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Learning experiences of mathematical situations in university students from the innovation project

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Abstract--The research allowed to describe and assess the learning experiences of mathematical situations from the actions of the Innovation Project. Due to the methodological sequence, the study presented a qualitative approach of phenomenological design, of an interpretative descriptive type articulated to strategies of analysis of specific facts; for this purpose, the participation of engineering university students was described. The phases of the project were developed with thirty groups made up of four members each. In conclusion, the Innovation Project allowed nodes to be detected as phases during the learning of mathematics: idealization, exploration, plan design and the final product. In addition, the methodological

sequence of the project detected that interactivity is linked to creativity, unpublished, innovative and heuristic solutions during the approach to the project thanks to the Sankey diagram.

Keywords---Innovation Project, Mathematics Complements, learning, creativity, innovation.

Introduction

The study shows the importance of the application of mathematical content to concrete and experiential situations of the professional training of the university student in different professional careers since it allows them to detect the importance of the topics applied to their professional career inserted in the syllabus of Complements of Mathematics.

The innovation project supports the development of effective methods, strategies and/or techniques that serve students as basic tools for training and developing good study habits (Gonzales Flores et al., 2022). When observing the profile of the people within the training plan, innovation plays a fundamental role in the development of creativity and innovative solutions for educational and business projects, given that the contributions and experiences gained thanks to research are valued (Fernández Gacho et al., 2020; Vicente -Bújez et al., 2020). Processes and strategies are considered in a systematized way to introduce and provoke frequent changes in divergent situations (González Alba et al., 2020) .

For its part, innovation implies creativity of the actors deployed in an environment with common purposes (González Alba et al., 2020); while the practices of teachers are slowly transformed by proposals for change since, by themselves, they do not represent modifications and/or improvements in the teaching work (Jérez and Vera, 2021) . Educational innovation is the set of systematized actions, processes and strategies in order to introduce and cause changes (Lozada and Fuentes, 2018; Parada Camargo et al., 2017) .

In this regard, from the perspective of mathematics for engineering, an eco-sustainable house was designed with a set of ecological systems that, in addition to contributing to the care and preservation of the environment, allowed to reduce the costs of public services (Barragán -Alturo , 2016). For their part, Bujanda and Bujanda (2021), in their educational intervention based on gamification, made it possible to improve knowledge about diabetes based on the assessment of healthy eating in socio-health settings. Martínez (2019) y Perin (2018) evaluated different gamification proposals in different areas of knowledge of the exact and humanistic sciences associated with viable projects generated by students.

The study emerges from the lived experiences of the student when developing each topic of the subject of Mathematical Complements, who show the perspective of creativity, the ways of applying the conceptual content to concrete situations, allowing to search for innovative creative, critical, logical and experiential solutions. awakening the skills of working collaboratively and active participation during contextualized learning.

The actions of the Innovation Project is a scenario where members with common interests interact (Carreiro, 2019); they are detachment actions in order to solve problems in different areas from a creative perspective within their professional training (Gazzo, 2020). The students, within the universities, contribute and promote innovation through the search for novel solutions with quantitative, analytical and numerical support from the contents of the mathematics curricular experiences associated with the project sequences.

Method

Materials and methods

The study presents a qualitative approach, with a phenomenological design, of an interpretive descriptive type articulated with analysis strategies for specific events (Baena, 2017); these strategies allow describing the findings, processes and actions of the actors; For this purpose, the participation of the university student in front of the Innovation Project in the professional careers of science within the curricular experience of Mathematical Complements has been described, allowing to describe and interpret the actions during the development of the stages of the project, interviewing and describing the acts to thirty groups made up of four members each.

In the actions taken during the sixteen weeks of the academic semester, the sequences that consisted of a) beginning were developed, at this stage the expectations of the project and the motivation were generated, it consisted in the recovery of previous knowledge inserted at the beginning of each sessions of learning (Pérez de Paz, 2019), allowed to assess the initial level with what the student has to plan the teaching-learning process, to take into account the process of knowledge construction and provoke cognitive change ; b) the development consisted in the exemplification of mathematical situations to specific cases of their specialty; for this purpose, the induction and deduction of mathematical applications was promoted (Men, 2006); for the resolution of a problem, basic abilities to read, reflect, plan, establish strategies and procedures to proceed to the solution and state the result are required, and c) technological applications, at this stage, the student carried out various simulations through the use of technological tools such as Geogebra , Symbol and Demos in order to solve the problematic situation of the project (Fajardo Valencia, 2020). For all of the above, the mathematics teacher must rethink their practices in the face of technology, since it is part of the teaching practice.

The collaborative work in each group was evidenced in the sequence d) teamwork, which consisted in the development of workshop sheets with exercises and problems close to the study of the project using small rooms; The students showed different solutions with different procedures, arriving at unique answers using the Padlet tool . The presence of the teacher as a mentor was decisive for the validation of the prototypes for their next presentation and exhibition. Finally, stage e) the closure, was the stage of the evaluation of the aforementioned processes, in this stage the results were verified in each or all the procedures, who evaluated and reformulated the procedures of the stages thanks to the metacognitive processes (Ángel, 2019). Metacognition refers to the ability to

reflect, understand and control one's own cognitive processes; for example, in the final part, its novel findings and innovations are exposed from heuristic positions.

Results

The development of the project actions allowed the detachment of three axes of interest in the area of sciences: humanistic, detecting the interaction between the participants, assertive communication within the framework of trust and common interests (Mota y Veras, 2020); It is related to human culture, highlighting humanistic training, since the selection of the study topic was identified and selected among the members in a consensual manner, in addition they validate the feasibility and applicability of the topic to specific cases of the professional career, who address the sequence in a creative, critical and innovative way during the solution of the study. Finally, in the technological axis, it is based on the use and promotion of the application of technological virtual tools associated with simulators, virtual prototypes, processing programs and calculators that allowed detecting the feasibility in terms of the concordant answers during the development of the study. (Martínez Prats et al., 2021).

The arguments expressed by the actors of the Innovation Project experienced that, from the detection of the study, the project is an activity where they inserted their experiences and assumed the applicative sense of the mathematical concepts in specific cases developed. Innovation, understood by Martínez Prats et al. (2021), is the detachment of creative and innovative activities to address the stages of the project.

The frequent arguments during the support of the projects allowed to detect, in the activities, new ways of learning mathematics in a contextualized way in specific cases, having to be developed during the different academic semesters, accessing the information of the properties, theories, mathematical formulas for associate the processes of the solution in an active and participatory manner, involving permanent motivation during the approach (Cáceres et al., 2021). Motivation is the signaling that is discovered towards a certain means of satisfying a need, thereby creating or increasing the necessary impulse.

The methodological sequence of the project made it possible to demonstrate the coping with the solution of the case with creativity, innovation of ideas, critical postures and procedures by the actors (Cáceres et al., 2021). The development of the stages of the project was carried out within the curricular experience of Mathematical Complements, which allowed the learning of mathematical concepts under the sequence of creativity, imagination, perseverance for the detection of spontaneous heuristic solutions (Ventling, 2018). They are a strategy, method, criterion or trick used to make it easier to solve various problems.

During the presentations of the projects, the students frequently state that innovation as creative actions should be applied from basic education since creativity could be strengthened and released in university classrooms, allowing the development of utilitarian science and technology that the Peruvian State requires. (Carrasco et al., 2012). Under these arguments, mathematical content assumes the applicative and practical role within professional training careers (Alguacil et al., 2016). Mathematics is important for the formation of the citizen

since it constitutes a powerful instrument for analyzing reality, which allows promoting innovation and creativity of students from university classrooms. The arguments, from the incubation of the project idea, the execution, participation, creative idealization, emergence of heuristic ideas for the creative solution, and innovation for future projects, have detected the knots that allowed the various activities and feasibility processes to be released. which are detailed below.

The development of the Innovation Project is a parallel experience during the development of mathematical content in sixteen weeks. The semantic network shown detected nodes, representing main components of the experiment such as 1) exploring, at this stage, the group of students detected the contextualized problem with a possible solution from the mathematical content (Pisula et al., 2021; Stott, 1973), the specific solution associated with concepts and rules, procedures, Mathematical formulas lead to the next feasibility, in addition, emotions are released, the desire to identify and know the procedures to be developed, frequently answer the questions : will it be a novel solution?, will it allow its practical application?, the solution detected, allows new proposals for entrepreneurs?, these questions and expectations respond to the detachment of the second component 2) define, in this scenario, the challenges are concretized, the unprecedented actions, who carried it out in specific situations raised in the first moment of the exploration , the mathematical concepts are assumed for their applicability that allows its development by associating the exercises and problems raised in the sessions and their applicability (Chun et al., 2020; Muhammad et al., 2021).

The third component that allowed the challenge to face the solution and the challenge to assume new forms is that of Ideate; At this stage, methodologies were developed that allowed responding to situations in different guidelines (Soares et al., 2021), in addition, brainstorming techniques, Crazy technique, were applied for the idealization of solutions and the elaboration of a solution plan, who responds to the design component ; In this phase, solution prototypes were generated with sequences and mathematical calculations. This (Chen et al., 2021);is the act of validating specific solutions within numerical calculations and the detection of the mathematical model with a patterned and innovative solution. Finally, in the checking phase, validated the solution and the model detected with feasibility and unprecedented thanks to the detached heuristics. In this regard, Durán y Monsalves (2020)they point out that it consists of facing solutions to the phases of the project, previously verifying in the Focus Groups , online opinion surveys and appreciation of the proposal (De Alba y Ramos, 2020); the scientific proposal allows the members to assume the role of leadership, to generate inspirations in the new and novel way of approaching problems from the concrete application of mathematical content embodied in the syllables of the curricular experience of Mathematical Complements.

The development of the actions in its different stages of the Innovation Project in Mathematical Complements detached thematic fields from the approaches of the literary review. The investigation consisted of the search for diverse solutions, giving off good assertive attitudes and commitment to the resolution of the case study, idealizing, generating action plans, associating ideas of mathematical

calculations for the appropriate solution (Cabieses et al., 2021), creativity is evidenced thanks to autonomous work with reflection, during exploration and heuristic detachment in each of the processes demanding assertive and contextualized solutions oriented to their professional career (Pichon-Riviere et al., 2021).

Criticality was fostered from reasonable tidal actions during decision making within the various stages of the project during workshop hours. These workshops were developed at the end of each session, which consisted of advice, sequences of processes, association of mathematical concepts, detection of models and various applications, encouraging participation in a collaborative manner (Melero et al., 2020).

The detection of the solutions in the different processes of the project, from the idealization, elaboration of the plan, detection of the mathematical concepts for the solution and the discovery of the mathematical model, allowed its practical application to simulated concrete situations. These concrete facts were manifested in innovation with approaches of creative solutions and valuing the ideas emitted by the participants with a high spirit of motivation and research.

The diagram allowed to detect the frequencies of the interactions between the terms during the development of the phases of the Innovation Project. Regarding interactivity, it is the most recurrent term in the study; It consists of the participation of agents during learning such as the exchange of opinions, solution planning, teacher interaction and validation of mathematical models (Melero-Aguilar et al., 2020). The solutions are creative, novel and innovative in each phase of the project ; creativity was manifested in approaching tasks in differentiated ways and transferring the methodology to other activities with similar characteristics. Learning the mathematical situations inserted in the Innovation Project solution allowed the student to assume a participatory commitment, consolidating teamwork and collaboration, arriving at logical, consensual and contextualized solutions within their professional careers. Finally, interactivity is linked to the creativity and unprecedented, innovative and heuristic solutions of the learning actors.

Discussion

The experiences of the Innovation Project detected the nodes of exploration, which consisted of contextualizing specific situations. In this regard, para Pisula et al. (2021) y Stott (1973), the projects are approached creatively and contextualized specific solutions. The students, under this criterion, approached with innovative ideas. On the other hand, to Chun et al. (2020) y Muhammad et al. (2021), allow concrete challenges, unprecedented actions during the exploration. Under these arguments, the students were able to address unprecedented mathematical solutions, selecting various solution processes under brainstorming techniques, previous presentations, which allowed the best solution clues to be made viable.

Creativity and innovation is associated with heuristics, manifesting challenges, logically valid spontaneous solutions, where students manifested with logical applications from concepts, theories and mathematical formulas. In the study

Soares et al. (2021) jointly with Chen et al. (2021), it was pointed out that the act of validating specific solutions within the numerical calculations allows detecting heuristics associated with motivational loads for each member, awakening cooperative scenarios under the argument that, during the experimental sessions, coping with various postures and processes to approach with consensual solutions. In the study by Durán y Monsalves (2020), collaborative work was detected through Focus Groups, paying attention to opinions.

The initial stage of the Innovation Project allowed for the awakening of innovative, creative approaches that promote heuristics from student participation. Pichon-Riviere et al. (2021) they evidenced the search for diverse solutions; During the experimentation, the actors showed motivating participation, interest in detecting varied and creative solutions, although sometimes there are some difficulties in the evaluation process (Vértiz et al., 2020). Cabieses et al. (2021) associated reflective autonomous work and creative detachment of university students; Finally, in the study by Melero-Aguilar et al. (2020), idealization was promoted as the initial stage of a project, as evidenced in the student's reactions at the beginning of the project, showing interest in addressing the problem by associating the concepts of mathematics to specific cases of their professional career.

Conclusions

The development of the methodological processes of the Innovation Project made it possible to detect the nodes as phases during the learning of mathematics: idealization, manifesting itself as the methodological sequences; the exploration phase, where the student understands what they want to do and address them to arrive at a solution proposal; likewise, the phase of designing plans and sequence of prototypes detecting mathematical models; finally, the phase of the final product, where the solution was compared with metacognitive processes. In addition, the methodological sequences of the project allowed the promotion of collaborative work, arriving at consensual and contextualized logical solutions within their professional careers. Finally, interactivity is linked to creativity and unprecedented, innovative and heuristic solutions to mathematical problems, inserting collaborative and participatory work between the learning actors.

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