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Analysis On The Relationship Between Geotechnical Engineering Education, School Psychology And Wellbeing

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ABSTRACT

The work of geotechnical engineers has the potential to affect the physical and mental health of the people they serve. Thus, this article investigates the relationship between geotechnical engineering and wellbeing through a bibliometric analysis. A bibliometric analysis processor was used with a database of high-impact articles reported in the literature. Wellbeing refers to an individual's physical, mental, and emotional health and happiness. Geotechnical education focuses on studying soil and rock mechanics and their applications in civil engineering and construction, whereas wellbeing refers to an individual's physical, mental, and emotional state of health and happiness. However, a vital education in geotechnical engineering can lead to greater professional fulfillment and advancement opportunities, which can contribute to overall wellbeing and school psychology. Finally, It has been analyzed that wellbeing is not necessarily related to geotechnical education, but it can influence some aspects such as increased social support, sense of belonging, promote community engagement, and improved access to services.

Keywords: geotechnical engineering education, school psychology wellbeing, bibliometric analysis.

1. INTRODUCTION

Geotechnics education refers to the study and training of the principles and techniques used in the design and construction of engineering projects concerning soil and rock mechanics (Knickle, 1995). It encompasses understanding the behavior and properties of soil and rock, analyzing and designing foundations, slopes, embankments, and other earthworks, and assessing and managing soil and rock hazards(Sutterer & ASCE/TCFE, 2003). Geotechnics education typically includes coursework in soil mechanics, rock mechanics, geology, geotechnical engineering, and engineering geology (Budhu & American Society for Engineering Education, 2001). In addition, geotechnical engineering is the branch of civil engineering concerned with the engineering behavior of earth materials. Geotechnical engineering education typically includes courses in soil mechanics, foundations, earth retention systems, and site investigation techniques(Ngan-Tillard et al., 2008). Students learn about the properties and behavior of soils and rocks and how to use this knowledge to design and construct foundations, slopes, retaining walls, and other structures(Pantazidou, 2020). They also learn about the principles of soil and rock mechanics and the methods used to investigate and analyze the subsurface conditions at a construction site. Some programs may also include courses in environmental geotechnics, which cover topics such as contaminated land, landfills, and underground waste storage (Macedo et al., 2015).

Several factors can influence the field of educational geotechnics, as presented in Figure 1, including advancements in technology, industry demand, research and development, government regulations and policies, and economic factors (Pantazidou, 2013). Developing new technologies and software in geotechnics can significantly influence how the subject is taught and studied. These advancements can also lead to new research opportunities and the discovery of new methods for analyzing and designing geotechnical projects. Also, the industry's demand for geotechnical engineers can influence the focus and curriculum of geotechnics education. As the industry shifts towards more sustainable and environmentally-friendly practices, educational institutions may adjust their curriculum to reflect these changes.

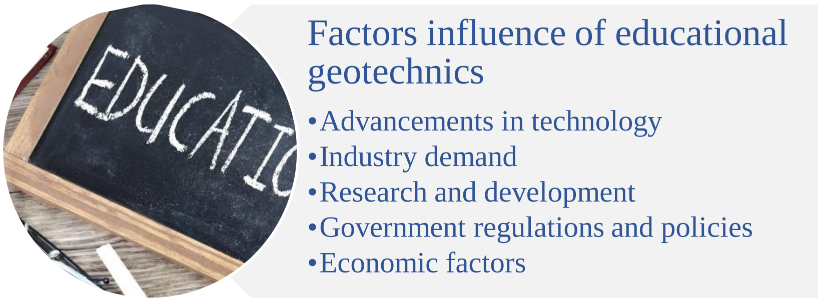

Figure 1. Main factors influence of educational geotechnical engineering

As new research and development in geotechnics is conducted, the understanding and knowledge of soil and rock mechanics can evolve, leading to changes in how the subject is taught and studied. Government regulations and policies can also impact geotechnics education (Welker & Engineers, 2012). For example, changes in building codes and regulations can affect the design and construction of geotechnical projects, affecting the curriculum and teaching methods used in geotechnics education. Finally, economic factors such as funding for research and education and the construction industry's state can also influence educational geotechnics (Pantazidou et al., 2020).

Advancements in technology can significantly influence the field of educational geotechnics. Figure 2 displays the leading advanced technologies in geotechnical education. For example, new technologies such as computer modeling and simulation can significantly enhance the ability of students and researchers to analyze and design geotechnical projects(Koehn & American Society for Engineering Education, 1999). This allows for a more accurate and efficient assessment of soil and rock mechanics, as well as the behavior of structures under different loading conditions. Another point related to the advances in geotechnical instrumentation and monitoring can provide more detailed information about soil and rock properties, enabling a better understanding of the behavior of geotechnical systems. This can be used to improve the design and construction of geotechnical projects and to monitor and predict the performance of existing structures. In other aspects, GIS and remote sensing technologies can map and analyze a site's geology, geomorphology, and soil properties. This can identify potential hazards and design geotechnical projects(Platis et al., 2020). Machine Learning and Artificial Intelligence can be used to develop models and software for geotechnical analysis and design, which can improve the efficiency and accuracy of geotechnical projects and can also be used to improve the understanding of soil and rock mechanics. In addition, virtual and augmented reality: Using virtual and augmented reality in geotechnics education can provide students and researchers with a more interactive and immersive learning experience(Gupta et al., 2004). It can also be used to simulate and visualize geotechnical projects, making it easier to understand and analyze complex geotechnical systems (Canakci, 2008).

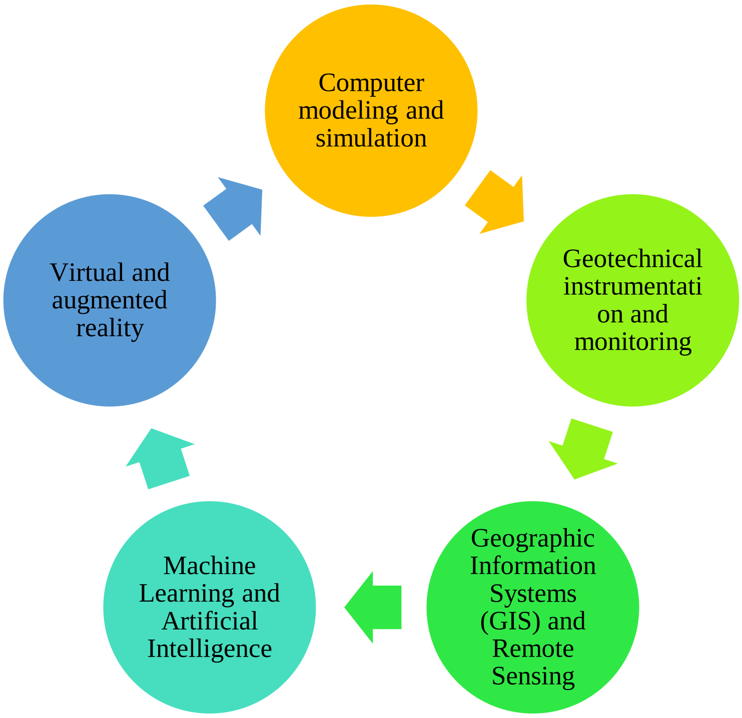

Figure 2. Advancements in technology influence the field of educational geotechnics

Computer-aided learning (CAL) is increasingly used in geotechnical engineering education to enhance the learning experience for students. CAL refers to using technology, such as computers, software, and online resources, to assist in teaching and learning (Toll & Barr, 1998). One of the critical advantages of CAL in geotechnical engineering education is its ability to provide students with hands-on experience through simulation software. These simulations allow students to conduct virtual experiments, analyze results, and make decisions based on their findings. This can be particularly beneficial for students who may not have access to physical laboratory equipment or fieldwork opportunities (Oliver & Oliphant, 1999). Another advantage of CAL in geotechnical engineering education is its ability to provide students with immediate feedback on their work. This can be particularly useful for formative assessment, allowing students to identify areas of weakness and make improvements before moving on to more advanced material. CAL can also be used to create interactive multimedia resources that can be accessed online. Such can include videos, animations, and interactive diagrams that help students visualize complex concepts. The subject being addressed can make the material more engaging and easier to understand for students (Springman et al., 2013). Overall, CAL is a valuable tool for geotechnical engineering education, as it can help students to develop practical skills, improve their understanding of complex concepts, and prepare them for the workforce (Jaksa et al., 2020; Toll & Barr, 2009).

Critical concepts in geotechnical engineering education are fundamental principles and ideas that students must understand to be successful in the field, as presented in Figure 3. These concepts include soil mechanics, foundation engineering, slope stability, earth retention systems, site investigation, environmental geotechnics, and numerical modeling (Day, 1993). Overall, understanding these key concepts is essential for students of geotechnical engineering education, as they form the foundation of the knowledge and skills required for the field (Goodings & Ketcham, 2001).

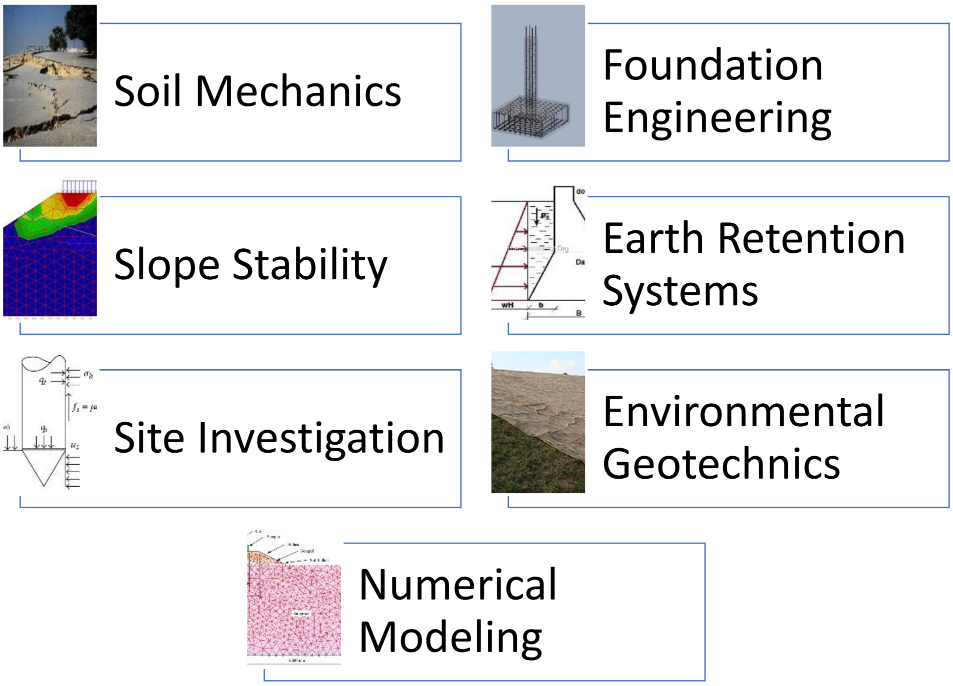

Figure 3. Main concepts in geotechnical engineering education

Laboratory-to-field experiments are an essential aspect of geotechnical engineering education. These experiments provide students with hands-on experience with the geotechnical principles and techniques they have learned in the classroom. They also allow students to apply their knowledge to real-world problems and develop practical skills that will be useful in their future careers(Schaub, 1984). One example of a laboratory-to-field experiment that is commonly used in geotechnical engineering instruction is the field testing of soil samples. This can include performing tests such as standard penetration test (SPT), cone penetration test (CPT), and borehole drilling to determine soil and rock properties at a specific site. These tests can determine soil classification, compaction characteristics, and shear strength(Bilow & Dewaters, 2022). Another example of a laboratory-to-field experiment is the construction and monitoring of slope stability. The current matter can include performing a slope stability analysis, designing and constructing a slope stabilization system, and monitoring the system's performance over time. Field experiments can also include studying the behavior of existing geotechnical structures, such as retaining walls, embankments, and foundations. This can include performing inspections, collecting data, and analyzing the results to determine the structure's condition and identify potential issues ((ASCE), 2019).

Although geotechnical engineering is fundamental in civil engineering education, some related concepts, such as psychological education and wellbeing are not yet well established. Thus, this paper presents the connections between these concepts through a bibliometric analysis.

2. MATERIALS AND METHODS

The method used was data collection through a database of journals available on the network. It was based on pre-established lines of research in the area of geotechnical engineering with the addition of wellbeing and educational psychology, where it was possible to carry out a more refined "string" containing the materials of interest and the most used for this purpose.

With the "string" defined, the base of interest was accessed, in this case, SCOPUS, and the search for articles and materials of interest began. A query line of research was obtained to search for articles related to geotechnical engineering education, school, and wellbeing. The line of research demonstrates the best attempt to cover articles only related to the topic.

After a defined query, a representative bibliometric network of the residues used was created, using data in RIS (Research Information Systems) format. Obtaining the files in RIS (Research Information Systems), and using the VOSviewer software version 1.6.18, a map is created based on bibliographic data, and the minimum number of a keyword is defined in 5 occurrences. They allow the design of varied groups according to the need, facilitating the location of research groups, types of materials, and universities.

Groups, "cluster", with sizes of 200 items for the first group, 180 items for the second group, and 120 items for the third group, are created, organizing similar materials in each group. Finally, the bibliometric network is analyzed in 3 clusters to define the most used concepts, their segments, the least used, and those that do not provide a relationship between geotechnical education, psychological education and wellbeing or do not apply. The string used in this work was defined as: ("geotechnical engineering" AND" education")OR(("geotechnical engineering" AND" education" AND" wellbeing)OR("geotechnical engineering" AND" phychological")

3 RESULTS AND DISCUSSIONS

Data analysis in the bibliographic manager was possible to carry out the bibliographic network. The bibliographic network is shown in Figure 4. The most accepted concept within the 500 articles in the database was "geotechnical engineering". Because there are no pre-existing connections or studies on psychology in the sector of geotechnical engineering, the keywords are found related to the teaching concepts as "teaching", "teaching methodologies", and "education and training". The relationship between geotechnical engineering education and wellbeing can be seen in the impact of geotechnical engineering on the built environment and the people who live and work in it. Geotechnical engineering plays a crucial role in the design and construction of safe and stable structures, including buildings, bridges, and infrastructure, which directly impact the wellbeing of individuals and communities (Poulos, 1999). For example, by understanding the mechanics of soil and rock, geotechnical engineers can design foundations that can withstand earthquakes, landslides, and other natural hazards, which can help protect lives and property (Calvello, 2020). Additionally, geotechnical engineering education can also include the study of sustainable design principles, which can help promote the use of environmentally friendly and energy-efficient building materials and construction methods, which can contribute to the overall wellbeing of individuals and communities(Lee, 2015).

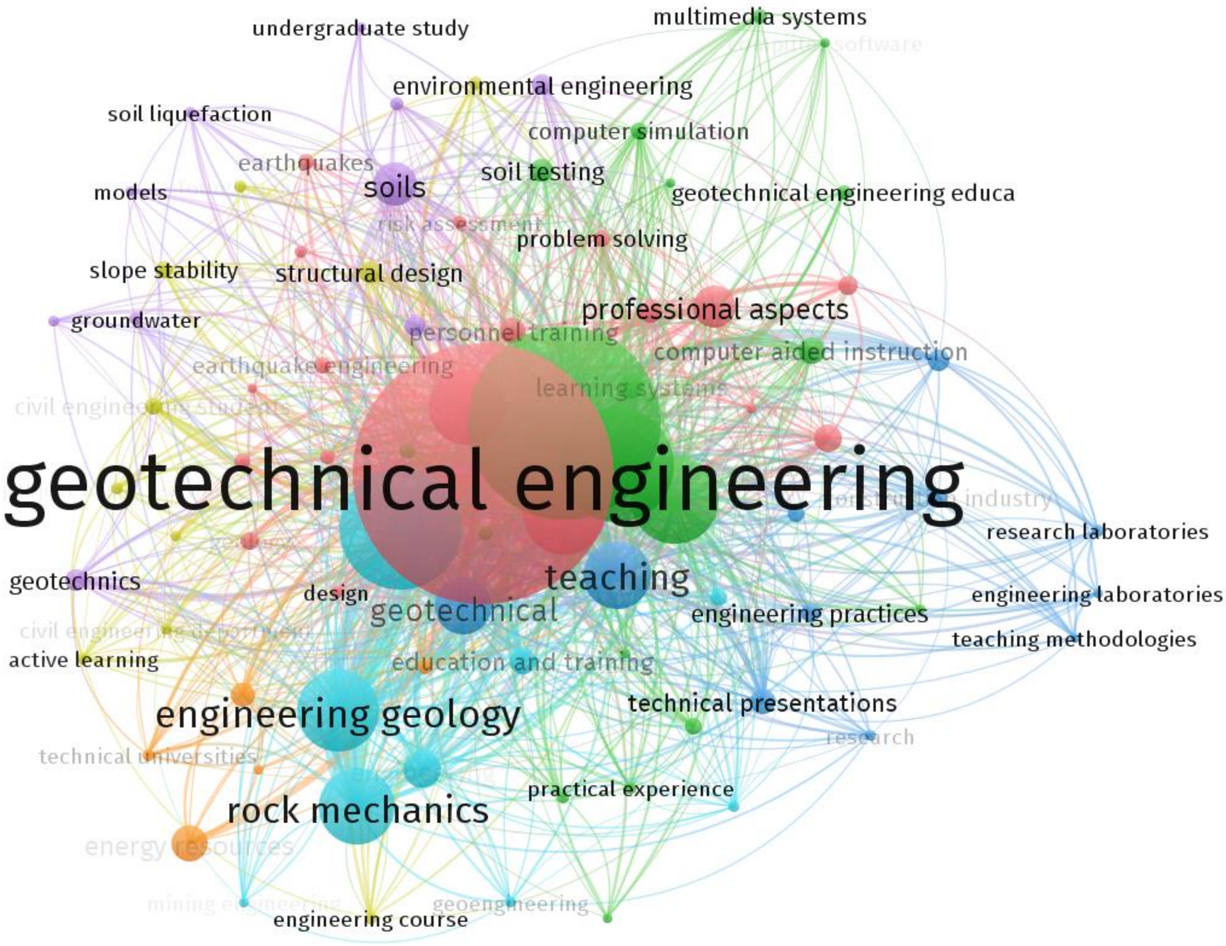

Figure 4. Bibliometric network

Figure 5 presents the countries where more wellbeing studies and educational geotechnics have been developed. The main studies have been carried out in the United States, the United Kingdom, and China. The other countries are Colombia, India, Spain, Chile, Japan, Australia, and Italy. The number of documents published by universities in the United States is more significant than 100. The following country is the United Kingdom 20. Much less than half that in the United States.

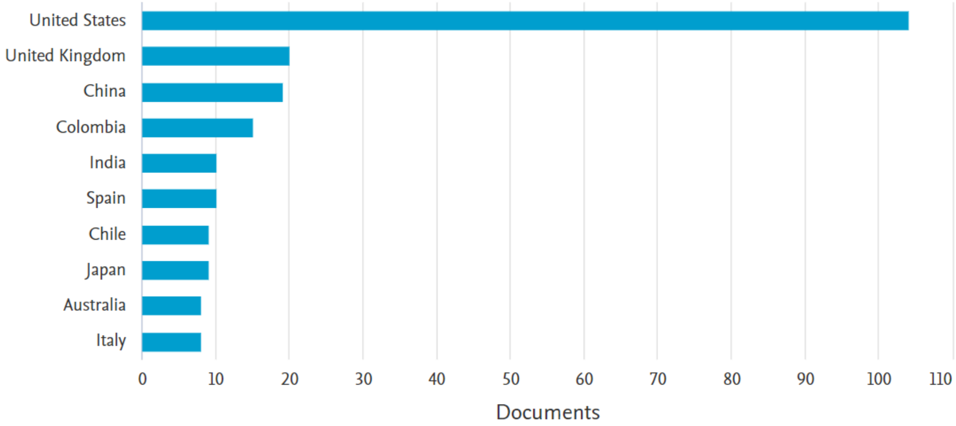

Figure 5- Countries where educational geotechnics and wellbeing are most studied (SCOPUS Database Analysis)

Figure 6 presents the production by year of the articles that relate geotechnical engineering and education. Note an increase from 2010 to 2020, with a drop until 2022, possibly due to the COVID-19 pandemic.

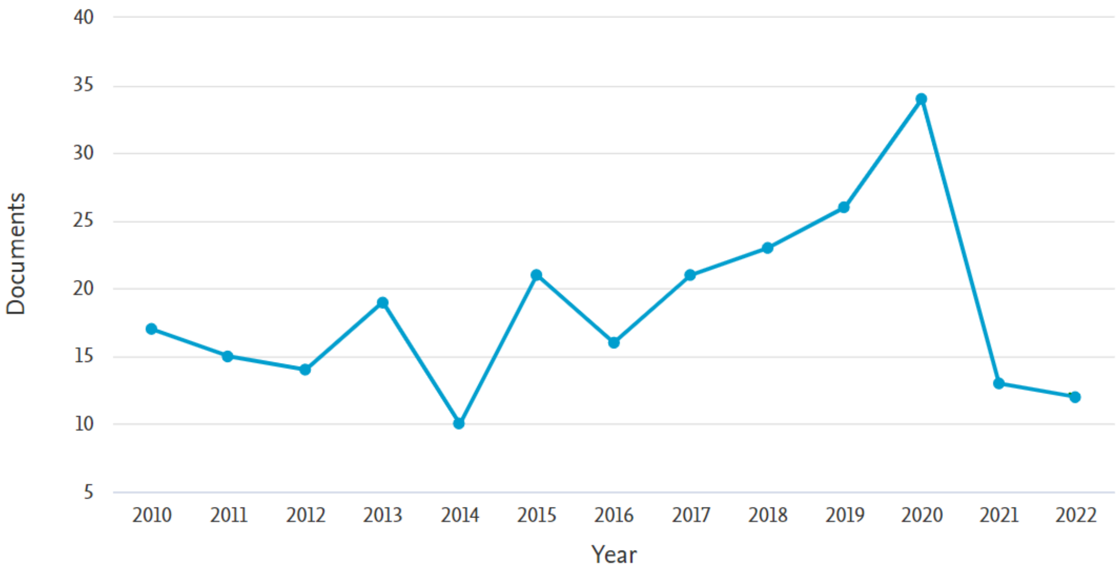

Figure 6- Production per year on educational geotechnics, wellbeing and educational psychology (SCOPUS Database Analysis)

One of the most studied topics in the article database is the future challenges of geotechnical engineering. Figure 7 shows a continuous flow of the main challenges of the study of geotechnics. The challenges include keeping up with advancing technology, incorporating sustainable practices, meeting the needs of a diverse student body, emphasizing hands-on learning, and preparing students for emerging trends.

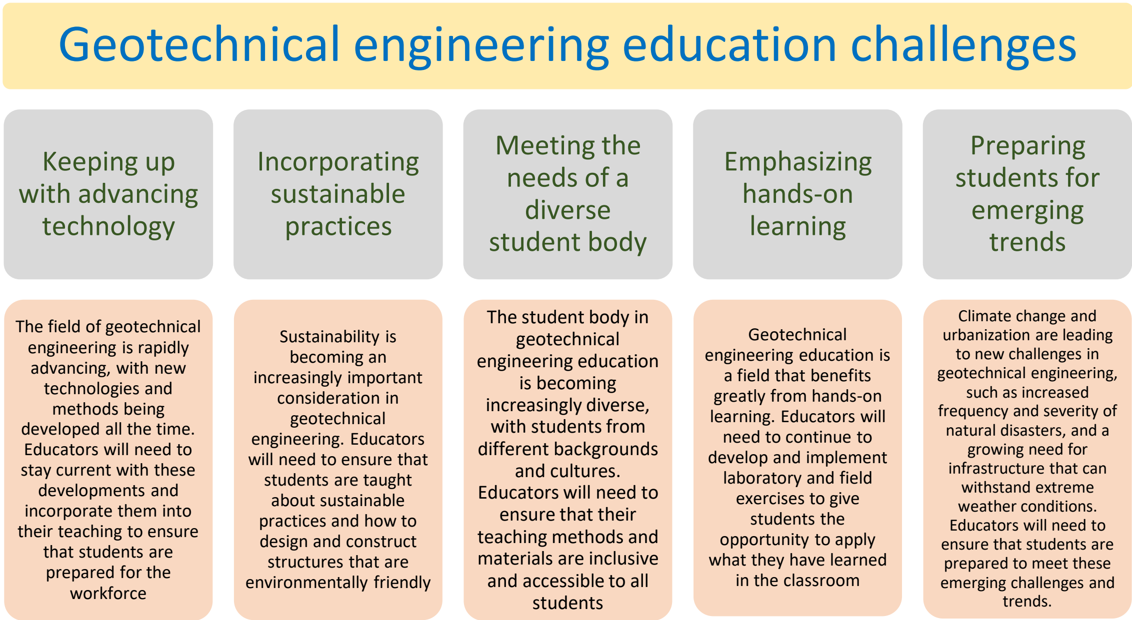

Figure 7. Geotechnical Engineering Education challenges

Developing transferable educational material is an essential aspect of geotechnical engineering education. Transferable educational material refers to resources used in different contexts, such as university course offerings, to support student learning(Jiang et al., 2021). One example of transferable educational material is a laboratory manual. A laboratory manual can be developed for a specific course and include detailed instructions for conducting experiments and information about the equipment and materials needed. Instructors can then use this manual at other universities teaching the same or a similar course, providing them with a valuable resource to support student learning. Another example of transferable educational material is online course modules(Sowers, 1978). These modules can be developed to cover specific topics and can include interactive resources such as videos, animations, and quizzes. These modules can be made available online and can be used by instructors at different universities, who can incorporate them into their course offerings. Another way to develop transferable educational material is by creating interactive simulations, with the help of software, that can be used to demonstrate the behavior of soil and rock, the performance of geotechnical structures, and the effects of different loading conditions(Sadrekarimi et al., 2008; van Tol et al., 2009). These simulations can be used in different courses and can be used by instructors to supplement their lectures and help students understand complex concepts.

In concordance with bibliometric analysis, the relationship between educational geotechnics and school psychology may not be immediately apparent, but there are several ways the two fields can intersect. The fields include environmental factors, active learning, stress and anxiety, STEM education, and safety. School psychology focuses on students' emotional, social, and cognitive development, and the physical environment can significantly impact student wellbeing and learning(Dewoolkar et al., 2012). Educational geotechnics can play a role in creating safe, healthy, and comfortable learning environments by ensuring that the school's physical structure and infrastructure are sound and that the surrounding area is safe and free of hazards. Educational geotechnics can play a role in providing opportunities for active learning, which is a crucial principle in school psychology. Active learning strategies can be used to engage students in hands-on, experiential learning activities that can help to deepen their understanding of geotechnical concepts and principles. In addition, school psychology also focuses on students' mental and emotional wellbeing, which can negatively impact learning(Budhu, 2005). Educational geotechnics can play a role in creating a safe and secure learning environment, which can help to reduce stress and anxiety and promote student wellbeing. On the other hand, educational geotechnics is a field of engineering and geology. It has often been considered that STEM education is an essential part of the educational curriculum. School psychology may play a role in understanding and addressing the challenges students may face in STEM education, such as a lack of interest or confidence in these subjects. Lastly, safety is critical to educational geotechnics and school psychology(Aydilek, 2007). Educational geotechnics can play a role in ensuring the safety of school buildings and facilities, while school psychology can focus on students' and staff' emotional and mental wellbeing. While educational geotechnics and school psychology may seem unrelated at first glance, they can intersect in several ways, including creating safe, healthy, and comfortable learning environments, active learning strategies, and promoting student wellbeing and safety(Jaksa et al., 2020).

Some crucial points in the relationship between geotechnical engineering education and wellbeing include understanding soil and rock mechanics, designing for safety and stability, sustainable design, Risk Management, and site characterization and investigation. Thus, Figure 8 displays this relationship. Geotechnical engineers use their knowledge of soil and rock mechanics to design foundations, retaining walls, and other structures that can withstand the forces of nature, such as earthquakes, floods, and heavy loads (Hanson et al., 2021). This helps to ensure the safety and stability of the built environment, which directly impacts the wellbeing of individuals and communities. A good understanding of the site conditions, including soil and rock properties, groundwater, and other subsurface factors, is crucial for designing and constructing safe and stable structures. Site investigation is a fundamental step that geotechnical engineers perform to get the necessary information to design and construct safe and stable structures (Scharle, 2005; Toll, 2017).

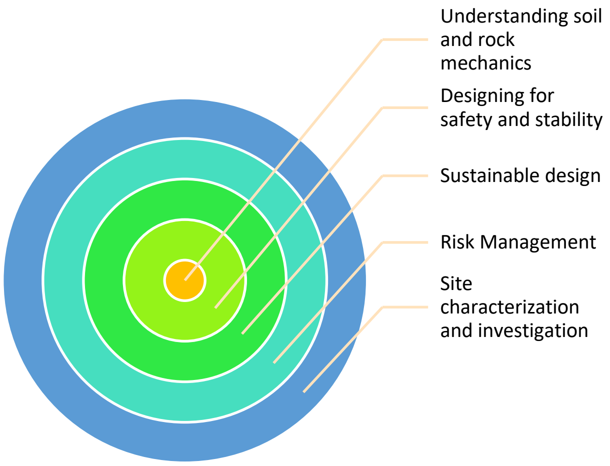

Figure 8. Relationship between geotechnical engineering education and wellbeing

The relationship between geotechnical engineering education and positive psychology and well-being can be seen in the impact that safe and stable built environments have on the overall psychological wellbeing of individuals and communities, as presented in Figure 9. It's important to note that geotechnical engineering education alone does not guarantee positive psychological outcomes, but it is an essential tool that can be used to create safe and stable built environments that can foster positive psychological outcomes((ASCE), 2019; Bilow & Dewaters, 2022; Gallagher et al., 2019). The sense of security provided by safe and stable built environments can positively impact the overall psychological wellbeing of individuals and communities. The design and construction of safe and stable structures, such as buildings and infrastructure, can provide individuals and communities with a sense of security by reducing the risk of physical harm from natural hazards, such as earthquakes and floods(Budhu, 2006; Lei & Najafi, 2012). The design of accessible and inclusive built environments can foster social connections, which can positively impact the overall psychological wellbeing of individuals and communities. It's important to note that the social connections fostered by accessible and inclusive built environments are just one aspect that can contribute to the overall psychological wellbeing of individuals and communities. Other factors, such as a sense of security, access to nature, and positive aesthetics, also play an essential role in fostering positive psychological outcomes(Duncan et al., 2008; Jackson et al., 2012; Platis et al., 2020).

Figure 9. Relationship between geotechnical engineering education, school psychology, and wellbeing

4. CONCLUSIONS

The bibliometric analysis was satisfactory and with a potential for research mapping and feasibility analysis of studies on the relationship between educational geotechnical engineering and psychological wellbeing. It was essential to use the VOSviewer software in conjunction with the bibliometric analysis, facilitating the cluster delimitation and interpreting the results obtained. Finally, the interest in the search for the main factors that influence the relationship between educational geotechnics, school psychology, and wellbeing was met. Although there is no direct relationship between the three, there are related concepts, such as stress reduction to improve learning, access to nature, improvement of services, and social connections.

The number of documents published was up to 2020, with a reduction due to remote access to education caused by COVID-19. The countries where the relationship between school wellbeing and geotechnical engineering has been investigated the most are the United States and the United Kingdom.

The close relationship between the concepts that influence school psychology and educational geotechnics can produce other concepts or lines that can improve learning about geotechnical engineering in engineering schools, especially in terms of the potential use of more sophisticated tools such as modeling, state-of-the-art laboratory tests, and field tests.

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