Differentiated Education on Teaching Notions of Plants' Pathology Assessment

IOANNIS VAGELAS[1], STEFANOS LEONTOPOULOS[2]
[1]Department of Agriculture Crop Production and Rural Development,
University of Thessaly,
Fytokou str., N. Ionia, GR-38446, Volos,
GREECE

[2]School of Applied Arts and Sustainable Design,
Hellenic Open University,
Parodos Aristotelous 18, 26335 Patras,
GREECE

Abstract: - The learning workshop, in terms of the workshop of the course called Plant Pathology at Technological Education Institute of Thessaly, was reinforced with two learning tools, the multi-formed material as well as the paper of the project. The research study was conducted on a specific sample of students in three consecutive academic years. Selective and short use of the multi-formed material can help the assessment positively. The task paper, which is completed in every laboratory (lab) task, probably brings every student into focus so as for him/her to comprehend the most the multiple approaches of the disease of the plants, through the reasons that cause the plant disease (e.g., fungi), as well as the terminology used in the course (e.g. genus and species of the pathogen).

Key-Words: - Multi-formed material, project paper, assessment, differentiae education, plant pathology, education, university teaching.

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1 Introduction

Human engagement with the environment is primarily about the innate need for curiosity that can lead to revelation. This phenomenon is more pronounced in young children who are interested in getting to know themselves, the environment that surrounds them, animals and plants everything else that comes into direct contact with them. Over time, they ask about weather phenomena and their effect on the environment, become interested in the technical world, and ask questions about objects and their properties. With observation they seek information from various sources, design and carry out investigations and simple experiments while for a better understanding of various concepts, they use tools, they dig, cut, connect, dissolve, use instruments, etc. Like children, most adults always seek to explore and educate themselves through life-long learning programs and procedures, [1], [2].

Learning is achieved through self-activity. Self-activity requires motivation to learn. Therefore, teaching at any stage becomes effective when the student operates under the influence of learning motivation. Already at the time of F. Frobel, but mainly after the appearance of "Reformist Pedagogy" and above all with the pedagogical-teaching movement of the "School of Work" it was accepted by everyone that at any stage of development, the student learns to act independently but also to be happy by acting, learning and creating, [3], [4], [5], [6]. The educational value that knowledge provides to the one who acquires it, depends to a great extent on the very method of acquisition. Knowledge offered to students by the "feed" so-called method does not affect the student's education. On the contrary, knowledge acquired through self-activity, and activation helps to a large extent in a student's education. The issue therefore for the teacher at any level of education shifts to motivating the learners to self-act. But it is known and accepted by everyone that in order to act one must be under the influence of motivation. The stronger these motivations are, the greater the intensity of the learner's activity. The greatest art of the teacher is therefore recommended in creating learning motivation for his students. For this reason, modern Psychology with the relatively branch of

"Motivational Psychology" investigates the possibilities of developing learning motivation in learners, [7]. Therefore, the teacher who wishes to create motivation for learning by knowing the preferences of his students for the various drives, tendencies, or needs, should create a temporary situation that stimulates some "motive" of the student. The more mastery this connection becomes, the more intense the motivation to learn will be created. Thus, the teacher's role is not only to ascertain what the student has learned but to motivate, [8], and to deepen the student's observation by providing him with data, and activities to increase curiosity and automatically create motivation to learn (Figure 1).

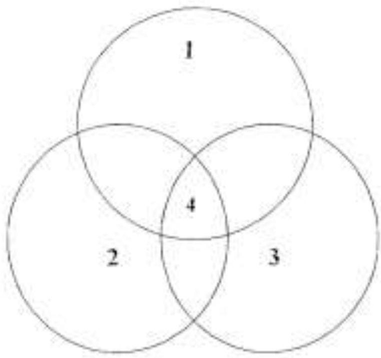

Fig. 1: Triadic model of interdependence of the learner's motivational psychology (4) when coming into contact with a field of environmental education. Where: 1-Teacher, 2-Motive, 3-The student's curiosity, attitude, etc.

The process of learning in agricultural sciences is mainly based on the use of as many senses as possible during the act, which is achieved by applying basic principles of learning such as repetition, support, role plays, experiences, simplification of goals, etc. More specifically, the methodological approaches that are applied are based on collaborative teaching and learning processes. Depending on the topic, problem-solving, and the project method, field study, and case study are applied, which can be enriched with other actions, such as the constructive approach, brainstorming, concept mapping, role-playing, simulation games, inquiry method, by asking questions, experimental method, and surveys. Through laboratory exercises, students enrich their knowledge and vocabulary by understanding new words and concepts, many of which they hear for the first time. They are allowed to visit new, interesting places like crop fields and gain new knowledge and experiences. They learn to observe the natural environment, plants, and their diseases and to discover new knowledge inquisitively, to be concerned and to search for information, and generally to act independently.

Some of the basic principles in the education of students are assessment as a continuous process and the different ways of obtaining assessment information, clarity in the formulation of objectives, the use of a variety of methods, techniques, strategies and materials, systematic teaching strategies, the strengthening of motivation, the connection with the student's experiences or everyday life, the utilization of the student's interests, the availability of materials and equipment depending on the level of education, the cooperation between teachers, and co-teaching, [9], [10], [11], [12], [13], [14].

Regarding the Analytical curriculum, modern approaches support the adaptations towards an enriched analytical program (watering up the curriculum) and the learning of the student in terms of the content, methods, and product of the teaching, [13], [14]. The Greek Ministry of Education has proceeded with the adaptations of detailed study programs for students attending different levels of education (kindergarten, elementary, and high school) and for different academic subjects. However, universities do not provide educational services to students with learning disabilities since universities are involved in researching this issue and do not apply for their own, [15].

Following the instructions of the Greek Ministry of Education, the educational material of the laboratory (lab) pursues some specific goals, has a particular foundation, and form, and becomes unique for every academic year. This happens so that the trainees can be guided and assessed in the same way. Therefore, each lab task is unique and is conducted in a specific way and the student is assessed at the end of each task according to the project work-paper. The workshop course of Plant Pathology was adjusted to these new demands and besides the classic way that was mentioned above, the tuition of the workshop tasks was reinforced with the use of model multi-formed material through pictures or short videos in terms of the workshop, so that each trainee understands better the lab examples. This is something that helps the teacher-tutor gain some important benefits, such as improving his/her teaching strategy, by getting feedback, as he/she gets involved in the effort that the students make to comprehend the workshop. This task is aimed at the teaching strategy as well as at the process of finding other ways to accomplish particular goals.

This research work, utilizing the relevant instructions of the Pedagogical Institute of Greece, aims to detect the most suitable teaching strategy so that the students can understand the laboratory exercises in more detail through the polymorphic material, [16], [17], [18].

2 Materials and Methods

Living organisms (plants, animals, autotrophs, or heterotrophs), are governed by general and specific morphological characteristics. These particular features are closely related to definitions that correspond to actual concepts. So, a child can very easily distinguish the mammal "dog" from the mammal "cat" without knowing their scientific name. These particular features may have a common name for a morphological feature of the organism such as the leaf of a plant. Thus, a child can very easily distinguish a leaf of wheat from a leaf of cotton without knowing the scientific value of each of them. However, things are more difficult in the case of distinguishing microorganisms, such as fungi, perhaps because we cannot easily observe them. These real concepts, scientific terms, or cognitive goals, are simply repetitive and respond to the image we see by activating the psychomotor activities e.g., a diseased plant has yellow leaves. The diseased plant is different from the healthy plant, so a child would easily categorize the two plants based on their appearance (color, growth, etc.). From this observation, it is immediately noticeable that the above two symptoms describe a possible infection of the plant by some pathogenic cause, but this is not certain, since the same symptoms can appear in case of lack of fertilization, water, adverse weather conditions, tissue injuries, etc. Finding the possible cause of the appearance of these symptoms motivates the interest to learn in the course of plant protection. This repetition of the same concepts outside of memorization with collaboration gives learners suitable information about the organism that are studying, and with simple logic (dissociative logic) the categorization is simpler. With the above example, the separation and ranking of the two relationships follow the model of Figure 2, where the evolutionary path of awareness (self-activity with observation) to knowledge at the beginning of engagement (motivation) is recorded.

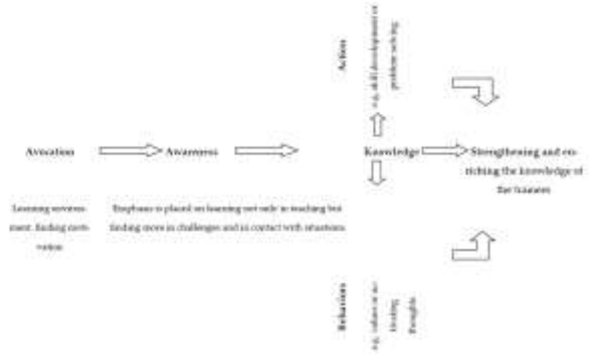

Fig. 2: Evolutionary procedure of self-efficacy in the learning process with the environment.

Teaching agricultural sciences, particularly teaching the subject of plants' pathology is directly associated with the disease caused by some pathogenic microorganism (the cause of disease) such as the fungus, and the microorganism is classified further in the genus and species by the morphology of specific exogenous forms, characters of the sexual or the asexual reproduction e.g by the formation of conidia, which are borne on specialized stalks called conidiophores (asexual reproduction in the phylum Ascomycota). Until recently, the goals of the workshop tasks were based on the examination of several samples of the plants, as well as on the observation of several species or genus of fungi (cause), through some laboratory cultivations; thus, the students were able to acknowledge the morphological characters (exogenous forms, characters of the sexual or the asexual reproduction), that the diagnosis of the cause appeared to have. After finishing the workshop tasks, the assessment was held using questions, presentation of the diseased plant parts, and diagnosis of the morphological kinds of the taxonomy of fungi in microscopic samples. In other words, there was the traditional examination, where the teachers assessed only once to which extent trainees had comprehended all the workshops, without getting into this process of assessment for each lab task separately. Lately, the teaching strategy and, even more, the teaching of the workshop, were introduced to the multi-formed material which aims at achieving a more effective connection between the notions and the natural observation of the fungi (cause). For example, the infection of the plants by the fungi that belong to the genus of Oidium species (Fungi; Ascomycota; Erysiphales; Erysiphaceae), can be explained through a short video, where the conidia (asexual fruiting bodies) of the fungi grow, those provide texture mycelium, further, the mycelium becomes parasite for the cells of the host plant, and creates fruition (fruiting bodies, fundamental to the basic taxonomy), of i) asexual reproduction (short conidiophores; with chains of conidia) and ii) sexual reproduction (cleistothecia, an ascocarp - the fruiting body - which contains the ascus and the ascospores). Both asexual and sexually fruiting body reproduction allow the new plant infections caused by the conidia or the ascospores in Ascomycetes (the phylum Ascomycota) [19], [20], [21]. The purpose of this course is to prepare the students to be able to discriminate the diseased plant's tissues and define the group that the pathogenic cause based on fungi taxonomy. This purpose is accomplished by attending the corresponding course, where the notions of the pathology of plants are directly connected to some microscopic preparations; indirectly, students come close to finding the answers to the potential cause of the plant disease through 'clinical' and the basic of fungi taxonomic knowledge, concepts, skills and other possibilities that the laboratory of plant pathology provides. For the application of the above-mentioned purposes the teaching materials that they were used were multi-formed material, models taken from the internet, and video projector, case studies, [22], [23], [24], (infected plants or plant material with symptoms, cultures of fungi and use of the microscope, workshop handbooks, books of plants' pathology.

In order to assess the use of the materials provided three methods of lab teaching (A, B, and C) were applied. The presented research work is about the results of the assessment of several groups of students in two workshops during three consecutive academic years (2016, 2017, and 2018) at the workshop of Phytopathology (Pathology of plants) of the 4rth semester, in the Department of Agricultural Engineering Technologists at University of Applied Sciences of Thessaly. In all cases, the assessment was held with the use of project papers (70%) and through final examination in the traditional way, which was mentioned above (30%).

Method A (applied in academic year 2016). The task paper was completed every 5 workshops. The material of the lab task was analyzed through the video projector which was based on a series of detailed slides (program of PowerPoint) making the most of the workshop material with lots of examples. The duration of this presentation covered two hours (out of three) most of the time. Shortly after that, and during the one hour left, the students briefly observed the samples of the lab task through the microscope (the number and the kind of samples used were the same in every academic year during which this project was being studied).

Method B (applied in the academic year 2017). The task paper was completed every three workshops. The material of the lab task was presented through the video projector using a series of slides (program PowerPoint) covering the main points of the workshop with some chosen examples. The duration of this presentation was not more than one teaching hour. For the following two hours, each student had enough time to observe in detail his/her concoctions and set several questions to the trainers (this could not happen in the previous academic year 2016 as there was not enough time).

Method C *(*applied in the academic year 2018*)*. The task paper was completed in every workshop. The material of the workshop task was presented through the video projector using a series of slides (program PowerPoint) covering the main points of the workshop with a few chosen examples. The duration of this presentation did not exceed 20 minutes. For the time left, each student had the opportunity to observe in detail his/her concoctions (lab samples), set questions, and compare his/her findings to the slides of the presentations, as well as to the workshop manuals and books that were provided for this purpose.

The educational equipment used in the workshop were: 18 to 19 microscopes, one for each student, where he/she can have up to 20 observations the most, in each workshop, so as for him/her to comprehend fully the workshop task. All data were analyzed using the statistical package MINITAB Release 19.2.0.

3 Results

In all three academic years of the studies, there is a large percentage of students who do not attend the course. This percentage is about 25,3% ± 0,67 (24% the minimum and 26,1 the maximum percentage of the students' leak respectively) and doesn't differ statistically, p=0,754, every academic year; while the percentage of participation until the final examination is 74,67% ± 0,67 (73,9% and 76% the minimum and maximum percentage of attendance correspondingly) and doesn't differ statistically, as well, (p=0,354, every academic year). However, the total number of students in laboratories increases in their number per academic year or study (Figure 3), outgrowing the admissible number of students per lab as presented by the discontinuous line in Figure 3.

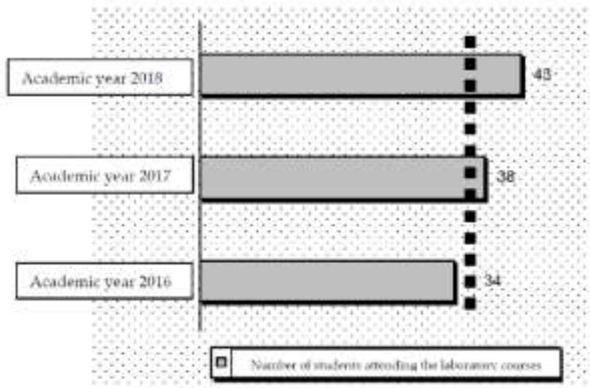

Fig. 3: Total number of students trained in the two study laboratories per academic year. The dotted line defines the maximum number of trained students in the two study laboratories per academic year.

In all three academic years of attendance, the proportion of students who participated in the program showed a significant statistical difference between the two academic years (Figure 4). During the academic year of 2018, the most notable percentage of success was noted down, while the smallest percentage of success was noted down during the academic year 2016 (Figure 4). Also, during the academic year 2018, grades higher than 6/10 show the highest frequency, about the low scores of the other academic years of the study.

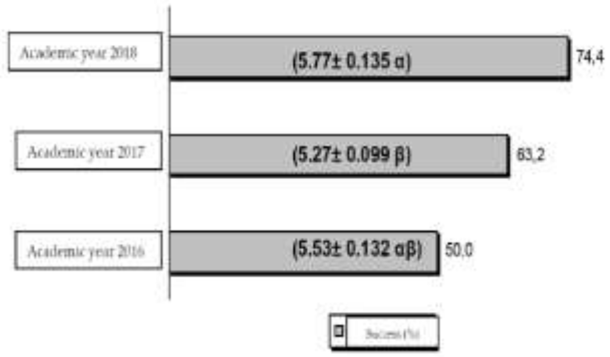

Fig. 4: Success rates of students in the two study labs per academic year. In parentheses (in each bar), the mean of student returns per academic year is given ± the statistical error. Means were determined after analysis of variance (ANOVA) with analysis of one factor (year), while separation and differences of means were determined by letters α and β with Tukey's test.

By the observation of Figure 5, we can conclude that the specific application of the same practices in the lab by the specific sample of students differs according to the methods applied. More specifically, method A presents a serious disadvantage in comparison with method B and mainly with method C, where the percentages of success and failure are about the same for both methods in questions and for the periods of study (Methods B and C) in this work (Figure 5).

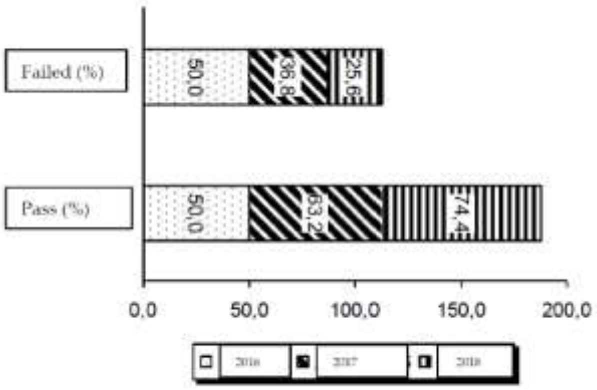

Fig. 5: Percentages (%) of pass and fail grades of students in the two study laboratories per academic year.

4 Discussion

Teaching plant pathology to students is a challenge for university teachers. Nowadays, it is well agreed that students are not alike and each faces different challenges and difficulties, [25], [26], [27]. In addition to the difficulties that exist due to the participation of a new teaching subject like plant pathology, about which students have heard little or nothing, the difficulty in understanding the definitions and morphological characteristics of microorganisms such as fungi and bacteria, some students may also have learning difficulties or be charismatic. Thus, although the majority of students tend to have the same cognitive characteristics, there is also a portion of students who need special treatment since this diversity can have both positive and negative effects, [28], [29], [30], [31]. To date, numerous studies have concluded that the population of students with learning difficulties constitutes the largest percentage of students with special educational needs, [11], [13], [14], [32]. For this reason, the need to offer multi-level help to those students who need it is imperative. According to, [32], "learning disabilities are not a one-dimensional category". In contrast, there is great heterogeneity and difficulties in language, reading, writing, and mathematics. So, according to studies by the above authors, the difficulties faced by students with learning difficulties may concern visual or auditory perception and processing, phonological awareness, oral language, vocabulary development, understanding oral language, syntactic awareness and morphological awareness, factors influencing reading performance and comprehension, decoding and fluency. Memory difficulties are also linked to learning difficulties and involve both short-term and long-term memory. For all the above reasons it is important to consider the use of new technologies and new teaching tools especially when it comes to teaching a subject for which the student has been taught little in the past, [33], [34], [35], [36], [37], [38], [39], [40].

According to the above-mentioned factors and the principles of differentiated instruction, the average student does not exist. This implies that students acquire knowledge through active learning and problem-solving, while at the same time being taught how to think and learn. It is therefore understood that differentiated teaching responds to the demand of the times for respect for the particularities and needs of the student, part of which are the different ways of thinking and the different ways of learning of students, [41], [42]. According to Gardner's criteria, [43], the following 8 types of intelligence have been recognized: linguistic, logical-mathematical, spatial, kinesthetic, musical, intrapersonal, interpersonal, and naturalistic. Differentiated instruction is essentially a mix of small laboratory-group instruction, individualized intervention, and classic class-laboratory instruction. The areas in which differentiation takes place are content, process, and learning products, [44]. In contrast to traditional teaching, which addresses an assumed "average" student with the same material and the same assessment method for all, differentiated teaching materials of graded difficulty are used, and teachers take multiple intelligences into account when designing activities in, [43]. It is therefore understandable that the goal of differentiated instruction is to highlight the value of each student and integrate them into the learning environment.

Regarding the learning environment and the general climate of the class-laboratory room, an important role is played by the emotions experienced by students, [45]. According to, [46], in order to feel academically adequate and emotionally secure, students should engage in projects commensurate with their skills and abilities. However, undoubtedly, the purpose of the teacher is not to set lower goals for some students but to provide the conditions that will allow everyone to develop as much as possible, [47], [48].

However, before the teacher proceeds, he should clarify, among other things, what his students can do after the end of the teaching unit in relation to what they have learned, [41]. If the students manage to enjoy their success both individually and at the group level, then the teacher will also have in his hands a basic tool of encouragement and empowerment in the classroom laboratory, [46].

Furthermore, the class-laboratory room should be organized in a way that allows for different ways of working, interaction, and collaboration between students. The class-laboratory room should also be organized so that the arrangement of desks and furniture is suitable for participant interaction. In general, a welcoming learning environment should be created and the class-laboratory room organized in a way that provides flexibility, comfort, and safety while good lighting should also be taken into account. The availability of material depends on the level of education (printed material, supervisory material, educational software, computer, etc.), the visual marking of the location of the materials (e.g. signs, photos, etc.), the comfortable access to the students to the materials but also the decoration of the class-laboratory room to create a pleasant environment that simultaneously enhances the learning process (e.g. material related to academic subjects, visualized examples, graphs, student assignments, etc) help to create a positive education climate which motivates the students and favors their expression, communication, interaction and active participation, [9], [32], [49]. On the contrary, we should avoid the organization of the class-laboratory room that does not allow different ways of working and the cooperation of the students, the absence of flexibility and organization of activities at individual and group levels, the poor environment in terms of material and equipment, the difficulties of access of the students in the available material, the inappropriate lighting of the room but also the proximity of the class-laboratory room close to disruptive factors and noise sources.

It is also believed that an important role could be played by the systematic active participation of teachers in experiential, laboratory-type courses. However, the difficulty for the teacher appears to motivate students to respond to the laboratory activities. For this reason, both teaching and student participation in various laboratory activities are believed to be more effective when the student operates under the influence of learning motivation and inclusion. Differentiated teaching is also considered a means of implementing inclusion, where each student is a separate entity and must be treated accordingly, [50]. According to, [51], the modern education system is no longer the only vehicle for the dissemination of knowledge, but one among the multiple resulting from the combination of traditional and new ways of transferring knowledge and information. The readjustment of the educational program should aim at the application of teaching methods that enhance in-depth learning, and on the other hand at revising and enriching the taught material and adapting it to the requirements of these students so that the educational process becomes easier and attractive.

Using various media, education provided in the laboratory must support properly, and educate students with creative activities that hold their interest in a variety of ways in an educational environment that respects their individuality and diversity. For example, [52], in their paper, present the development of an integrated online system for teaching and learning of microscopic pathology and exemplify how it can be used. Besides the use of technology, we should not forget that according to, [44], elements that characterize an effective learning community are both the admission that each person should feel welcome and that everyone should contribute to making everyone feel welcome, as and the mutual respect which is non-negotiable, but also the sense of security on a physical and emotional level. Also, an effective learning community must offer equity by providing equal learning opportunities and appropriate support with simultaneous collaboration between teachers and students and between students so that the expectations of everyone involved are met. However, we should not forget the opinion of, [53], as it is mentioned in, [54], that education has as its philosophical starting point that the educational needs of some children should not be treated as separate difficulties but as issues that generally concern the way the education system itself operates.

Plant pathology courses are offered worldwide, [55]. It evolves towards multi-disciplinarity by mingling with several allied subjects to cater to the needs of the times. Because of its complexity, teaching plant pathology remains a major challenge for both teachers and students, [56]. According to, [57], the importance of a good balance between theory and practical activities as well as the need for lifelong learning in such a field, together with the possible innovations in teaching methodologies affect the effectiveness of plant protection courses such as phytopathology. This balance became more difficult to apply during the Covid-19 period where the majority of the Universities and classes applied distance learning methods. For example, [58], and [59], in their article present strategies and regulations applied to university teaching and reflect upon the achievements reached and the challenges in plant pathology education in its virtual form.

From the above descriptions of the two introduced learning tools, the multiform material, and the worksheet, it results that it can lead to the failure of the learner to follow the laboratory exercises when the two tools are used extensively and without planning respectively. The differences that emerged from the three teaching methods are due to the different ways of presenting and explaining the same laboratory material to the students. The didactic laboratory strategy of the detailed presence of the laboratory exercise extensively limiting the time of the exercise, led the trainees to a significant failure, combined with the late mode of examination of the students. The careful use of the polymorphic material properly combined with the laboratory exercise showed better results. In this case (method B), the failure rate remained high due to the late examination time of the students. In the last case (method C), the correct use of the polymorphic material by providing sufficient time for the learners to understand the concepts of the laboratory samples proves to be more edifying, when it involves the learner actively, in understanding the new questions by completing the corresponding worksheet in each laboratory module. Furthermore, we could assume that the way of presenting the laboratory exercise with the polymorphic material facilitates the student's understanding of phytopathological concepts by organizing in their memory the levels of perception of these concepts. Thus, the meaningful representations of the videos and the shapes or images are organized in the practitioner's (student) memory to solve the problem.

The extensive information of teaching method A shows that the simple problem through intense information becomes huge, possibly exceeding the capacity of the working memory, creating gaps and unsolved questions or even misunderstandings in the student. These gaps and consequences are limited, (teaching methods B and C), by observation and laboratory exercise and are removed from the student's memory. The active participation of the students in the laboratory exercise, (teaching methods B and C), shows that the students develop a high level of skills and approach to knowledge, which is in agreement with the high grades during the evaluation of the assessment. Regarding grade differentiation among the examined methods, it is agreed that the most basic element differentiating the newer views of psychology about the older ones is the great emphasis placed on the self-confidence and self-worth of the learner. The student who believes in his abilities - even under the influence of weak motivation to learn - is very likely to be active, because he hopes that he will succeed in his endeavor. On the contrary, the one who has low self-esteem and considers his abilities to be lower than others, fearing that one more failure will accumulate to his credit, does not try and therefore does not take action.

The selective presentation, (teaching methods B and C), shows that it precedes and reinforces the learning of the concepts through the laboratory exercise and makes it easier due to the time in order to cover gaps and questions, (mainly teaching method C), by asking and discussing between student and teacher. This observation agreed with that of, [60], study, where their results indicated that case studies helped students develop the critical thinking skills required to diagnose plant health problems while actively engaging them in the course content. The timing of the assessment is equally important because when this is delayed, gaps are reinforced and the logical structure of the understanding of the workshop is distorted, increasing failure. Finally, introducing new skills and abilities, such as communication, critical thinking, writing, and international experience is very useful, [57].

5 Conclusions

Today's University education is multifaceted and for this reason, education today is not only a learning process. Through the educational process, it not only provides knowledge and education but also prepares students for their integration into society. In addition to the knowledge and information provided at universities, it is necessary to shape those conditions so that students develop, in addition to their abilities, other skills so that they can cope with various challenges that they may face in their lives. From the above description of these two introductory learning tools of the polymorphic material, it occurs that it can lead to the failure of the student to participate in the lab tests when these two tools are widely used and without proper preparation. The differences that occurred between these three methods of teaching are due to the different types of presentation and the same lab material used. In the presented work, the evaluation and the most effective way of teaching phytopathological concepts appears to be achieved by the selective, brief presentation of the concepts with the polymorphic material, preparing the student to understand the laboratory exercise. With the laboratory exercise, the student is encouraged to understand the concepts, express questions, and fill in the gaps in the presentation. The strong intervention of the teacher during the laboratory exercise increases its persuasiveness, encouraging the student while the worksheet positively intervenes by reducing failure due to student indifference. Finally, students and teachers now have easy access to images, simulations, and all types of information and new possibilities for communicating among them, sharing teaching material, and exchanging experiences. It will be very useful to repeat this research in a broader range of subjects besides plant pathology in the future. It is also important to incorporate at Universities' plant protection educational programs that the new generation of students must be capable of critical thinking, adaptable to future changes, flexible in different difficulties, and, able to communicate and work as a team with other plant protectionists, farmers, and scientists.

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