cubano. O exposto exige uma visão profissional dos conteúdos químicos aplicados à Agronomia; ao mesmo tempo que a actualização do modelo económico do país requer uma mão-de-obra qualificada para transformar a agricultura e levá-la a elevados índices de eficiência produtiva. Nessa direção, como objetivo do artigo, diagnosticou-se o estado da profissionalização dos conteúdos químicos da especialidade Agronomia na praxis pedagógica. Para isso foram aplicados métodos empíricos: revisão documental; pesquisas com professores, tutores de entidades trabalhistas e estudantes; observação do processo de ensino-aprendizagem de Química e prova pedagógica. Da mesma forma, foram utilizados como materiais: os planos de estudos para a formação de técnicos médios na especialidade de Agronomia (Resoluções Ministeriais 109/2009, 106/2020), os programas das disciplinas de Química e de Formação Profissional Básica e Específica. Os resultados obtidos confirmaram a manifestação de insuficiências na formação profissional do aluno da especialidade Agronomia, a partir das limitadas possibilidades de estabelecer relações essenciais entre conteúdos químicos e profissionais, para a solução de problemas agroquímicos. Estas permitiram confirmar as principais causas que deram origem ao problema em questão. Além disso, justificam a necessidade de uma nova proposta que permita a solução dos problemas agroquímicos nos contextos essenciais da Educação Técnica e Profissional.

Palavras-chave: diagnóstico; profissionalização; conteúdo químico; processo de ensino-aprendizagem.

INTRODUCTION

Updating the country's economic model requires a qualified workforce to transform agriculture. In this sense, the professionalization of content in various areas of knowledge is a topic worth highlighting due to its social importance, since it is necessary to conceive a teaching-learning process that allows giving a professionalized vision of the chemical contents applied to Agronomy.

Studies on professionalization, currently, constitute a field accessible to diverse perspectives of analysis in different middle and higher level careers. The search carried out on the topic in the last five years revealed that, in general, the published articles revolve around: pedagogical professionalization (De la Rosa *et al.*, 2018). Likewise, publications focused on teacher professionalization were found: Rivero *et al.* (2019), Delgado (2019), Agüero *et al.* (2021), Clavero *et al.* (2021).

In addition, there are other publications associated with the professionalization of teaching: Milián *et al.* (2017), Cedeño *et al.* (2019), Rodríguez *et al.* (2021) and Cherrez (2023). The analysis of these investigations showed that professionalization is a highly studied category in the context of medical sciences in Cuba in the management of the different processes carried out in Educational Sciences.

However, it is necessary to carry out a brief analysis of the research that, in the opinion of the authors, constitutes references, from the professionalization of teaching in Educational Sciences. In Cuba, León *et al.* (2014) recognizes as limitations that students show insufficient development in basic skills such as: modeling, optimizing, approximating, graphing and problem solving, which limits the use of Mathematics in scientific-student activities related to the object of study of the profession. In this sense, they consider the achievement of developmental learning as a result of the professionalization of the teaching-learning

process of Mathematics, which allows the Agricultural Engineer in training to make efficient use of the contents of this science in their scope of action.

They consider, for the professionalization of the teaching-learning process of Mathematics in the training of the Agricultural Engineer, four stages: diagnosis, planning, execution, control and comprehensive evaluation of the results. Each stage has its dimensions.

For their part, Milián *et al.* (2017) takes as a starting point the insufficiencies in the appropriation of content presented by students of the Masonry specialty to solve professional exercises in the Mathematics subject. Consequently, it offers a system of professionalized exercises in the Mathematics subject that boost the appropriation of content in students of the aforementioned specialty.

Meanwhile, Cedeño *et al.* (2019) focuses their study on the investigation of the essential characteristics of the professionalization process of Mathematics teaching, both in Cuba and Ecuador. The following difficulties are identified as: insufficient integration between the teaching-learning process and the production and service process; The problems present in social practice are not the object and starting point to develop the teaching-learning process. The results of the application of various instruments are presented, which allow us to know the regularities of this process.

In another order, Rodríguez *et al.* (2021) shows a set of professionalized teaching activities proposed for students of the Bachelor's Degree in Civil Construction, with the purpose of awakening their interest in learning Chemistry. These activities allowed the authors to interdisciplinary connection with topics of their profession and with the Environmental curricular strategy.

At the international level, Cherrez (2023) focuses on the professionalization of content in the teaching-learning process of Mathematics in

the Business Administration degree at the University of Guayaquil. The author carried out a study focused on the treatment of the professionalization of the content from the Applied Mathematics subject, in the aforementioned career. Its essence lies in revealing the importance of incorporating actions for the teaching-learning process of Mathematics, which integrate the modes of action of future professional activity.

In general, several of the cited authors converge in their approach to professionalization based on its procedural nature. Likewise, they take into account professional training in various contexts and the theory-practice link. We agree with them in understanding professionalization in its procedural nature, since it favors a didactic organization of the teaching-learning process of Chemistry, based on the logic of science; taking into account its interdisciplinary and integrative nature, contextualized to the demands of the professional model for the Middle Technician in Agronomy.

However, it still lacks sufficient theoretical argumentation from the didactics of Chemistry, around the professionalization of its contents, which has as its center the relationship between: the guiding ideas, the guidelines, and the agricultural production processes, such as way to contextualize the aforementioned process: to the object of the profession of the Middle Technician in Agronomy, to the productive reality and to the agrochemical problems that arise in the polytechnic school and in the labor entity. In this way, a process of professionalization of chemical content is assumed in relation to the professional needs of future Middle Technicians in Agronomy.

Everything previously addressed constituted the starting point to carry out a factual diagnosis with the purpose of verifying the current state of the professionalization of chemical content in the Agronomy specialty.

MATERIALS AND METHODS

The scientific research methodology used followed the descriptive and analytical approach, in which the relationship between guiding ideas, guidelines and agricultural production processes is taken as the unit of analysis of the study, for the professionalization of the chemical contents in the specialty Agronomy.

The research was developed at the "Armando Mestres Martínez" Polytechnic Institute, in the Yara municipality, with a population consisting of: 48 students (16 who received the subject of Chemistry in the first year and 32 who received it in the second and third years); 15 teachers (two who teach the subject of Chemistry in the Agronomy specialty, eight who teach the technical subjects in the specialty and five who are responsible for pre-professional practice); and 10 tutors from labor entities.

The study plans for the training of middle technicians in the Agronomy specialty (Ministerial Resolutions 109/2009, 106/2020) and the programs for the subject Chemistry and basic and specific vocational training were used as materials. In correspondence with the objective of the research, the following criteria for selecting the methods are taken: the study area, the characteristics of the research and the selected sample, the information from which it is based and the time for data collection. In this order, the methods applied were: surveys of students, teachers, tutors of labor entities, observation of the teaching-learning process of Chemistry and the pedagogical test. In addition, descriptive statistics techniques were used for data collection, processing and analysis.

The main limitation of the research is the determination of the opportune moment for the application of the instruments, which made the qualitative interpretation of the results difficult in the expected time.

RESULTS

To carry out the assessment of the results derived from the application of the instruments, the following indicators were determined: potential of the curriculum for the professionalization of chemical content; mastery of the professional model and professional problems related to Chemistry, by the teachers and tutors of the labor entity; treatment of chemical and professional content and mastery by students of chemical and professional content for solving agrochemical problems.

The results obtained in correspondence with each indicator were as follows.

The potential of the curriculum for the professionalization of chemical content is evaluated based on the document review method; in this case, the professional model and the Chemistry and technical subjects programs. The assessment of the professional's model showed that there is correspondence between the professional's tasks and occupations with the objectives of the Chemistry subject program. However, it is a limitation that the professional problems that students must solve are not defined, in correspondence with the tasks and occupations.

This difficulty also persists in the Chemistry and technical subjects programs. However, the in-depth study of these programs made it possible to distinguish the relationship between chemical content and professional content. In this order, the most general chemical content, which constitutes the central axis for professionalization, is that related to organic and inorganic components. From this, a more specific content system is broken down that is taught in the Chemistry subject in the first year.

This content system is composed of the following: structure of substances, periodic table, metals and non-metals, substances and chemical reactions, thermochemical and kinetic behavior of chemical reactions, solutions, molecular balance, ionic balance, chemical

reactions, oxidation-reduction, electrochemistry, general notions of Organic Chemistry. The contents are systematized from the distinctions of the professional content of the technical subjects.

In this way, in the subject Base of Agricultural Production, matters related to: chemical components and origin are addressed; the chemical properties of carbohydrates, lipids and proteins. On the other hand, the subject Comprehensive Soil Management I studies, among others, the chemical phenomena that occur in the soil, as well as the tasks that can improve and preserve its properties.

In this case, the essential chemical contents constitute: organic matter, chemical properties, essential elements for plant nutrition, agrochemistry and its importance in the development of agriculture, nutrient absorption, selective absorption and ion exchange, fertilizers, erosion, soil conservation and improvement, and sustainable land management.

Meanwhile, the subject Work in Agricultural Production, as an integrative subject in the training of technicians, addresses: the production and application of organic fertilizers; application of measures for the use, conservation and improvement of soils and the protection of the Environment; application of standards and technical instructions in soil preparation. It also develops content related to the execution of tasks in vermiculture, compost, and bioland in general.

Likewise, the subject Agricultural Production I and II constitutes within the curriculum, in the training of the Intermediate Technician in Agronomy, a governing subject of the study plan; It is an essential pillar in the training and development of professional skills specific to the specialty: fertilization; importance of applying fertilizer knowing the needs of the plants and the agrochemical cartogram; relationship of fertilization with other crop tasks; irrigation; types of irrigation; different irrigation

techniques, concept; relationship of irrigation with other cultivation tasks; fertigation; advantages; seed pretreatment: pregermination, soaking prior to sowing and other techniques or pretreatment (physical-thermal-chemical); fertilization in grain-producing species; characterization according to species; the cultivation of beans, soybeans, peanuts and others, as rotation plants, their benefits and limitations; the use of biofertilizers in grain production.

The previous evaluations certify that the current curriculum, based on the established curricular adjustments (RM-106-2020), offers potential for the professionalization of chemical content, in correspondence with the objectives and purpose of the professional model for the Middle Technician in Agronomy. However, it is considered that, in response to the need to professionalize this content, the use of the properties and applications of the substances as an articulating axis of the essential relationships between the Chemistry subject and the technical subjects is required.

To have an approach to the domain that the teachers and tutors of the labor entity have regarding the professional model and the professional problems related to Chemistry, 15 teachers and 10 tutors were surveyed. 80% of the teachers surveyed (12) claim to master the tasks and occupations of the professional model, to which their subjects apply, as well as the professional problems related to Chemistry that are solved from them. However, they assure that they only sometimes take into account the relationship of the content to be developed with the tasks and occupations of the professional model and with the professional problems related to Chemistry.

On the other hand, nine teachers of technical subjects, which represent 69.2%, affirm that they establish interdisciplinary relationships with the subject of Chemistry and the two Chemistry teachers claim to guarantee this process with the technical subjects. In both cases, the fundamental way is methodological preparation.

Meanwhile, one Chemistry teacher, representative of 50%, and eight technical subjects, which constitutes 61.5%, consider that the current curricular adjustments (RM 106/2020, MINED, 2020) favor the relationship between chemical contents and professionals, in correspondence with the tasks and occupations to which the Chemistry subject is concerned.

50% of the tutors (5) who attend the third-year work practice and fourth-year pre-professional practices surveyed (5) confirm the mastery of the professional model and the professional problems related to Chemistry, which students linked to Chemistry must solve productive or service activities, within the vocational training process. However, they agree in stating that it is a difficulty in the training guides, since activities that lead students to solve these and other professional problems are not conceived.

In one of the Chemistry classes observed (16.66%), the relationship of the content of the subject with the tasks and occupations of the professional model is partially appreciated. Also, partially, the relationship between professional and chemical content is contextualized, based on real situations of the object of the profession, in relation to the tasks and occupations of the professional model. Only in this percentage can we see that there is a correspondence between the conceived activities and professional problems and those related to Chemistry, based on real situations related to the profession.

In general, the previous assessments allow us to verify that the teachers and tutors of the work entity, for the most part, claim to master the professional model and the professional problems related to Chemistry. Despite this, there are difficulties in establishing interdisciplinary relationships that favor the professionalization of chemical content.

The qualitative and quantitative assessment of the surveys applied to 48 first, third and fourth year students of the Agronomy specialty allowed us to confirm that, for 45 (93.75 %), the content received from the Chemistry subject has no

relationship with other technical subjects. Regarding the ways used by the Chemistry teacher, more frequently in classes to deal with the content, five (10.41%) express sometimes using reflective questions; 41 (85.41%) use reproductive questions; while 15 (31.25%) say they never use problematic situations and argue that they cannot motivate them enough for learning.

On the other hand, 44 students (91.66%) claim that the teacher never uses exercises or problems. While seven (14.58%) confirm that they sometimes use exercises and problems, but only related to the chemical content. 100% express that the teacher does not carry out experiments that relate chemical contents to professionals.

Likewise, 46 (95.83%) claim that, in work and pre-professional practices, professional problems related to Chemistry are almost never used. Among their arguments, they argue that these practices are limited to carrying out activities in accordance with the needs of the labor entity, which are not always related to the content received up to that point.

To verify what was stated by the students, a total of 14 observations were made in classes, six in Chemistry and eight in technical subjects. As a result, it was obtained that only in two (33.3%) of Chemistry, and in two (25%) of technical subjects, teachers establish a relationship between chemical and professional content. It is also observed in four (67%) and five (63%) respectively, the development of experimental activities. Of these, only one (17%) Chemistry class and two (25%) technical subjects address the relationship between chemical and professional content.

Regarding the use of teaching tasks in Chemistry classes, those that contribute to reflection are used in two (33.3%) and reproductive tasks in four (67%). In the subject classes visited, reflective teaching tasks are used in three (37.5%) and reproductive tasks in five (62.5%). As for problem situations, they are used only in

one (17%) Chemistry class and in two classes (25%) of technical subjects. Meanwhile, the exercises are used in two (33.3%) Chemistry classes and the professional problems in three (37.5%) classes of technical subjects.

Of the 14 classes observed, 100% have difficulty relating chemical contents to professionals. The presence of insufficiencies in the learning of the content was confirmed, from its understanding to its deepening and application. The mastery of previous knowledge and skills is insufficient to assimilate new knowledge. The possibilities for establishing relationships between chemical and professional content linked to the exercise of the profession are restricted.

The results offered in relation to class observation allow us to verify that, even though the highest percentage of teachers surveyed demonstrate mastery of the professional model and the problems related to Chemistry, there are difficulties in the interdisciplinary treatment of chemical contents and professionals, for the professionalization of chemists, from its relationship with the object of the profession of Medical Technician in Agronomy.

The previous evaluations point to the lack of use of ways that allow the teaching and learning of chemical content to promote motivation and the interdisciplinary relationship between the subject of Chemistry and techniques as a cause of these insufficiencies. Another cause is that the teaching tasks used do not always promote the needs, motives and interests of students, reflection, the establishment of essential relationships between chemical and professional content, as well as their application in practice.

To evaluate the level of mastery of chemical and professional content for solving agrochemical problems, the pedagogical test is used as a method. This part of defining an agrochemical problem that students must solve, according to the chemical content received up to this point. Its solution occurs through a learning situation that the teacher poses, so that through the questions he asks, the student demonstrates his

mastery of the chemical and professional content to identify the agrochemical problem in question and, subsequently, apply them to give solution.

The indicators used to evaluate the test are the following: depth in the assimilation of knowledge, development of professional skills and development of professional values. A scale is used for each indicator of high, medium and low. Next, the structure and content of said test is described methodologically.

Pedagogical test

Objective: to verify in third-year students the level of mastery of chemical and professional content for solving agrochemical problems.

Agrochemical problem to solve: nutrient absorption as an essential requirement for the correct growth and development of the rice crop.

Learning situation

In the Basic Cooperative Production Unit, belonging to the Agricultural Company, "Paquito Rosales", which is part of the productive teaching strategy, 5 hectares of rice cultivation are established. The technician from the labor entity, together with the Chemistry teacher who is in charge of the activity, have detected the presence of the following symptoms in the crop: in some plants, the leaves show a dark green color, the lower ones mottled with necrotic spots on the tip and edges folded downwards, yellowing begins at the edges and develops towards the center; others, sometimes, take on an anthocyanin color. The stems, which are usually weak, lose elasticity and, in general, the plants achieve exuberant growth. According to the symptoms described, answer:

1. As studied in Chemistry classes in previous years, identify, based on the symptoms that rice plants present, the essential chemical element that is affecting the absorption of nutrients from the soil.

- 1.1. Locate it on the 18 column periodic table.
- 1.2. How many chemical elements does this table contain?
- 1.3. List the non-metal chemical elements.
- 1.4. Classify non-metal chemical elements into macroelements and microelements.
2. What agrochemical production processes need to be undertaken to mitigate the symptoms shown in rice cultivation?
3. Defines the technological process to follow.
4. Determines what chemical components are required for rice cultivation to guarantee adequate development and growth.
5. Establish a comparison between them.
6. Explain the possible causes that caused the problem with the absorption of nutrients from the soil and that could affect the proper development of the plant.

Indicators to evaluate:

1. Depth in the assimilation of knowledge.
 - Identify, based on the symptoms presented by rice cultivation plants, the essential chemical element that is affecting the absorption of nutrients from the soil.
 - Particularizes in the mastery of the chemical contents received in the first year of study.
 - Determines the agrochemical production process to be developed to solve the agrochemical problem.
 - Delimits the technological process to be developed for soil fertilization.
 - Relates the organic and inorganic components that intervene in the physiology of plants.
 - Explains the causes that cause the problem with nutrient absorption.

High: when students show mastery of the chemical content received in the first year, as well as when they identify the agricultural production process to be developed, they delimit

all the procedures that make up the technological process to fertilize, relate the organic and inorganic components and explain the causes that cause the emergence of the problem with the absorption of nutrients.

Medium: when students identify the agricultural production process to be developed, they delimit only some of the procedures that make up the technological process to fertilize, they relate the organic and inorganic components and cannot explain the causes that lead to the emergence of the problem with the absorption of nutrients.

Low: when learners only identify the agricultural production process to be developed.

2. Development of professional skills (fertilize ability).

- Transfer: logically uses technological procedures to fertilize, with different levels of complexity and variability.

High: apply the appropriate procedures in the technological process to fertilize, without making mistakes.

Medium: applies the appropriate procedures in the technological process to fertilize, but makes mistakes when reversing the order of operations.

Low: omits procedures in the technological process to fertilize.

- Precision: successful solution in the application of technological procedures to fertilize.

High: when it executes the specific procedures inherent to the technological process to fertilize.

Medium: when it executes the procedures inherent to the

technological process to fertilize, but shows inaccuracies.

Low: when in the execution of the technological procedure to fertilize, poor choices are made regarding the specific procedures to fertilize.

- Flexibility: they use several ways to fertilize, in accordance with the technology used and propose adjustments.

High: when they use more than one alternative and propose adjustments to mitigate the negative influence of nutrient absorption on the crop.

Medium: when they use only one alternative and propose adjustments.

Low: when they use an alternative and express limitations in proposing adjustments.

- Speed: use of the appropriate time to fertilize, in accordance with the technology used.

High: they use less time than it takes to fertilize.

Medium: Adjusts to the average time to fertilize.

Low: they need longer than average to fertilize.

- Independence: it is measured through the autonomy that is manifested to cope with new situations.

High: executes the technological process to fertilize in new situations, without resorting to any level of external help.

Medium: executes the technological process to fertilize, with difficulties in a new situation, which requires levels of external help.

Low: execute the technological process to fertilize only in known situations and resort to external levels of help.

High: when in the midst of the execution of a certain technological procedure they make value judgments, with knowledge of the facts, regarding its impact on the growth and development of rice cultivation, and on productive development in general.

Medium: when, in the middle of the execution of a certain technological procedure, they make imprecise value judgments about its impact on the growth and development of rice cultivation, but not on productive development in general.

Low: They have limitations to judge the impact of the technological procedure for the growth and development of rice cultivation and for productive development in general.

3. Development of professional values

It is evaluated by determining whether students show modes of action consistent with the objectives of the professional's model, during the execution of the technological process to fertilize.

Indicators:

- Demonstration of conscience of producers.

High: its mode of action is consistent with efficient food production, demonstrates mastery in the application of advanced technologies and correctly evaluates the technological procedures used to fertilize.

Medium: its mode of action is consistent with efficient food production, it demonstrates mastery in the application of advanced technologies, although it has limitations in evaluating the technological procedures used to fertilize.

Low: in its mode of action it manifests inconsistencies in relation to the efficient use of technologies and/or has limitations in evaluating the technological procedures used to fertilize.

- They show sustainability criteria during fertilization.

The qualitative assessment of the results from the pedagogical test applied to 16 second-year students of the Agronomy specialty allows us to verify that 12.5% of the students (2) identify the agricultural production process to be developed, delimit all the procedures that compose the technological process to fertilize, relate the organic and inorganic components and explain the causes that lead to the emergence of the problem with the absorption of nutrients. The above shows a high level of depth in the assimilation of knowledge.

18.75% (3) show a medium level in this indicator; although they identify the agricultural production process to be developed and relate the organic and inorganic components, they only delimit some of the procedures that make up the technological process to fertilize. In addition, they present difficulties in explaining the causes that lead to the emergence of the problem with nutrient absorption.

Meanwhile, 68.75% (11) show a tendency to reproduce and memorize knowledge and only

identify the agricultural production process to be developed, which is why they are diagnosed with a low level of depth in the assimilation of knowledge.

In relation to their development of the ability to fertilize, a high level is confirmed in only 12.5% (2), since they logically apply the appropriate procedures in the technological process to fertilize, without making mistakes. The same percent, although they apply the appropriate procedures in the technological process to fertilize, show an average level, since they make errors when reversing the order of operations. While 75.00% (12) show a low level, they omit procedures in the technological process to fertilize.

Regarding the level of precision, a high level is found at 18.75% (3), since they execute the specific procedures inherent to the technological process to fertilize. It has a medium level of 12.5% (2), given that they execute the procedures inherent to the technological process to fertilize, but show inaccuracies. With a low level, 68.75% (11) are corroborated, presenting difficulties in correctly choosing the technological procedures to fertilize.

In relation to flexibility, it is confirmed that 12.5% (2) show a high level, since they use more than one alternative to solve the problem and propose adjustments to mitigate the negative influence of nutrient absorption on the crop. 18.75% (3) use only one alternative and propose adjustments, which shows a medium level of flexibility; while 68.75% (11) are diagnosed at a low level because, in addition to using only one alternative solution to the problem, they exhibit limitations in proposing adjustments.

The evaluation carried out on speed showed a high level only in 6.25% (1), since it uses less time than is required to fertilize, in accordance with the technology used. With a medium level, 18.75% (3) are confirmed, they adjust to the average time to fertilize. At a low level, 75% are

diagnosed (12), while they require longer time to fertilize than average.

With a high level of independence in solving the problem, 12.5% (2) are shown, manifested in their autonomy to execute the technological process to fertilize in new situations, without resorting to any level of external help. 25% (4), with a medium level, execute the technological process to fertilize, with difficulties in the face of a new situation, which requires levels of external help. Meanwhile, 62.5% (10) show a low level; They execute the technological process to fertilize only in known situations and resort to external levels of help.

Taking into account the development of professional values during the execution of the technological process to fertilize, the manifestation of awareness of producers is evaluated at 12.5%, (2) at a high level, demonstrated by their mode of action consistent with production efficient food production, mastery in the application of advanced technologies and accurate evaluation of the technological procedures used to fertilize.

In this order, 12.5% (2), although they reveal a mode of action consistent with efficient food production and demonstrate mastery in the application of advanced technologies, present limitations in evaluating the technological procedures used to fertilize. The above verifies the development of a producer consciousness at a medium level. Meanwhile, 75.00% (12) express a low level caused because, in their mode of action, they reveal inconsistencies in relation to the efficient use of technologies and have limitations in evaluating the technological procedures used to fertilize.

In another order, 12.5% (2) express sustainability criteria at a high level during fertilization, in the middle of the execution of a certain technological procedure and make knowledgeable value judgments regarding its impact on growth and development of rice cultivation, and for productive development in general. The same percentage (12.5%) shows

an average level because, although during the execution of a certain technological procedure they make value judgments precisely about its impact on the growth and development of rice cultivation, they are not able to make precise judgments in relation to productive development in general. Finally, 75.00% (12) show a low level, since they have limitations to judge the impact of the technological procedure for the growth and development of rice cultivation and for productive development in general.

The quantitative assessment of the results of the pedagogical test, applied to 16 second-year students of the Agronomy specialty, allows us to verify that 68.75% of the students show a low level of depth in the assimilation of the essential knowledge to identify and develop the procedures that make up the technological process to fertilize; 70% show this level in the development of the ability to fertilize, while 75.5% show a mode of action inconsistent with efficient food production.

DISCUSSION

In this section, the results obtained are contrasted with those available in the literature consulted, with the purpose of seeking their agreement (or not) with the state of the art. In this sense, the qualitative assessment derived from the interpretation of what is signed in the instruments recognizes that, although in the professional model and the Chemistry and technical subjects programs, professional problems are not declared, at the discretion of the teachers, the current curricular adaptations offer potential for the professionalization of chemical content, in correspondence with the tasks and occupations to which the subject Chemistry for the Intermediate Technician in Agronomy pays tribute.

Likewise, it can be stated as a result of the surveys of teachers and tutors of the labor entity, that the highest percentage of those surveyed master the professional model, and the

problems related to Chemistry. However, observation shows that there are methodological difficulties, both for teachers and tutors, in establishing interdisciplinary relationships for the professionalization of chemical content. In the authors' opinion, the main cause lies in the lack of systematicity and depth of the analyzes in the methodological work.

On the other hand, interviews with teachers show the prevalence in the use of reproductive teaching tasks and the insufficient use of problematic situations and exercises in Chemistry classes and technical subjects, which favors the professionalization of chemical content, from its essential relationships and link with the exercise of the profession. This element reflects the contradiction between the potential of the program and its use, in terms of professionalizing the chemical content.

It was verified in the interviews with the students that, in Chemistry classes, the teacher rarely links its content with professional situations that require its integration to solve agrochemical problems. Likewise, the presence of insufficiencies in the learning of chemical content is evident, from its understanding, deepening and application, to solve agrochemical problems; as well as the limited possibilities to establish essential relationships between chemical and professional content. In this order, the use of teaching-learning strategies is required that favors theoretical thinking in students, as a higher level from which they can establish interdisciplinary relationships.

As part of the discussion of the results, the inadequate linking of the chemical contents with the purpose of the profession was identified as the main cause of the aforementioned manifestations, which makes it difficult for students to establish relationships between the essential elements of Chemistry and profession.

The situation showed the manifestation of an external contradiction given between the need to perfect the process of professionalization of chemical contents, tempered with the logic of the

profession, as an essential element in their professional training, and the limitations that the didactic order manifests teachers of the subject to guide the teaching-learning process from professionalization.

The limitations, the main cause, as well as the external contradiction derived from the diagnosis, denote the scope and significance of the research. Meanwhile, the indicators used can be applied in other research related to this one, adjusted to the uniqueness of the process of professionalization of chemical contents in other specialties of Professional Technical Education.

The contrast of the results obtained with those available in the literature consulted recognizes their agreement with the state of the art, which suggests considering the professionalization of teaching from the professionalized treatment of content from various areas of knowledge. In this order, the research results of León *et al.* are highlighted. (2014), Milián *et al.* (2017), Cedeño *et al.* (2019), Rodríguez *et al.* (2021) and Cherrez (2023). The recognition of insufficiencies in:

- The development of basic skills in students, which limits the use of Mathematics in activities related to the object of the profession.
- The appropriation of mathematical content to solve professional exercises.
- The integration between the teaching-learning process and the production and service process, and the treatment of professional problems as an object and starting point to develop the teaching-learning process.
- The theory-practice interrelation, taking into account the logic of science.
- The interdisciplinary link between Chemistry and the profession.
- The treatment of the professionalization of the content from the Applied Mathematics subject.

In accordance with the previous comparison, and to resolve the results obtained, it is assumed as

a new criterion that guarantees, in the opinion of the authors, a theoretical argumentation of the professionalization of chemical content based on the didactics of Chemistry; this is articulated from the guiding ideas, guidelines and agricultural production processes. This new logic responds to the purpose of the profession, to the productive reality and to the problems related to Chemistry, present in the contexts of Professional Technical Education. The above is considered a theoretical consequence of this research.

In this order of ideas, the novel and relevant aspects of the study lie in the conception of a didactic logic in which the agricultural production processes that mainstream the teaching-learning process of Chemistry are taken as an integrating axis. These processes are articulated with the applications of the substances that are conditioned by their properties and these, in turn, by their chemical structure (guiding idea), as well as with the properties and applications of the substances and interdisciplinarity as specific guidelines of this science.

The relationship between guiding ideas, guidelines and agricultural production processes allowed the delimitation of organic and inorganic components as essential chemical content; which enriches the Didactics of Chemistry. From this analysis perspective, the indicators for the diagnosis were determined and interpreted.

These aspects constitute novelty, as they have not been addressed in the aforementioned research, close to the object of study, in relation to the professionalization of teaching. At the same time, guidelines are considered to be followed for future research by the authors of this article.

As a final conclusion, we have that the results of the diagnosis allowed us to confirm the main causes of the origin of the problem of the present investigation and justify the need for a new proposal that allows the solution of agrochemical problems in the contexts of Technical Professional Education.

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The authors participated in the design and writing of the article, in the search and analysis of the information contained in the consulted bibliography.

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