Articles

Strengthening of the water resource management seedbed by implementing project-based learning

Fortalecimiento del semillero gestión del recurso hídrico implementando el aprendizaje basado en proyectos

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ABSTRACT

The continuous growth of the investigation group water resource management is based on research processes by applying the
project-based learning model mainly, a methodology that seeks to promote the active participation of students in academic activities such as presentations, undergraduate work and the published articles, this in order to improve soft skills within a framework of qualitative research applied in the field to real cases, looking for solutions for the community with real problems, be seen as opportunities for improvement and thus, from the academy, the students strengthen their knowledge by being taken to a real space and explore their creativity to generate human-centered projects in order to reduce negative impacts on communities and improve living conditions in these spaces and thus contribute to regional growth, the decrease in inequality taking into account normative and national policies and therefore enhance their training, all this seeking to increase the impact of the group in the region, in the department, in the country and in the world, generating higher quality products over time and seeking to make these visible. activities by participating by publishing the results in media with high academic and social impact as well as strengthening the soft, professional and social skills of students by working in spaces that allow interaction with communities, government entities and other elements of the academy.

Key words: Project-based learning, community, interaction, scientific production.

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RESUMEN

El crecimiento continuo del semillero gestión del recurso hídrico está fundamentado en procesos investigativos al aplicar el modelo de aprendizaje basado en proyectos principalmente, metodología con la que se busca fomentar la participación activa de los estudiantes en actividades académicas como son las ponencias, los trabajos de grado y los artículos publicados, esto con el fin de mejorar habilidades blandas dentro de un marco de investigación cualitativa aplicada en campo a casos reales, buscando soluciones para la comunidad con problemáticas reales, sean vistas como oportunidades de mejora y así, desde la academia, los estudiantes fortalezcan sus conocimientos al ser llevados a un espacio real y exploren su creatividad para generar proyectos centrados en el humano con el fin de reducir los impactos negativos en las comunidades y mejorar las condiciones de vida en estos espacios y así aportar en el crecimiento regional, la disminución de la desigualdad teniendo en cuenta normatividad y políticas nacionales y por ende potenciar su formación, todo esto buscando el aumento del impacto del semillero en la región, en el departamento, en el país y en el mundo generando productos de mayor calidad con el paso del tiempo y buscando la visibilización de dichas actividades al participar publicando los resultados en medios con alto impacto académico y social además de fortaleciendo las habilidades blandas, profesionales y sociales de los estudiantes al trabajar en espacios los cuales permiten la interacción con comunidades, entes gubernamentales y demás elementos de la academia.

Palabras clave: Aprendizaje basado en proyectos, comunidad, interacción, producción científica.

INTRODUCTION

In undergraduate academic processes it is a primary need to strengthen the skills of students in training and especially civil engineers in their years of study in order to generate spaces in which they face a controlled reality under the conditions of the classroom or academy, this in order to strengthen complementary skills in training such as social interactions, sensitivity to the problems of the community, professional ethics, applicability of theoretical concepts in real spaces and the strengthening of the same, it is there where the need to implement the methodology of problem-based learning in engineering mentioned by (Rodriguez-Mesa, Fernando; Kolmos, Anette; Guerra, 2017) with the proper alignment to the local conditions of the region in which the civil engineering program of the Regional Center Sabana Centro Centro and Ubaté has influence and generate in students the strengthening of skills by linking them with problems of their municipalities of origin.

With the passage of time and the adoption of clearer methodologies and applied to the development of activities in the Water Resource Management seedbed of the civil engineering program of the Corporación Universitaria minuto de Dios of the regional center Sabana Centro and Ubaté, it has evolved and improved in the internal and productive processes of the same through the implementation of the Project Based Learning (PBL) methodology and as mentioned by (Guerra, Rodríguez-Mesa, González, & Ramirez, 2017); (Rodriguez-Mesa, Fernando; Kolmos, Anette; Guerra, 2017) education with this methodology allows the development of soft skills, enhances the

knowledge acquired in the classroom and promotes better professional training in students who accept the challenge of participating in these research spaces by working with other professionals, students and especially with communities whose problems are the source of real problems with a possible engineering solution adapting such solutions in the objectives of sustainable development (ECLAC, 2018) in order to adequately target with national and international guidelines.

The project-based learning methodology is widely used around the world due to its adaptability to the academy and from there generate processes of improvement in training skills in students by subjecting them to real cases where they test their theoretical knowledge along with the special conditions that may have a community, it is there where the first variation of the methodology and its centralization in Latin America as mentioned by (Guerra et al., 2017,p48) the challenges of the students are focused on solving real problems of companies where the use of software aligned with the vision of the business is needed generating a quality system, likewise (Cornejo-aparicio, Flores-silva, & Bedregal-alpaca, 2019,p446) exemplify the application of the methodology by taking it to a software design for a higher education institution in order to record the attendance of both the teacher and the students, this in order to keep a proper record of compliance with the classes and attendance of each of those involved in the class process.

Likewise, (LAZAR & FACIU, 2019,p116) propose as a work proposal for students of the Master's Degree in Environmental Engineering the focus on 2 important topics such as the effect of industrial discharges of an artificial lake on the quality of the ecosystem and the effect of buildings on the dispersion of particulate matter in the air, with these topics in mention the authors of the topic work the basic elements of problem-based learning mentioned by (Rodriguez-Mesa, Fernando; Kolmos, Anette; Guerra, 2017) where guidelines, objectives and evaluation conditions should be established to assess the performance of students within the project to be developed based on literature reviews, theoretical foundation of previous courses as well as acquired knowledge and essentially autonomous learning by the student.

It is from these basic premises that the Water Resource Management research seedbed encourages its students to participate in its activities from a regional perspective where it takes advantage of the condition of plurality in the origin of the same students by coming from different municipalities near Zipaquirá, which allows identifying problems in the region and from an initial idea to replicate the projects developed by them in different areas and spatial locations determined that allow generating solutions for communities, such a case the community of Pacho mentioned by (García Puentes, Montaño Santana, & Pérez Rodríguez, 2019) in which successful work processes of students with the community of Asojuntas Pacho are evidenced and within which students generate housing solutions and community halls in order to meet the needs of the people.

It is also important to mention that students can be linked to the seedbed under 4 work modalities: volunteer work, practice in social responsibility, professional practice in

research and degree option, taking into account the curriculum, the last three options are subjects of the program curriculum and are part of the institutional educational project (Vargas, 2014) where training components such as the professional and complementary professional component as well as the Minuto de Dios component are developed and from the substantive functions teaching, social projection and research are strengthened as part of a whole by integrally developing the participating students and teachers.

Once this precision is made, students who wish to join the seedbed can do so under any modality regardless of the current semester, being ideal to start the process as soon as possible in order to develop the research idea with time and calm, focusing their work on topics of their interest and taste to achieve more dynamic work, with this in mind since 2017 the seedbed has generated a growth both in participants within the group and in the quantity and quality of production of research products, it is from there that projects arise framed in topics such as rainwater harvesting from which 4 degree works, 4 articles, 1 formative research project (C. Pérez Rodríguez, 2019), 13 research papers and 3 posters in academic events and 2 certificates of participation with citizenship.

A retrospective review when evaluating the evolution of the seedbed shows a growth of the internal activities of the working group due to the example of the leader and the students of the final semesters by committing themselves to generate research products of increasing impact, with better rigor and quality, so much so that there are prizes such as the 1st place in the 8th Uniminuto Research Conference and 6th meeting of seedbeds where 2 students of the seedbed obtained this achievement from a literature review on biodigesters and it is a topic under development within the seedbed by other students to continue the research line.

It is also true that as students complete their educational cycle within the institution and leave the quality of students to become graduates, it is possible to maintain links with these students to continue research processes or continue in the search to expand their knowledge by participating in academic events generating presentations or support in activities of the seedbed as the graduate engineer Andres Paez and his participation in the Girardot Regional Center, This is how interesting interactions are achieved within the work team due to the fact that each student may be from different semesters and academic backgrounds, but potentially grows due to the interaction with more academically advanced students or graduates, and a space is provided for the strengthening of knowledge based on experiences in the office or in the field when facing real problems and generating effective solutions to these problems.

It should be noted that the work developed by the seedbed is on a voluntary basis, students work on topics of their liking and generate their interest to investigate, they start their training process when they wish and generate the research process with a view to obtaining their degree option at the end of their career, it is there where the modalities of degree in research at the Corporación Universitaria Minuto de Dios (Vargas, 2014) are taken into account, there are options such as the paper, the article or the degree work and this is evident in the works with the highest production within

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the group are the paper and the articles, the article or the degree work and this is evidenced in the works with the highest production within the group are the paper and the articles since students with good research developments generate papers mostly, the disclosure in written media has been less accepted but it is an opportunity for improvement for both the teacher and the students in training and everything starts from the example given by the leader of the seedbed when publishing and participating in research activities as an appropriate strategy to motivate students and to be participants in academic events and publications.

MATERIALS AND METHODS

In the research process developed, quantitative methodologies based on project-based learning are used, a tool that allows students to generate research projects with a social focus, thinking of sustainable and practical solutions for the benefited community, this is where the student's freedom enters in the generation of proposals or alternative solutions to a problem determined by them or by the teacher in order to strengthen academic and professional training processes, It is then clear for the students the plurality of possibilities of work by not having a single project to develop and have the possibility of proposing activities of their interest and generate a taste for research in order to obtain the best results, this idea of work has led the seedbed to generate projects developed and implemented in municipalities of Cundinamarca such as Pacho, Zipaquirá, Nemocón, Tocancipá, Sutatausa and Ubaté, municipalities of origin of the students and that see opportunities for improvement in specific areas of work where it allows them to strengthen human and social relations by interacting with communities under study taking into account the human-centered design (IDEO.org, 2015) this is the tool with which students generate a project with the ideal of satisfying the manifest needs of a community and adapts to the culture and customs depending on the region.
Therefore, the work developed with the seedbed has a framework of topics in which students can choose related topics or break them down in a more specific way, in general, the topics selected by them can be grouped into 2 groups:
It is here where students apply theoretical knowledge of subjects such as hydraulics, hydrology, aqueducts and treatment plants in a real space in order to generate alternatives for the use of rainwater for resource optimization purposes (Rios & Rios, 2018); (Castillo & Pantoja, 2018) properly distributing the use of drinking water, reducing such consumption by using rainwater for non-drinking uses in homes or even proposing alternatives for water treatability (Romero, 2002); (Arboleda, 2000) with the idea of improving its quality for agricultural purposes, livestock or even for human consumption always taking into account the current regulations (Ministerio de Vivienda Ciudad y Territorio, 2017), the sustainable construction of systems by reducing the amount of material or even generating proposals with recycled materials (C. A. Pérez Rodríguez, 2020b) where constructive alternatives developed by the students of the seedbed are presented from a common idea which contrast with prefabricated systems (PAVCO, 2014).

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This process arises from the manifest need of the community of the San Jorge hamlet in the municipality of Zipaquirá, where social leaders approach the regional center to seek advice from the civil engineering program and the seedbed in order to propose a possible solution to surface discharges of gray and black water due to the absence of a total sewage system but to the management given by septic tanks, this generates problems identified by (C. A. Pérez Rodríguez, 2020a) by evidencing discharges into bodies of water and surface that generate landscape deterioration which do not comply with current regulations (Ministry of Environment and Sustainable Development, 2015), students see in this process not only the generation of the design of the sewage system but the possibility of treatment of domestic and commercial wastewater in order to reduce its impact on nearby bodies of water and even propose alternatives for solid waste management with exercises of separation at the source and use of material for recycling and creation of products or construction elements.
The truth is that the projects arose in a specific space to solve a local problem, but this does not prevent them from being replicated or adapted to local needs in other spaces, which is why the mention made regarding the possibility of working, for example, biodigester systems in complementary spaces such as the municipalities of Nemocón and Tocancipá where projects are currently being developed by students of the seedbed and are in the research and pre-feasibility phases.

RESULTS

As time goes by, there is evidence of a continuous generation of projects, products and activities within the seedbed, which motivates to continue with the process and that the students understand the dynamics of the work and thus enhance their learning processes in research and in their personal training, the following results are evident:
Generation of products in the topic of modeling and rainwater harvesting: within this macro project, based on a formative research project (C. Pérez Rodríguez, 2019), there is a space for the development of research in the field and in the office where students carry out processes of separation at the source, construction of models, generation of designs and quantification of variables in order to generate adequate results with the time dedicated to the topics, thus achieving the results shown in the following graph:

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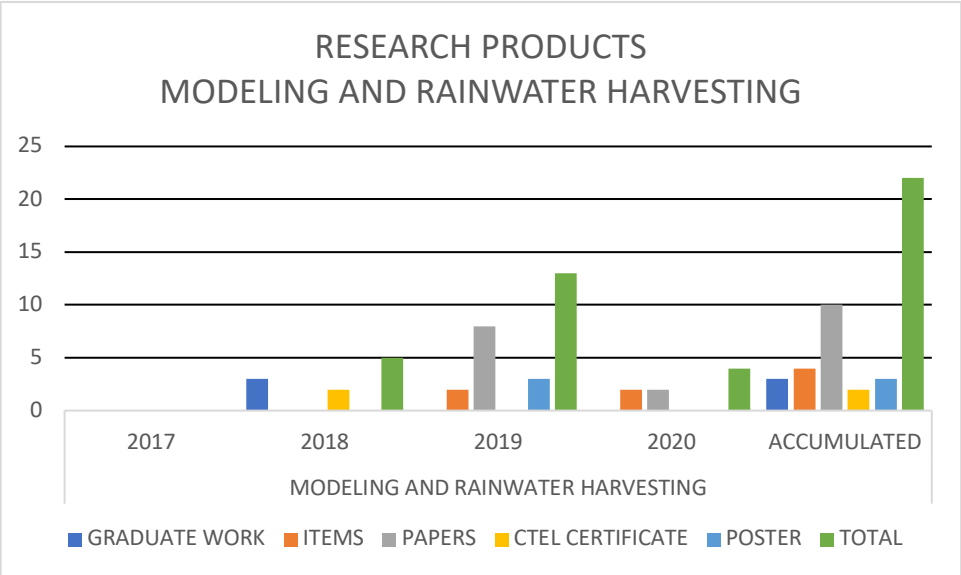

Graph 1. MINCIENCE TYPE PRODUCTS WATER RAINFALLS

One of the papers mentioned in the year 2019 was made by the student Geraldine Hernandez elaborating a rainwater collection gutter with soda and disinfectant bottles, research process that gave her the second place in her work table in the IV Regional Meeting Of Research, in addition to this can be observed growth in the generation of products with the passage of time, even in the year 2020 research processes are still being generated and products are being submitted for papers and articles on the continued development of these issues.

Academic production focused on sewage systems, water treatment and sewage sludge: being a process of intermittent development within the seedbed, the results shown are presented and freely chosen by the students:

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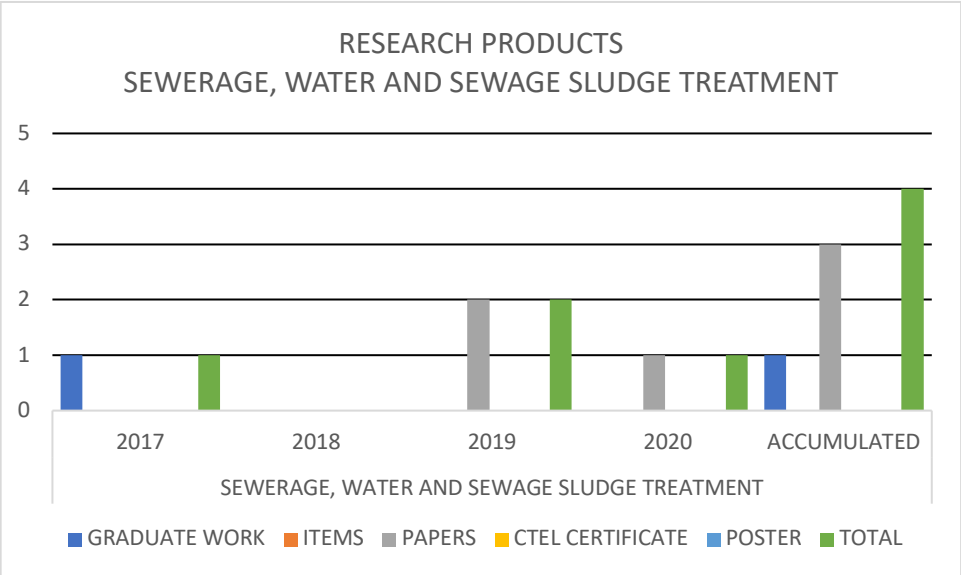

Graph 2. TYPE OF MINCIENCE PRODUCTS WASTE WATER

In this training project alternative, there is a special interest on the part of the students for the development of the work with the community of the Vereda San Jorge de Zipaquirá, where sewerage design processes arise (Ministerio de Vivienda Ciudad y Territorio, 2017); (Ministerio de Vivienda Ciudad y Territorio, 2016); (López Cualla, 2004), wastewater treatment and phytoremediation of sewage sludge (Romero Rojas, 2004), this last topic generated a paper with high acceptance in event (Science Tubers, 2020) where the student Cristian Mahecha develops an interesting research process on the treatment of sludge with radish and chard.

With the passage of time and the generation of research proposals and alternatives by the students, there is evidence of a growth in the generation of research products, in the visibility of the work developed by the students and in the improvement of reading, writing and public management skills as complementary skills fostered within the semester activities, as reflected in the following graph:

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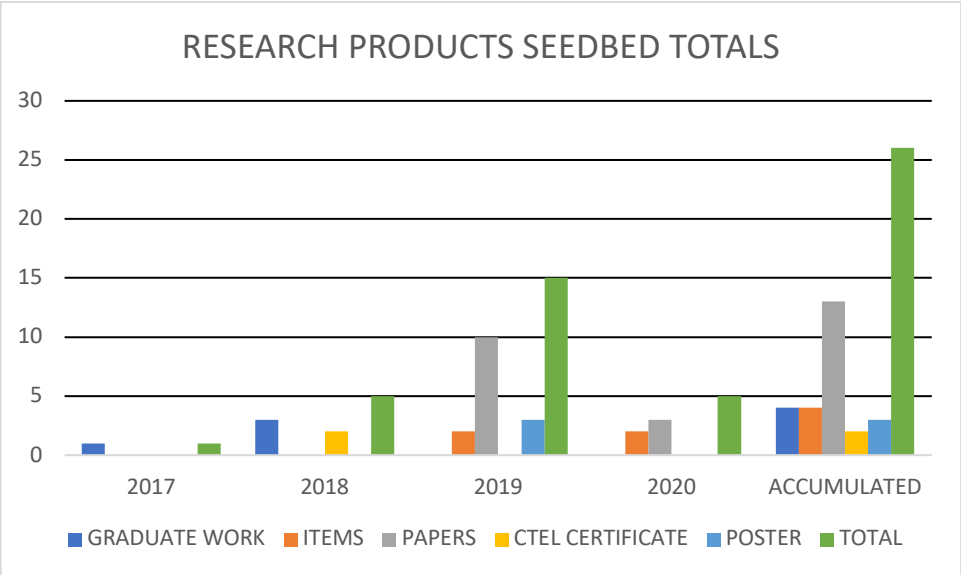

Graph 3. HISTORICAL HISTORY OF ACADEMIC PRODUCTION OF THE WATER RESOURCE MANAGEMENT SEMINAR

This is due to the ease shown by some of the students in handling the public, the interest in participating in academic activities and the interaction with other universities, cities and even customs or cultures with the ideal of enriching their professional training, the production of articles is in development and continues to be enhanced as better research processes are generated and better results are obtained.

DISCUSSION

As steps to be developed within the activities of the seedbed, the generation of high impact written products created by the students and the teacher is desired through the generation of confidence in the processes, the strengthening of competencies and skills in the students to be motivated to publish and lose the fears generated by the submission of products to peers or external people.

Obtaining external allies in the research processes, whether urban or rural communities, as well as academia and governmental entities, generates better applied learning processes since continuous improvement is sought in the projects, economic or logistical support can be generated by the interested parties and, consequently, the financing of the projects in order to materialize them.

There is an opportunity to improve these processes by encouraging the publication of research results by students, by generating greater participation in academic events where they can show their results, be valued and measured nationally or globally by observing the evolution of the research developed and its continuous improvement over time and the quality of the products as well, are challenges that must be assumed with height and must be supported by teachers and students.

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The breadth of topics worked on seeks in students the possibility of complementing their professional training in various topics related to sustainability, water and solid waste management, to evaluate how changes in the location of the projects influence their development, the variables to be taken into account to adapt correctly to the space, the community being worked on, the governmental, environmental and cultural conditions with consequent changes in the foundation, scope or implementation of the project.

CONCLUSIONS

Learning based on engineering projects generates in the seedbed the development of projects and clearer formative processes for the students, allowing the approach of works with social identity, adequate engineering foundations to promote benefits to the communities, the municipalities and the academy, since such interactions generate successful results with the different interactions during the project.

The progressive evolution in terms of the quantity and quality of the products generated is due to the continuity of the process, many of the 41 participating students are part of the seedbed with at least 1 year in their research processes, which generates adequate and better quality products by having an adequate dedication of time for the development of activities in the field, laboratory or office, with which their results are better each time and generate more feasible analyses, results and conclusions based on processes according to their needs.

The project-based learning process enhances the field of action of students and teachers because new spaces of interaction are known, new real problems to be solved and allows interaction with communities from different sectors of the region, thus the human and professional formation of the people involved is of constant growth.

The search for professional training spaces is not exclusive to the classroom, it is necessary the process of interaction with communities, government agencies, academia and public and private companies, to achieve these interrelationships is enhanced academic and professional growth of students as they have different real visions that in their professional life will face and that is where you can achieve a better preparation of the student in transit to being a graduate.

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