Transformative Action Research for Purposes of Academic and Scientific Socialization in Greek Tertiary Geotechnical Education

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Abstract

This paper presents a qualitative action research study, designed to explore the transformative impact of critical thinking on undergraduate Geotechnical Education students in Greece. The methodology was an intervention, consisting of thirteen workshops, premised on aesthetic experience and research action. A pre-intervention discussion identified limited academic and scientific socialization and, therefore, demonstrated the need to address this challenge. A focus group discussion was conducted halfway through the research to evaluate the development of the research process. A written interview, upon completion of the intervention, shed light on the impact of the experience on the students. This action research draws on constructivist learning theory, presupposing reflection, action and collective work. Although the data analysis process is currently in progress, initial findings establish broadening of assumptions about the role and mission of a geotechnical scientist, empowerment of soft skills, as well as student agentive potential.

Keywords: qualitative, action research, intervention, aesthetic experience, research practice

Introduction

This paper presents a qualitative action research study for purposes of academic and scientific socialization, aiming to explore the transformative impact of critical thinking (Mezirow, 2009; Kokkos, 2010) on undergraduate students of the Natural Sciences. In the context of the research, academic and scientific socialization refer to broadening of student assumptions, empowerment of competences, and development of student agency (OECD, 2019). Academic socialization is addressed through aesthetic experience while scientific socialization is approached via research practice, always aiming at the holistic development of the future scientist (Christodoulou, 2009).

The research methodology is an intervention scheme premised on study groups. The intervention is based on the application of critical thinking in the context of a combination of aesthetic experience and research practice. Gougoulakis (2024) argues that critical reflection and dialogue constitute key elements in transformative learning processes.

Initially, the present study aims to explore the students' current assumptions of their role as future scientists, and related facets thereof, challenge them, and, potentially, cause a transformation of these assumptions. Secondly, it seeks to investigate potential transformative impact on the metacognitive and social skills of the students, as well as on the importance attributed to them by the students themselves, prior to, and following participation in the action research. And, last but not least, it seeks to approach student agency issues in order to identify potential implications for the Curriculum of the Geotechnical Sciences, and for related educational policies.

Most research in higher education focuses on the development of methodological strategies and techniques aimed at enhancing students' knowledge and skills. However, times are changing, and the world needs people who are not only open-minded enough to embrace new ideas, but, even more importantly, people who are able to create new thinking. The Organization for Economic Co-operation and Development 2030 Compass (OECD, 2019)

proposes empowering and supporting students in order to promote well-being and contribute to the sustainability of society. As Cranton and King (2003) argue, educators, and learners alike, must participate equally in transformative learning, bringing with them their beliefs, and values, not intending to impose them, but aiming to test them, reflect on them, and arise wiser than before.

Research context

The goal of higher education is to create autonomous thinkers (Mezirow, 1997). Cranton (2006a; 2006b) argues that teachers must be supportive of learners' efforts to achieve autonomy. Transformative learning is an effective framework within which learners can develop a clear picture of their abilities and better understand their way of thinking, in order to adapt and function effectively in a constantly changing, international professional reality. As Kegan (1982) argues, human development is all about the individual's strife to emerge transformed and independent after a period of integration and consultancy.

Higher education is considered a suitable field for the implementation of transformative actions. In the context of higher education, the adult individual should be given the opportunity to consciously benefit from academic and scientific activity, whether as a student, or as a teacher. Conventional teaching models, which require copying, and rote learning are becoming increasingly outdated, without any provision for communication, collaboration, initiative or autonomous thinking. On the contrary, there is an urgent need to provide opportunities for the application of creative and critical thinking in order to strengthen academic and research skills in the field of Higher Education, in a more coordinated manner, basically within Curricula, so as to address all students (cf. The mission of Greek Higher Education, Law 4957/2022/Article 3/Par. 3).

Action research is a methodological approach "that has the potential to explore transformative learning in educational settings" (Gravett, 2004). Action research has only recently begun to emerge as an effective method of transformation (Taylor, 2000).

Taylor explicitly supports the use of action research in the context of transformative learning (ibid.). More specifically, she encourages teachers to improve their teaching through action research, "ensuring that critical reflection, trust and authentic relationships are at the core of their study". Taylor (1998) argues that the guiding principles for action research are fully aligned with the strategies proposed for transformative learning, with collaborative inquiry and critical reflection being the two most fundamental pillars.

Gravett (2004) confirms that any intervention, which is implemented in a transformative context, through an action research design, is sufficient evidence of upgraded teaching and improved teaching and learning techniques.

Additionally, Illeris (2016) argues that, in an educational process, aiming at a holistic approach to learning, each process must be carefully designed. Nonetheless, it is equally important, and essential, that teachers do not hesitate to implement innovative ideas.
McNiff and Whitehead (2010) describe action research as a conscious process, through which the researcher can discover new methods to improve his teaching, which means that he conducts action research aiming to create new knowledge.

In this sense, action research is seen here as both a tool for improving teaching practice, but, more importantly, in the context of the present study, expanded frames of reference (Mezirow, 2009) are sought through experience, dialogue, reflection and collaboration for the personal and social development of all parties involved. These four elements, namely, experience, dialogue, reflection and collaboration, which essentially constitute the four pillars of the present research, lie at the center of the theory of constructivism, as originally formulated by Piaget (1964) and, subsequently, further developed by Vygotsky (1978), who spoke of "new knowledge as an outcome of social interaction".

According to the rationale developed above, this action research program was designed for, and implemented in, the field of Higher Geotechnical Education, with the aim of exploring the potential of critical thinking to cause transformation, through immersion in creative thinking and research practice.

Significance of the study

Relevant literature shows that research in transformative learning (Mezirow, 1991; 2009) in Adult Education is gradually gaining ground. The present study is developed within an action research framework based on the theory of transformative learning. More specifically, it seeks to explore the transformative potential of critical thinking through the processes of academic and scientific socialization of undergraduate Geotechnical Education students in Greece.

Initially, while research based on transformative learning theory in the Humanities seems to be increasingly pursued, on the contrary, in the field of Higher Geotechnical Education it is rather limited, even less so in the context of action research. Therefore, there are questions warranting answers regarding transformative teaching and learning in Higher Geotechnical Education.

Furthermore, there is currently no single, autonomous, critical thinking-based thematic unit, drawing on a combination of aesthetic experience and research practice, in the context of Tertiary Geotechnical Education. Therefore, the present study seeks to detect possible implications of an interdisciplinary rationale for the specific context of Higher Geotechnical Education, in which the research is conducted. These implications will potentially inform the Natural Sciences Curricula as well as the field of University Pedagogy (Gougoulakis & Oikonomou, 2014), in terms of the role of the teacher, the development possibilities of students, and the educational policies of Geotechnical Departments.

Last but not least, in the present action inquiry study, transformation is sought in an English-speaking environment, thus attributing an international dimension to both the research itself and, more importantly, offering participants the opportunity to experience this dimension. Interaction, both during the workshops, and during the data collection process, was conducted in English on the grounds that opportunities to use and reuse the foreign language promote comprehension and production of foreign speech. As the process develops, knowledge of the foreign language is facilitated and strengthened (Pica, 1994; Swain, 1985; 1995). Gass (1997) claims that interaction in the foreign language is a valuable tool for second language acquisition. In line with the relevant literature, the present study provided participants with an engaging context and gave them ample opportunity for critical reflection, interaction, dialogue and collaboration in an English speaking context.

In summary, the present study lays claim to originality on the basis of using transformative learning theory in an action research project, implementing the transformative action research project in the field of Geotechnical studies, and using English as a Foreign Language throughout the research procedure, both as a self-development, and, also, as a data collection tool.

Methodology

Most studies conducted within the framework of transformative learning theory are qualitative. The present study was based on an intervention, consisting of thirteen sessions, spanning over one academic year.

The sampling method was purposive, meeting specific criteria, such as early adulthood (18-25 years of age), student representation across all semesters of study, willingness to participate in a collaborative research scheme based on aesthetic experience and research practice, and, at a minimum, an intermediate level of English. An invitation to be informed about the research was extended to all students of the Geotechnical School from the entire spectrum of semesters. Twenty-five students responded positively. Following an analysis of

the structure, content, research process and the obligations that participation in this research would entail, twelve students expressed interest to sign up. As this sample was representative of the entire spectrum of semesters, with moderate knowledge of English, and an expressed willingness to participate in a collaborative research team, four study groups were created. The participants were assigned a mutually acceptable code to ensure the element of confidentiality.

Considering that no independent course in the Geotechnical Sciences Curriculum includes academic and scientific socialization processes, utilizing critical thinking based on aesthetic and research experience, participants faced relative difficulty in fully realizing the requirements of the activities each time, and in identifying appropriate material, defining objectives, preparing for each session, and, were, also, confronted with challenge conducting the entire process in English as a Foreign Language. Therefore, a reasonable amount of time had to be allocated between sessions for the intake and consolidation of a large volume of new data and information.

For reasons of validity and reliability, a combination of data collection tools was used in this research study. The data collection tools used were a pre-intervention interview, a focus group discussion conducted mid-interventionally, self-awareness sheets, group work evaluation forms, a post-intervention discussion, the researcher's notes kept in a diary, and the session creative and critical thinking activity sheets.

The research tools

According to Kvale (1996, p. 104), the interview technique is used in cases where the research focuses on investigating the personal assumptions of the participants while, further, Robson (2007) argues that the "semi-structured" interview in qualitative research is the most appropriate way of collecting data in cases where the research is long-term, and the aim is to identify whether these assumptions have been modified. The introductory semi-structured interview consisted of predetermined discussion topics, prepared by the researcher, which provided security in terms of determining the cognitive background, experiences, needs and desires of the students, thus aiming to explore, and establish necessity of implementation. The interviews were conducted individually in oral form, in English, and were audio-recorded with the students' written consent for reliability reasons. As previously mentioned, not only the workshops, but, also, the entire data collection process was conducted in English. Students were encouraged to interact in English, as relevant research suggests that consistent use of the foreign language, in "language-related episodes", and participation in "collaborative dialogues", can lead to linguistic, cognitive and behavioral empowerment (Swain & Lapkin, 1998). Negotiating meanings and communicating ideas was of primary importance. In difficult cases, however, students were encouraged to describe more extensively, or explain, using simple language rather than resorting directly to the mother tongue. It is reasonable that the students' attitude toward emerging language challenges varied from time to time. However, the choice of each student was always respected.

Zuber-Skerritt (1992a; 1992b) supports action research in the context of Higher Education. She proposes the "CRASP" Model as a definition of action research: "C" stands for critical collaborative research (Critical), "R" for research conducted by people who reflect (Reflective), "A" for accountability in terms of publishing the results (Accountabilty), "S" for self-assessment practices (Self-assessment), and "P" for the participatory element in problem solving (Participatory). Having said all this, it is clear that, in the context of the present action research, the students were required to work in groups, reflect upon their choices regarding strategies, and content, receive feedback on their work, and evaluate their own performance while, at the same time, be active both in the preparation, but, also, in the presentation stages. Based on these processes, adjustments and changes were made that would further inform the research with the emerging needs, level of satisfaction, questions and expectations

of the students. Therefore, obtaining new data in the form of feedback from the group members was most crucial. All of the above were achieved through an enlightening discussion in the context of a focus group interview. Consequently, it becomes clear that the CRASP Model provided a most appropriate framework for the present action research on account of the fact that its core elements have their roots in constructivist learning theory, and transformative learning, and, thus, served the present action research rationale effectively.

The post-intervention interview was semi-structured, and aimed to shed light on the "how's" and "why's" of any changes in the students' assumptions, skills, and dispositions observed after the implementation of the intervention. According to the relevant literature, the semi-structured interview allows the researcher to delve into issues that could not have been predetermined (Iosifidis, 2003, pp. 40-41). In addition, participants were asked to contribute their own thoughts on a research process they created and experienced, to justify their opinions, evaluate the process, make new suggestions for adjustments and, finally, express themselves in the form of free comment. The post-intervention interview was conducted in written form to ensure rich contribution of data from the participants (Handy & Ross, 2005). For any further explanation or clarification, the students responsibly declared that they would be at the researcher's disposal. This interview took place in English, in the same way as with all data collection procedures.

The main idea behind the intervention proposed here is that of critical reflection. Various types of diary notes encourage reflection, acting formatively on the learner, when kept during an activity. Cranton (2016) speaks of "diary activities" that can promote critical reflection. In the context of these activities, the learner divides a sheet of paper into two sections, calling one of them "Feelings" and the other one "Thoughts". Learners are asked to record their thoughts and feelings about specific variables related to the lesson each time. According to Cranton, after the learners have written down their thoughts and feelings, the educator studies the notes, adds further comments, and, thus, establishes constructive dialogue in the group. In the context of this research, we adapted the activity by analyzing it into a series of specific cognitive and behavioral prompts, which required completion by the students. For example, the prompts "I think that…", "I feel that…", "I learned that/to…", "I asked…", "I need to rethink…" appear on the self-awareness sheet, and invite the student to think about the content, and process of each workshop. In this case, through critical reflection, the students came into contact with the idea of self-discovery. A "Free Comment" section encouraged participants to express themselves more openly, regarding self-awareness issues. Here, we utilized Cranton's (2016) idea as a form of activity that fosters transformation through dialogue, which was the original intent, and, also, as a tool for collecting and analyzing data at the same time. The "Group work Evaluation Form" used in this study was inspired by the "Take a Stand" activity of the "Perspective-taking" thinking technique of Project Zero by Harvard University, which was also used in the research.

The Group work Evaluation Form is a tool for cultivating critical thinking. Students were asked to reflect as a group in order to delve deeper into the way their group worked, and to make assessments. The form required responses regarding the steps taken by the group members to reach the goal set each time, the challenges they faced on the way to achieving that goal, how they addressed those challenges, what needs to be reviewed, while, in addition, they were asked to offer any ideas or suggestions related to working in study groups. The rationale behind this type of activity is to motivate learners to apply reflective skills, work collaboratively, explore the perspectives of their partners, envision new perspectives, and revise their work strategies. Therefore, it is safe to argue that such an activity carries with it a transformative potential, beyond its usefulness as a data collection and analysis tool.

The intervention

The research design was composed of a thirteen-workshop intervention, simulating the structure of a conventional university course. It was designed in such a way that half of the sessions were based on the application of critical thinking drawing from aesthetic experience (Koutsoukos & Fragoulis, 2017), while the rest offered participants the opportunity to utilize their critical thinking drawing from research.

The material compiled for the aesthetic experience sessions was derived from literature, and the arts, thus addressing issues of academic empowerment. The material was common among the four groups, and to utilize critical thinking, the Perkins' (1994) method of observation and analysis of works of art, the Project Zero palette of thinking techniques by Harvard University, and the Learning by Design methodological approach (Kalantzis & Cope, 2005) were drawn on. The research papers, used in the respective sessions, were selected by the groups, who worked on them in order to critically evaluate them and, in this way, practice their research skills. Each group sought, and selected for critical analysis and presentation, research papers that were relevant to the particular scientific, and research interests of its members. To approach these tasks, the instructions given in the framework of the Doctoral Program of the Educational and Social Sciences of Frederick University of Cyprus were used, after special adaptation to suit the level and needs of the undergraduate students. Each research-based workshop included a short tutorial, conducted by the researcher, aiming to address gaps in the students' knowledge of research, as these were identified in each preceding research workshop.

The aesthetic experience and research workshops were held alternately (Figure 1). The idea was for the students to gain an insight into theoretical issues of academic identity, such as qualities and skills that characterize a scientist, while providing them with the opportunity to apply these very same qualities, principles, and skills in the next research session. The sessions were designed to be held with an interim of at least fifteen days in between, thus, giving the four groups time to explore literary and audio-visual material, as well as trace research papers, but, also, compile queries, and concerns, which, they believed, required an answer in the next session.
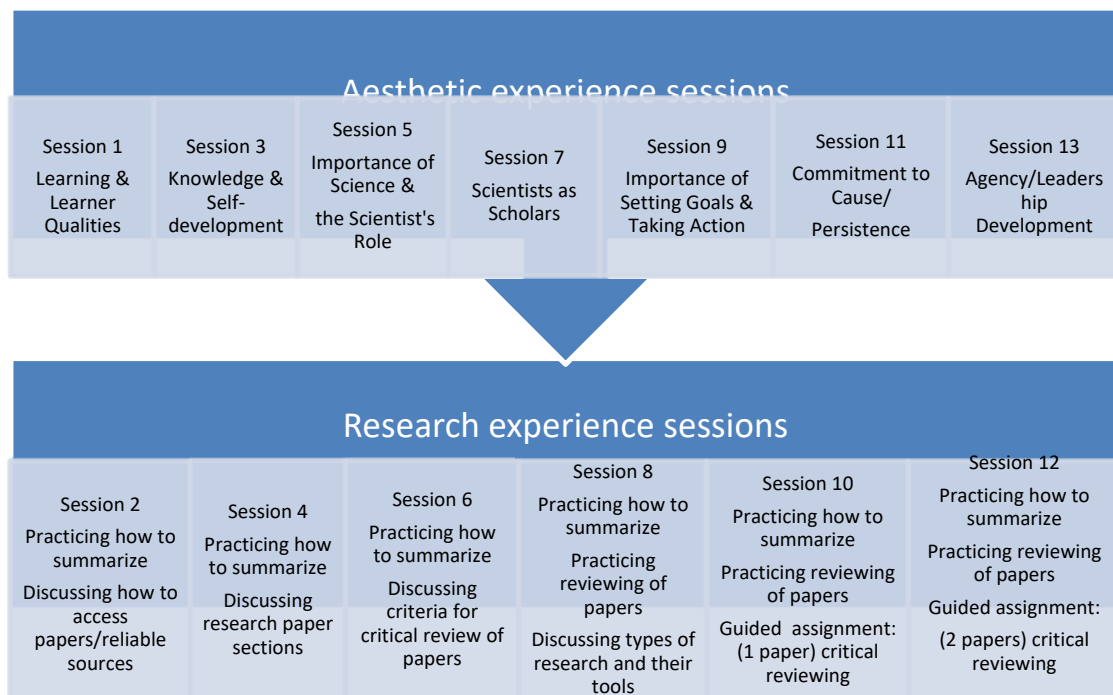

Figure 1. Alternating aesthetic and research experience workshops

The debate about validity and reliability in quantitative and qualitative research is ongoing. We must always consider the research goal, and how well it will be served by a specific type of research and its methodology. The criteria for validity and reliability between the two types of research differ. Quantitative research is based on numbers, and seeks a high rate of generalization, while qualitative research is based on people's stories, and seeks meanings in order to interpret them in relation to the goal the research has set.

Guba and Lincoln (1989, op. cit. in Cohen et al., 2018, p. 247) suggest that "the term validity be replaced by the term authenticity". Accordingly, Maxwell (1992) posits that the term "understanding" be used as it is more appropriate than the term "validity" for qualitative studies. Examining, and cross-referencing our perceptions and opinions, about a topic with those of other people can ensure validity. Furthermore, Lincoln and Guba (1985, op. cit. in Cohen et al., 2018, p. 270) choose the term "dependability" in contrast to "reliability", as the goal of qualitative research is not to replicate the results in other cases or generalize the findings to the wider population, but to describe the nature of the research process. In order to overcome the problems of "authenticity", the research presented here used clearly formulated questions, understandable to the respondents. In addition, the data collected are analyzed and interpreted extensively, as the data analysis phase is underway, while findings from the twelve participants were cross-referenced to the findings from three students of the Geotechnical Sciences, who had not participated in the action research project. On the other hand, in terms of addressing "dependability" challenges, the present research uses the strategies of triangulation, extensive field knowledge, and participant validation of data.

Discussion

Although the intervention and data collection phases have been completed, the content analysis and data interpretation phases are currently in progress. However, initial findings eloquently reveal illuminating information in relation to the three questions posed in our research.

Initially, the students' perception of their scientific role, pre-interventionally confined to that of a specialist consultant in the workplace, seems to have expanded, an element that reveals a more reflective attitude toward previously held assumptions about this role (Table 1). Analysis of the data collected, following the students' participation in the intervention, places in the picture additional roles for the geotechnical scientist, such as that of researcher, reviewer, observer, feedback provider and that of a reflective scientist. Regarding critical qualities involved in the work of a scientist, post-interventionally, the participants highlight elements such as curiosity, open-mindedness, inquisitiveness, self-awareness, commitment, critical thinking, goal setting, and embracing different perspectives. The students' perspective demonstrates an expanded frame of reference, which now encompasses the concept of social contribution and work for the benefit of humanity. In the new frame of reference, this perspective has clearly undergone a significant qualitative shift from a focus on the individual to empathy toward fellow human beings.

Table 1. Transformed frame of reference for the role of a geotechnical scientist

When asked how they perceive their role as geotechnical scientists, and the perspectives involved in it, the students answered…
Student 2
"As far as I know, a geotechnical scientist works in [field of work] and advises people on how to make good quality [product name]" (pre-interventionally)
"A geotechnical scientist has many missions … works in [field of work], … promotes the [product], chooses the best variety, … But beyond the practical things, … he must develop in various fields, … express his point of view, … acquire knowledge, … explore new methods, …

evaluate the feedback he receives, be open to new things, … pass on his knowledge to the younger ones, … inspire, … recognize his strengths and weaknesses" (post-interventionally) *"For me personally, the whole process of research has helped me improve … to understand myself better … I learned to listen … to consider the opinions of others … to collaborate … to provide information that may affect the lives of others for the better…"* (transformed frame of reference)
Student 10 *"The job of a geotechnical scientist is to be part of the process [of producing the material]. He has the ability to make [material name] into a great [product name]… is responsible for the construction… and monitoring of the … process"* (pre-interventionally) *"A geotechnical scientist is a professional… monitors the process… decides the right time to… supervises production… takes care of hygiene… watches industrial indicators… … scientists are not only that but also research, think, explore… do research work… present their work publicly … work collaboratively … provide feedback … encourage employees … seek partnerships …"* (post-interventionally) *"… a deeper look at the elements of a true leader … understand the supreme importance of patience … perseverance … willingness to go the extra mile … to improve personally and professionally … to work for the benefit of the people…"* (transformed frame of reference)

Secondly, cross-referencing of the data confirms that specific social and metacognitive skills and competences of the students have been empowered (Table 2). The students share that, after participating in the present action research, they feel less hesitant to participate in new research projects, be confronted with challenge, adjust, monitor their emotions, and reactions, and obtain a clearer picture of themselves, of their strengths and weaknesses. The students' personal perspective of the skills, and competences of a scientist appears to have expanded, showing signs of transformation. It becomes evident that the students now highlight resilience and self-awareness as two of the competences a scientist must possess, and try to develop.

Table 2. Transformed Frame of Reference for Confronting Challenge

When asked about confronting the study group challenge, the students answered…
Student 8 *"I would not feel very comfortable because I have never done it before …", I would need practice … probably working with more people so I can exercise my communication skills … practice, doing the same thing…", "I like working individually… I am anxious in groups… I think I will be judged …"* (pre-interventionally) *"I have learnt to be patient and work in teams … that co-operation is important in a group … learnt the importance of perseverance and of setting goals … how to be self-aware and how to express my opinions and ideas"* (post-interventionally) *"another point is patience … learning can be difficult that's why you should never give up and always believe in yourself", "… developing collaboration skills through group work would be very important for future scientists …"* (transformed frame of reference)
Student 5 *"… first of all, I have never been a member of a study group before … I just tends to do it on my own … I prefer working individually … would think of quitting from this project", I don't like disagreements … not used to study groups … working individually … so that I can focus better …"* (pre-interventionally) *"at first, I wanted to leave the group … but as time passed, I was able to express myself easier or accept other's opinions and advice … but the persistence this research taught me lead me to make it through the end of the sessions … working with a group has affected me*

> *in a positive way. It taught me to be patient and listen carefully to my colleagues …"* (post-interventionally)
>
> *"I'm going to search for another research project or group workshops to participate in … looking forward to the next challenges and how I am going to be able to face them …"*, *"dilemmas can always occur in every stage of our scientific career"*, *"the point is to find ways to overcome problems"*, *"not being manipulated by successes or failures but we should have self-control"* (transformed frame of reference)

Finally, when invited to envision their future, in the introductory discussion, prior to the research, the students describe their professional career in strictly technical terms, considering themselves mostly as 'performers', or 'employees' rather than 'agents' or 'game changers'. Nonetheless, nearing the end of the academic year, after completion of the research process, a different picture emerges from the data (Table 3). When the students are confronted with the same question, they provide a discernibly different perspective of themselves. They place particular emphasis on issues such as determination, and initiative. Furthermore, they seem to go a step further by interpreting these emerging assumptions as critical for the scientist, thus validating their transformed view of the role, and mission of a geotechnical scientist, as discussed above.

They internalize and appropriate the concepts of pioneering, autonomous thinking and action, and successfully addressing challenges, and incorporate them into their new understandings of the scientist's mission. According to Housen (2002), content transfer, that is, critical thinking that is transferred from one situation to another is a clear indication of transformation.

Table 3. Transformed Frame of Reference for Agency

Invited to envision themselves, and their professional future, ten years from now, the students responded…
Student 3   *"with a stable job, in a [job position], advising people … being in a lab …"* (pre-interventionally)   *"could possibly picture myself teaching … being a member of a research team … more comfortable with sharing my ideas …"* (post-interventionally)   *"now picture myself in many situationships and work invironments"* (transformed frame of reference)
Student 7   *"I don't know for sure, maybe, I will work in a [place of work], maybe I will work in a lab …. I don't know for sure"* (pre-interventionally)   *"I am indecisive … I am thinking about it"*, *"I could think of myself as a scientist, and researcher … as I have learnt to work in a research group … teaching in a school or university, especially for me teaching is a possible career, something close to this"* (post-interventionally)   *"I can have many different identities at the same time (scientist, researcher, leader, teacher etc) which will make it easier for me to choose my career field in the future this way"* (transformed frame of reference)

Drawing on the students' narratives, osmosis of the Natural Sciences with the Humanities in the action research framework described here appears to have a positive impact on the Geotechnical Education students. The students' perspectives, reflecting broadened academic thinking and research familiarization, constitute an interdisciplinary challenge for both fields.

Conclusion

The action research study presented here aimed to explore the potential of critical thinking to induce transformation of assumptions, skills and dispositions in undergraduate Geotechnical Education. The methodology adopted in the context the present research was that of the intervention. In this context, thirteen English Language workshops were conducted in the course of one academic year. Data analysis was conducted using the qualitative approach. A pre-intervention interview, a focus group discussion, a post-intervention interview, the researcher's diary, and the creative and critical thinking activities of the workshops provided the tools for data collection. From the initial analysis of the data collected, findings emerge, which clearly document that the sum of learning activities implemented in the context of the critical thinking based intervention has the potential to transform students' assumptions, competences, and dispositions, and contributes positively to their academic-research socialization in the field of the Natural Sciences.

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