ISSN 2340-8170 (Print)
ISSN 2386-3137 (Online)
DOI: http://doi.org/10.18543/tjhe

Tuning Journal for Higher Education

Generational differences in University Students: Challenges or opportunities?

Volume 12, Issue No. 1, June 2025
DOI: https://doi.org/10.18543/tjhe1212025

Tuning Journal for Higher Education

DOI: http://doi.org/10.18543/tjhe

Tuning Journal for Higher Education is included in:

Tuning Journal for Higher Education

Volume 12, Issue No. 1, June 2025

DOI: https://doi.org/10.18543/tjhe1212025

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University of Deusto
Bilbao
2025

University of Groningen
Groningen
2025

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Publication Frequency and Format
Tuning Journal is published electronically (in full open access) and in print version twice a year (May/ November). Its first issue appeared in November 2013.

Subscriptions
Currently, no charges for submission, article processing, publication, online access, and download are applicable. Few print copies are freely made available for key collaborators and partners.

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P.O. box 1 - 48080 Bilbao, Spain
Publications Service
Phone: +34-944139162
E-mail: publicaciones@deusto.es
URL: www.deusto-publicaciones.es

ISSN: 2340-8170 (Print) 2386-3137 (Online)
Legal Deposit: BI-1482-2013

Printed and bound in Spain

Tuning Journal for Higher Education, Volume 12, Issue No. 1, June 2025
DOI: https://doi.org/10.18543/tjhe1212025

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Tuning Journal for Higher Education (TJHE)

Volume 12, Issue No. 1, June 2025

DOI: https://doi.org/10.18543/tjhe1212025

Generational differences in University Students: Challenges or opportunities?

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Generational differences in University Students: Challenges or opportunities?

Editorial

Mary Gobbi
Editor

doi: https://doi.org/10.18543/tjhe.3306

E-published: June 2025

> "Each generation imagines itself to be more intelligent than the one that went before it, and wiser than the one that comes after it." George Orwell[1]

This quote, from George Orwell, aptly speaks to the debates concerning not only intergenerational differences, but also how different generations perceive themselves and the extent to which such claims are accurate!

Common terms that distinguish generations include *silent* generation (born 1925–1945), *baby boome*r generation (1946–1962), generation *X* (1963–1981), generation Y *or 'Millennials'* (1982–2000), and generation *Z* or i*Gen,* (1997 and 2012). These classifications typically focus around motivational and value differences. Presuming global uniformity, there is the danger of creating inappropriate stereotypes for some specific contexts and students. As our papers on COVID-19 illustrated, the impact of COVID-19 upon students across the age spectrum from infancy to early adulthood has created additional legacies in their lives. Higher education student groups in particular disciplines and institutions may be homogenous or heterogeneous (age diverse) with respect to the generations present in the cohort. While the possibility of intergenerational learning is promoted with heterogeneous groups, for some groups, the differences may cause conflict and tension

[1] George Orwell (1903-1950), English writer.

George Orwell, Sonia Orwell, and Ian Angus, eds., *The Collected Essays, Journalism and Letters of George Orwell, Volume 4: In Front of Your Nose 1945-1950* (Secker & Warburg, 1968), 51.

between students and the tutor as to how best to handle divergence of educational need, expectation and sometimes beliefs and attitudes.

It is frequently argued that when there are differences between generations, often due to specific socio-economic, cultural and historical contexts, access to university, pedagogic strategies and resource availability meld together to shape the expectations and experiences of both the students and the academic staff. In recent years considerable attention has been given to the impact of these intergenerational differences in workplace, education (all sectors) and social settings. With intergenerational social mobility being a goal of Higher Education at socio-historical moments, particular with disadvantages or marginalised groups, understanding generational differences, when and where they apply, aids the academic teacher in their facilitation of student learning and the promotion of intergenerational social mobility.

In a previous edition of this Journal (Vol 10, Issue 2, 2023), such differences were explored by a team from Slovakia, who studied the differences between first- and second-generation university with respect to study choices. Two years on, in this edition, three papers explore aspects of these phenomena. I trust readers will find the different papers of interest and provoke reflection on their relevance to contemporary practises in Higher Education across the globe, revealing the challenges and opportunities that arise within and between generations of students and academic teachers.

Editorial Team
June 2025

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 13-14 •
doi: https://doi.org/10.18543/tjhe.3306 • http://www.tuningjournal.org/

Introductions

Generational differences in University Students: Challenges or opportunities?

Introduction

Mary Gobbi*
Editor

doi: https://doi.org/10.18543/tjhe.3307

E-published: June 2025

Abstract: Three of the eight papers that comprise this Edition of the Journal, focus on different aspects of intergenerational learning. The remaining five papers address internationalisation strategies in Africa; career paths of local and international doctoral students; peer tutoring programmes, perspectives of science teachers, including mathematics and physics, and models of Higher Education. The papers reflect a varied range of participant countries both in terms of the authors, but perhaps more importantly the study sites including several from Latin America (Africa, Chile, Bulgaria, Paraguay, Peru, Spain, Turkey and Uzbekistan). Similarly, the programmes of study range from dental education, geological sciences, teacher education (in various forms), ongoing development of academic staff and the evolution of embryonic Higher Education systems. From these rich and diverse papers, one can see the crucial importance of eliciting, at national level, (1) those factors that are unique to the national context and culture; and (2) those that are like other systems and countries, whether in a historical moment of evolution, or those that resonate with contemporary and parallel contexts. Building the national and international evidence base in Higher Education requires both types of study, if only to satisfy the criterion of generalisablity.

Keywords: quality assurance frameworks; internationalisation, intergenerational learning; doctoral education; higher education models.

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The first paper in this edition focuses on the strategic and systems-based dimensions to Higher Education in Africa where the history of Quality Assurance Frameworks is more recent. Lazarus Nabaho, Wilberforce Turyasingura, Ivan Kiiza Twinomuhwezi, Kenneth Alfred Kiiza, Margaret Nabukenya, and Felix Adiburu Andama have reviewed initiatives concerned with internationalisation and the metrics associated with its evaluation (*Making the university more international: An exploration of higher education internationalisation strategies in Africa from a continental perspective')*. In this study, they deployed the African Quality Rating Mechanism (AQRM), and education framework of the African Union to undertake a descriptive study. Given the colonial histories across the continent, the AQRM had been designed within a decolonial lens. The study found that while there were clear face similarities to the historical Anglo-Saxon, Eurocentric models with respect to mobility and the academic research community, the substance of current internationalisation shows attempts to decolonise the Anglo-Saxon models of internationalisation. Probably due to funding processes, there has been an internationalisation of the Bologna Process in Africa. None the less, they note attempts to adapt rather than adopt Global North strategies where common goals exist, for example student mobility within a continent or neighbouring regions. The paper has a strong theoretical thread in its critique of policies, applications and influences.

The next three papers explore different dimensions to intergenerational learning and development.

The importance of data to understand doctoral student education and career trajectories and the relationship with the local and international labour market is evident in our next paper from Paraguay by Laura Diaz Villalba and Montserrat Castelló Badía *('Academic and non-academic career paths of international and domestic PhD holders')*. While there is literature regarding those national students who studied abroad or at home, there was little in the Latin American context, especially in the wider labour market—not just academia. In this study 126 Paraguayan doctorally qualified people who graduated between 2012 and 2022 were surveyed with respect to their perceptions of the usefulness of their doctoral education.

Results showed that many graduates were working in a variety of non-academic roles and institutions, with approximately a third of university-based respondents having two jobs. Two thirds had studied abroad. The wealth of data generated in this study reveals the aspirations of the graduates to work in a variety of academic and non-academic roles In Paraguay. participants revealed how they had adapted their doctoral skills to their

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 17-22 •
doi: https://doi.org/10.18543/tjhe.3307 • http://www.tuningjournal.org/

Paraguay work contexts but also indicated factors that had helped or hindered transition. The detail in this study provides points of reflection at the national level on how best to support these graduates through doctoral training and post-doctoral employment at organisational and structural levels.

Our next paper is in the field of mathematics education where Aziz İlhan and Serdal Poçanop compared Generation Z and Y mathematics teachers with respect to their understanding of Algebra (*'Understanding of Algebra of secondary school mathematics teachers from different generations: A qualitative comparative analysis of the answers')*. While it is known that misconceptions can arise in learning mathematics, arithmetic and algebra, there is little data as to whether there are generational differences that influence teachers/students in their thinking skills or modes of learning and teaching. Aziz İlhan and Serdal Poçanop therefore explored algebraic operation skills and awareness levels of mathematics teachers using a phenomenological approach. They found that there were some differences between Generation X and Z in their knowledge and skills with some similarities in misconceptions and mistakes. The implication of these findings —if generalisable— implies that generational differences in teachers, once identified, enables opportunities for professional development to mitigate generational deficiencies. A clear role for teacher education research and practice in mathematics education.

In contrast, Dragomir Iliev, Daniela Ilieva, and Zhelyo Zhelev from Bulgaria found no significant correlations between three generations in either their characteristics or preferred teaching methods in an economic discipline *('Teaching methods through the eyes of Bulgarian students from three generations')*. The literature review in this paper provides a good discussion of the preferences of respective Generations in the use of technology and learning strategies. The aim of their survey was to discover whether different generations preferred different pedagogic strategies and whether they were appropriate to the students (Generation Z). Contextual factors were well explained, especially the demographic representation of Bulgaria within Higher Education. In this study, where different generations were learning at the same time and place, they exhibited similar preferences, namely the integration of visual and interactive approaches that enable active engagement and involvement of the audience. The paper provides a detailed account of the methodology and statistical techniques deployed.

Rapid reform has been a feature of recent Peruvian Higher Education in the attempt to improve education quality and regulatory oversight. In this case, there had been concerns in the field of dental education that graduates were not entering the labour market in a timely way and that

education itself needed to improve to support better the dental health of the nation. To understand and measure any change in successful graduation, the authors Karla Lucero Avalos-Baltodano, María Claudia Garcés-Elías, Roberto Antonio León-Manco, Esther Noemi Quevedo Fernandez, and Cesar David Rojas-Senador deployed the concept of 'terminal efficiency' to retrospectively elicit data concerning student success (*Determinants of the successful graduation of undergraduate students from a Peruvian university dental school over six years')*. Terminal efficiency is a metric that takes account of programme duration, educational quality and the point at which a student successfully graduates— and in this case enters the labour market as a licensed professional. A cross-section design enabled the analysis of student records during the period 2017-2022. A key finding of the study was the reduction in the time taken for students to graduate from 1.23 years beyond the standard programme length to 0.55 years in 2022. Other data revealed the university trajectory of the students, including information regarding the educational experience and its quality. Together these data provided a platform for identifying educational enhancements to the programme. The authors argue for the application of the concept of 'terminal efficiency'.

Yurdaer Babuçcuoğlu, Uzokovich Maksud Isokov, Munojat Sultanmuradova Bobomuradova, and Jurabekovich Jakhongir *Movlanov*'s case study from Uzbekistan demonstrates how rapid and focussed development can meet a country's labour market needs, maintain a country specific orientation and align itself with international higher education trends. Given Uzbekistan's natural resources and mining industries, specialized expertise was needed for economic growth and positioning in the international labour market. Accordingly in 2020 a University of Geological Sciences was founded with an associated network of specialist academic research institutes. The paper ('*Different university model approach in the field of earth sciences*') provides a detailed account and analysis of the emergence of the fields of study with both a market driven, research and human resources hybrid model of Higher Education. The organizational structures together enable adaption over time to meet future labour market and economic needs.

Camila Véliz and Oscar Navarrete's study, in Chile, analysed the effects of being a student tutor to other students within a structured university programme that included peer tutoring (*'Peer tutoring programmes: comprehensive training and generic competences from the experience of tutors in a Chilean university')*. While the benefits of being tutored have been researched, there is little research on the effects on the

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 17-22 •
doi: https://doi.org/10.18543/tjhe.3307 • http://www.tuningjournal.org/

student tutors themselves. This study sought to address this gap in a context of competence-based education and a desire to address socio economic inequalities. A critical review of peer tutoring and its relationship to generic competence development in students and concepts of bonding are well explained in the paper. Exploring the experiences with eighteen tutors, some very rich data were elicited that demonstrated the socio educational impact of the peer tutoring bond and the benefits for the tutor. It was also evident that peer tutors improved their generic competences in several domains including leadership and interpersonal skills. A key aspect was that the peer tutor process contributed to improving equity in the Chilean higher education arena.

Our last paper by Marina Martínez-Carmona, Beatriz Bravo-Torija, and Luisa López-Banet addresses the extent to which science teachers can encourage argumentative, evidence-based debate in their classrooms with respect to climate change *('What ideas about climate change do future science teachers possess and how do they integrate them when arguing about greenhouse effect? A case study')*. Situated in Spain, this case study summarises the related national educational policies and the shift in pedagogies expected of modern teachers to foster argumentation, application of evidence and debate. The authors note that many teachers may have experienced a more didactic form of secondary education than is now expected. The methods are quite detailed; in that the participant teachers wrote an essay based upon a news item related to climate change. Their findings revealed that many teachers lacked sufficient knowledge about climate change and had difficulty in assessing the quality of the evidence and integrating it within their rationale.

This last paper resonated with so many elements from our earlier papers. Generational differences influence teachers as well as students especially with respect to the use, evaluation, sufficiency and currency of the evidence necessary to evaluate modern trends in society, educational techniques for different cohorts of students but also the science within the discipline.

As countries and institutions make transitions in different era and with different adoption rates of change, then context specific data and evidence are necessary for Higher Education academic staff to make decisions as to improve and inform their curriculum; make the curricula 'fit' for the labour market; and to promote the necessary cognitive skills, behaviours and professional attitudes for the graduates' role the labour market. All the papers in this edition have to some extent added to these debates and dilemmas.

About the author

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 17-22 •
doi: https://doi.org/10.18543/tjhe.3307 • http://www.tuningjournal.org/

Articles

Making the university more international: An exploration of higher education internationalisation strategies in Africa from a continental perspective

Lazarus Nabaho, Wilberforce Turyasingura, Ivan Kiiza Twinomuhwezi, Kenneth Alfred Kiiza, Margaret Nabukenya, and Felix Adiburu Andama*

doi: https://doi.org/10.18543/tjhe.2899

Received: 30 November 2023
Accepted: 11 February 2025
E-published: June 2025

Abstract: Internationalisation is one of the contemporary issues in the higher education (HE) academic and policy discourses. Since the 1990s, scholarship on the internationalisation of HE has burgeoned. Nevertheless, the internationalisation of HE in Africa is relatively under-researched. Using the African Quality Rating Mechanism (AQRM), an education framework of the African Union, this article explores the approaches to the internationalisation of HE in Africa. A qualitative descriptive design underpinned the study and the data was analysed using content

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Acknowledgements: None.

Funding: None.

Conflict of interests: None.

analysis. The findings show that the AQRM comprises five dominant Eurocentric HE internationalisation strategies: student and faculty mobility, academic mobility, international research collaboration, dissemination of research at international conferences, and curriculum internationalisation. However, despite the similarity in the form, the substance of the internationalisation shows that attempts have been made to decolonise the Anglo-Saxon models of internationalisation. It can therefore be concluded that: (a) mobility (of persons and programmes), the elitist version of internationalisation, is integral to most internationalisation practices in the AQRM; (b) the AQRM was designed within the framework of the decolonial lens which repudiates the dominant colonial conception that what qualifies to be "international" must be associated with Europe and North America; and (c) political and academic rationales dominate the internationalisation discourse at the continental level.

Keywords: Internationalisation; strategies; collaboration; regionalisation; harmonisation; mobility; curriculum internationalisation.

I. Introduction

International higher education and the internationalisation of higher education are inescapable, yet distinct, concepts in the contemporary higher education (HE) academic and policy discourses. The twin concepts emerged in the HE lexicon at different pivotal moments. International education is as old as European medieval universities (Yang 2002; Guri-Rosenblit 2015; Bamberger and Morris 2024) and dominated the HE landscape from the 11th century to the late 1980s. The ethos of international education included, *inter alia*, the use of Latin as a common lingua franca, the recruitment of international students and faculty (Altbach and de Wit 2021), the movement of professors across borders to disseminate knowledge and learn from other nations (Maringe 2009). The 19th century witnessed the emergence of the nation-state in Europe and the resultant de-Europeanisation and nationalisation of universities (de Wit and Merkx 2022). However, the nationalistic orientation did not deter the universities from engaging in some form of cross-border activities. The post-World War II period altered the landscape of international education. The global HE landscape experienced an unprecedented increase in international educational exchange programmes (Egron-Polak 2012) based on the Soviet or the American model (Huang, 2007). The hallmarks of both models were: (a) the domination of the North in international education; and (b) the use of similar internationalisation strategies: mobility (of well-to-do and academically gifted students from the Global South to universities in the Global North, and scholars from the Global North to the Global South), technical assistance to the Third World,

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 25-43 •
doi: https://doi.org/10.18543/tjhe.2899 • http://www.tuningjournal.org/

and stimulating cooperation between individual countries in HE matters (Huang 2007; de Wit and Merkx 2022) to promote the political ideologies of the superpowers and their allies. Nevertheless, international education strategies were manifestly "ad hoc, fragmented, and implicit rather than explicit and comprehensive" (de Wit 2020a, p.i); and reactive.

Internationalisation of HE is a relatively new concept (Altbach 2004; de Wit and Altbach,2021; Knight 2003; Maringe 2009). There is a consensus in the academic literature that the internationalisation of HE emerged in the education lexicon after the Fall of the Berlin Wall in 1989 (Bamberger and Morris 2024) and has since replaced international education. Unlike international HE, internationalisation of HE – a concept which was occasioned by the imperative to globalise and regionalise economies and societies, the collapse of the Soviet Union and the rise of global (American) capitalism, and the dictates of the knowledge economy (de Wit 2020a; Bamberger and Morris 2024) – approaches the infusion of an international dimension in universities from strategic and proactive perspectives. The internationalisation of HE dictates that the operations of universities ought to transcend state systems. Furthermore, universities should position themselves as actors, rather than spectators, in the global knowledge network (Guri-Rosenblit 2015).

Internationalisation of HE is a strategic agenda (Maringe et al. 2013; Guri-Rosenblit 2015; de Wit 2020a; de Wit and Altbach 2021) and a policy priority at institutional, national, and supranational levels. It is now an established thematic field of research in HE (Kosmützky and Putty 2016). It has, and continues, to attract considerable attention in academic research (Tight 2021, 2022) in the last three decades. Nevertheless, the extant studies on the internationalisation of HE are biased towards the Western world (de Wit 2020b; Lee and Stensaker 2021) and "heavily reflect Western timelines and perspectives" (Bamberger et al. 2019, 205). Tight (2022), after an extensive survey of the existing studies on the internationalisation of HE across the world, concluded that "[t]he internationalisation of higher education in Africa appears to have been relatively little studied, or, at least, relatively little research on it has appeared in English language outlets" (p.249). The paucity of research implies that a dearth of knowledge exists on how universities in Africa should and/or are pursuing the internationalisation of their classical (teaching and research) and contemporary (or public service) missions in the post-colonial era. Against the above backdrop, the article answered the question: How should universities in Africa internationalise their missions from the perspective of the African Union and the Association of African Universities?

II. Literature review

The literature review hinges on the meaning of internationalisation, typologies of internationalisation and their attendant strategies, and the theoretical lens for the article.

II.1. Conceptualisation of internationalisation

Internationalisation (of HE) defies a single definition. The concept has, in the last three decades or so, attracted a plethora of definitions. The proliferation of the definitions, and the contestations surrounding them, attest to the fluid and slippery nature of the concept. Jane Knight coined the earliest, and most-quoted, definition of internationalisation (of higher education) as: "the process of integrating an international, intercultural or global dimension into the purpose, functions and delivery of post-secondary education" (Knight 2003, 2). de Wit and colleagues modified Knight's definition. The authors decoded internationalisation as "[t]he intentional process of integrating an international, intercultural or global dimension into the purpose, functions and delivery of post-secondary education, in order to enhance the quality of education and research for all students and staff and to make a meaningful contribution to society" (de Wit et al. 2015, 29). The definition introduced the word "intentional" to stress the idea that the process of internationalisation ought to be carefully planned and strategically inclined (de Wit 2019) and also promoted the notion that internationalisation should be viewed through the lens of enhancing the quality of HE and positively contributing to society (de Wit et al. 2015). The (modified) definition underscores academic and public service (or impact) rationales of internationalisation.

However, scholars from Africa, argue that the modified definition partially suits Africa (see Teferra 2019, 2020). Teferra, in both publications, argues that the internationalisation of HE in Africa is not a purely intentional process. In most HE systems on the Continent, internationalisation of HE is usually a coercive process. Teferra, therefore, calls for a more neutral, and "intention-free" definition of internationalisation of HE.

II.2. Typologies and strategies of internationalisation

The majority of the extant studies on the internationalisation of HE underscore two typologies of the concept: internationalisation abroad and internationalisation at home. Internationalisation abroad has a cross-border component and relies on strategies such as student mobility, academic staff mobility, and provider mobility (de Wit and Altbach 2021). Internationalisation

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 25-43 •
doi: https://doi.org/10.18543/tjhe.2899 • http://www.tuningjournal.org/

at home – "the purposeful integration of international and intercultural dimensions into the formal and informal curriculum for all students with domestic environments" (Beelen and Jones 2015, 69) – has gained popularity in HE since the 1990s. It entails the internationalisation of the curriculum. The internationalisation of the curriculum connotes "the process of incorporating international, intercultural and global dimensions into the content of the curriculum as well as the learning outcomes, assessment tasks, teaching methods and support services of a programme of study" (Leask 2015, 9). The internationalisation of the curriculum is an inclusive and less elitist approach to the internationalisation of HE that is intended to benefit non-mobile students.

Mittelmeier et al. (2019) have advanced another typology of internationalisation: internalisation at a distance. Under internationalisation at a distance, students remain at home but register for online or distance learning academic programmes at institutions based in other countries. This typology of internationalisation overlaps the classical classifications of internationalisation but can neither be nested into internationalisation abroad nor internationalisation at home.

The foregoing discourse has focused on the internationalisation of the teaching mission of universities. Universities' second (research) and third missions are also candidates for internationalisation. International (or intercultural) doses can be infused into research through international research collaboration to solve global challenges, and co-authorship (de Wit and Altbach 2021). Conversely, the third mission (or the public service role) of universities can be internationalised through, among others, creating opportunities for students in health disciplines, for example, to gain experience through clinical placement in other countries (Jones et al. 2021).

The extant literature on internationalisation, albeit Eurocentric, provides useful insights into the strategies for making HE international. However, scholars recognise that "the understanding of internationalisation, the rationales presented, the strategies applied …differ between contexts" (Ndaipo et al. 2022, 1). Therefore, the internationalisation strategies shaped by the cultural tradition of the Global North cannot be generalised to the African context.

II.3. Theoretical framework

The neo-institutional theory, developed by Meyer and Rowan in 1977, serves as the theoretical lens for the article. It is often used in organisational studies. It nuances understanding organisational responses to environmental

pressures. One of its fundamental assumptions is that organisations operate in environments with prevailing expectations of acceptable behaviours which hinge on policies, rules, and structures. The expectations of the external environment put organisations under immense pressure to align their policies, practices, structure, and behaviours to the requirements of the external environment to attain legitimacy. Generally, attainment of legitimacy – and reduction of uncertainty – override efficiency concerns in organisational responses to environmental pressures.

From the neo-institutional standpoint, organisations adopt new systems, practices, and policies because of external influence or isomorphism (DiMaggio and Powell 1983; Meyer and Rowan 1977). Institutional isomorphism– "a constraining process that forces one unit in the population to resemble other units that face the same set of institutional conditions" (DiMaggio and Powell 1983, 149) – occasions policy convergence among similar organisations. Isomorphic change is occasioned by three fundamental mechanisms: coercive, mimetic, and normative (DiMaggio and Powell 1983). Coercive isomorphism is induced by organisations that wield considerable influence over others such as regulators and major providers of resources. Imitation (or emulation) of policies, strategies, structures, and technologies already successful in related organisations is a hallmark of mimetic isomorphism. Under mimetic isomorphism, organisations tend to model after similar, but successful organisations, in the external environment (DiMaggio and Powell 1983) as opposed to searching for their context-sensitive solutions to problems. Finally, normative isomorphism occurs through professionalisation. DiMaggio and Powell (1983, 152) defined professionalism as "the collective struggle of members of an occupation to define the conditions and methods of their work, to control the production procedures, and to establish a cognitive base of legitimisation for their occupational autonomy.

III. Methods

The qualitative tradition and the qualitative descriptive design underpinned the study. The tradition and design are appropriate for exploratory studies that answer the "how" research question(s) and aim to enhance understanding of phenomena. Consistent with the qualitative tradition, document review was the sole data collection method. The data was elicited from the African Quality Rating Mechanism (AQRM) survey questionnaire (AUC 2014) which contains the minimum standards for HE in Africa, including but not limited, to standards on the internationalisation of

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doi: https://doi.org/10.18543/tjhe.2899 • http://www.tuningjournal.org/

universities in Africa. The AQRM cannot be discussed without referring to the African Higher Education Harmonisation Strategy (AHEHS). The AHEHS – which the Third Ordinary Session of the Conference of Ministers of Education of the African Union (COMDAF III) adopted in 2007 in Johannesburg, South Africa – provides a framework for the internationalisation of HE in Africa. The AHEHS envisages the creation of a common HE area with compatible national HE systems along the lines of the European Higher Education Area (Nabaho and Turyasingura 2019). Harmonisation of HE aims to, *inter alia*, promote the comparability (or reduce variance) of the multiple HE systems which were shaped by colonial legacies and to "facilitate the recognition of academic qualifications and promote the mobility of African students and academic staff across the continent" (AUC 2018a, 4).

The Harmonisation Strategy – the African equivalent of the 1999 Bologna Process (or Declaration) in Europe – gave birth to the African Quality Rating Mechanism (AQRM) which COMDAF adopted in 2008 (AUC 2018b). Within the AQRM, internationalisation is explicit and is assessed during self-assessment and quality audit (or peer review). The member states of the African Union are required to domesticate the AQRM. The external quality assurance agencies for HE in Africa ought to use the AQRM while conducting quality audits of universities. Therefore, the HE internationalisation strategies in the AQRM are prescriptive for the entire university sector in Africa.

Content analysis – "a research technique for making replicable and valid inferences from text (or other meaningful matter) to the contexts of their use" (Krippendorff 2004, 18–19) or a method of analysing written messages (Cole 1988) – was employed to make sense of the data. It is one of the available techniques for analysing qualitative data and enables the distilling of a few categories (explicit content of text) which represent similar meanings from the words of the text (Hsieh and Shannon 2005). The three sequential stages in analysing the data — "skimming (superficial examination), reading (thorough examination), and interpretation" (Bowen 2009, 32) were followed. At the level of a thorough examination of the text, consistent with the guidance by Elo and Kyngäs (2008), we generated the main category, generic categories, and sub-categories from the text. The main category which resonates with the research question is the "international dimension of HE". Using inductive content analysis, we created two sub-categories: the international dimension of teaching (or the education mission) and the international dimension of research. Sub-categories were created for each of the generic categories which focus on the classical missions of the university and which are candidates for internationalisation. The sub-categories are the

HE internationalisation strategies that are manifest in the AQRM and describe social reality concerning HE internationalisation in Africa.

IV. Results

This section presents the findings on the research question. Five internationalisation strategies are apparent in the AQRM: student and staff mobility; academic mobility; international research collaboration; international dissemination of research in conferences; and curriculum internationalisation.

IV.1. Student and faculty mobility

This theme of internationalisation, which aligns with the notion of internationalisation abroad and is unequivocal in the AQRM, necessitates that students and faculty engage in non-permanent cross-border movement to pursue full degree programme and take up full-time teaching (or research) positions respectively. The AQRM elicits information, *albeit* not for rating purposes, on the profile of each HEI undergoing either self-assessment or quality audit on two aspects: the number of students and faculty from other countries; and the proportion of international students in the total enrolment of the institutions. The proportion of international students and students is a proxy indicator of the quality of education offered by the institution, and the reputation of the university. Nevertheless, the AQRM is non-prescriptive on the ideal proportion of international students and faculty.

Staff and student mobility is an imperative for Africa's academic and political integration. In the African higher education landscape, the multiple HE systems manifest the Anglophone, Francophone, Lusophone, and Arabophone colonial legacies and militate against cross-border mobility of students and scholars, and recognition of academic qualifications. The African Higher Education Strategy which envisions the creation of a common higher education area devoid of colonial imprints – the African Higher Education and Research Space (AHERS) – aims to eliminate the bureaucratic obstacles to the free mobility of students and faculty. However, there are non-bureaucratic obstacles to mobility. In Africa, institutional policies that require international students to pay higher tuition and low staff salaries may serve as a disincentive to attracting international students and faculty. However, in some regional HE spaces such as the East African Community, the HE harmonisation efforts have gone hand in hand with the harmonisation of tuitions.

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In addition to probing whether HEIs have international students, the AQRM interrogates whether the international students, in case the institution has attracted them, hail from other African countries or outside Africa. The nature of the information sought about international students advances the notion that the internationalisation of HE in Africa should have both a regional (intra-Africa) and a global (inter-regional) focus. Under the regional focus, Africa is viewed through the lens of a region as opposed to the alternative categorisation of the continent as a geographical space comprising Western, Southern, Northern, Eastern, and Central Africa as regions. The tension between the regional and the global perspectives of mobility is illuminated in the standard for quality rating on student and staff mobility which is assessed under the teaching mission of HEIs. The standard for quality rating 4.9 – "The institution has a devoted office to…enhance intra-Africa mobility of students and staff" (AUC 2014, 9) – dilutes the global (or inter-regional) focus of mobility. The strong intra-Africa focus, especially for students, is not accidental. First, it is intended to give effect to the African Higher Education Harmonisation Strategy that is unequivocal on the promotion of intra-Africa mobility. Second, it is geared towards supporting Africa's integration process of Africa that is envisaged in the vision of the African Union. Finally, it is an attempt to decolonize mobility or reduce the hegemony of the Global North in mobility.

IV.2. Academic mobility

Academic mobility has a cosmopolitan orientation. Nevertheless, the kind of mobility inherent in academic mobility, unlike student and faculty mobility, is temporary or is not for the whole academic programme. In essence, academic mobility involves non-permanent cross-border inter-university collaboration that allows students to move between institutions located in different countries, during the study programme, to study. Similarly, faculty can also move between institutions in other countries to teach or research. The duration of mobility may range from a semester to an academic year. Academic mobility is explicit in question 29 of the AQRM: "Is your institution currently involved in inter-university academic mobility programmes?" (AUC 2014, 9). Where the response of the institution in the self-assessment is affirmative, the assessors of the HEI obtain additional information on the name(s) of the programme(s), the thematic area(s) of study, and the number of African and non-African institutions involved in the programmes in question.

The AQRM is silent on specific academic mobility programmes. It merely seeks information on the programmes. However, such programmes may include student exchange programmes, faculty (or staff) exchange programmes; and research mobility programmes. Academic mobility may also entail programme mobility where students travel abroad, enroll at an institution to study for short periods, and transfer credits back to their home degree. The idea that academic mobility should, though not exclusively, have an intra-Africa dimension is explicit in the AQRM. The intra-Africa dimension aligns with the intentions of the African Higher Education Strategy.

Within the internationalisation discourse, programme mobility has the potential to enhance academic experience, provide opportunities for international exposure, and foster cultural understanding.

IV.3. International research collaboration

This strategy for internationalising research is built into the AQRM as a standard for quality rating. The standard for quality rating 5.10 – "The institution has established linkages to promote international joint research and publications" (AUC 2014, 20) – points to international networking research. International research collaborations can take three forms: intra-Africa, South-South, and South-North. However, collaborations in research between universities in Africa and those in the Global North have often been faulted for, *inter alia*, perpetuating Eurocentric domination in knowledge generation, reflecting a junior-superior relationship, and not responding to Africa's unique needs. The AQRM provides a caveat to guide research collaborations: the research should be "…relevant to the resolution of African problems and the creation of economic and development opportunities" (AUC 2014, 20).

The AUC does not advocate global engagement in research and publication in a vacuum. Joint international research can enrich research by incorporating knowledge and insights from different cultural perspectives, introduce fresh perspectives that guard against academic inbreeding, generate high-quality research outputs, unlike local collaborations, and increase research impact. International collaboration in research equally has the potential to strengthen research capacity and increase the volume of patents and innovations. It enables the transfer of local (or indigenous) knowledge to the international audience and allows the sharing of research infrastructure such as laboratories. Finally, it allows the pooling of fiscal resources in an environment where public funding of HE and research has been reduced across many political jurisdictions.

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doi: https://doi.org/10.18543/tjhe.2899 • http://www.tuningjournal.org/

IV.4. International dissemination of research

This theme is about international conferences and is derived from the standard for quality rating 5.6 – "Researchers are encouraged and supported to present their research at…international conferences" (AUC 2014, 20). The standard agitates for, though indirectly, making opportunities available to scholars to traverse national borders to present their research findings. Such conferences are an avenue for researchers to both publish in peer-reviewed journals and to disseminate their findings to academic and professional communities. International conferences provide scholars with an opportunity to receive constructive feedback on their research work, establish opportunities for collaboration in research and joint publication, and interact with scholars and students from different cultural settings and thereby appreciate their cultures. These conferences can also strengthen the intercultural competencies of the conference attendees.

The watchwords in the standard for quality rating are "encouraged" and "supported". Encouragement can be through articulating the benefits of presenting papers at such conferences. On the other hand, the support dimension may entail partial or full funding of academics to attend international conferences. This necessitates that HEIs should appropriate resources to international conferences in their respective annual budgets. The budget for international conferences is a reliable indicator of the commitment of the HEI to internationalisation through international conferences.

IV.5. Curriculum internationalisation

The previous internationalisation strategies involve (physical) mobility and are therefore elitist. Curriculum internationalisation constitutes an inclusive variant of internationalisation. In the context of Africa, this HE internationalisation strategy entails adding an international subject to the formal curriculum to benefit non-mobile students, who constitute the majority. Question 36 of the AQRM probes whether "internationalisation" is a subject area in the curriculum of the institution. In instances where internationalisation is a cross-cutting subject area, self-assessment teams are required to rate the extent of internationalisation using a scale of 1(weak) to 5 (very strong). It should be noted that the rating scale for the internationalisation of the curriculum is diametrical to the one used for standards for quality rating, which ranges from 1(poor quality) to 4 (excellent). This means that the internationalisation of the (formal) curriculum does not have a bearing on the overall rating of HEIs. However, international quality assurance experts

can report on the internationalisation of the curriculum as either a good practice or as a strength of the institution.

The AUC is wary about entrenching internationalisation as a subject area in the AQRM and according to it the status of a standard for quality rating, which would require every HEI within the African HE landscape to develop and run a stand-alone course unit on internationalisation. Doing so would constitute a breach of the autonomy of HEIs to design and conduct academic programmes. However, the fact that the AQRM interrogates whether internationalisation is a subject area in the curriculum is an indirect way of raising awareness about the subject area and, therefore, a remote way of steering HEIs towards the internationalisation of the curriculum.

Internationalisation of the curriculum – which should also entail internationalisation of learning outcomes and pedagogy – seems to be geared towards preparing domestic students to become globally competent citizens and professionals who are capable of living and working in an increasingly borderless world. Intercultural sensitivity, global citizenship, and tolerance are some of the implied competencies that an internationalised curriculum can engender.

V. Discussion, conclusions, and contributions

The findings provide insights, from a supra-national perspective and the perspective of the African Association of Universities, on how HEIs in Africa should internationalise their classical missions. The majority of the internationalisation strategies in the AQRM – student and faculty mobility; academic mobility, international research collaboration; international dissemination of research at conferences; and curriculum internationalisation – mirror the internationalisation strategies from the Global North (see Maringe et al. 2013; Knight and de Wit 2018; de Wit and Altbach 2021). Studies conducted in some countries in the Global South (e.g. Tamrat and Teferra 2018; Ndaipa et al. 2022) point to similar internationalisation strategies at the institutional level. Therefore, policy convergence in the domain of internationalisation strategies is evident. Thus, the various isomorphic forces account for the convergence of HE internationalisation strategies in the Global North and Africa. This renders the neo-institutional theory a reliable explanatory lens for the apparent convergence. Teferra (2019, 2020), while critiquing de Wit and colleagues' definition of internationalisation which stresses the word "intentional", lends credence to the proposition above by asserting that Africa adopted the Eurocentric internationalisation strategies through a coercive rather than an intentional

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process. The AQRM was funded by the European Union (EU) and the African Union as part of the EU-Africa partnership. It is, therefore, probable that the EU, the principal funder, could have influenced the adoption of Eurocentric internationalisation strategies. However, mimetic isomorphism (or emulation) cannot be ruled out. The African Higher Education Harmonisation Strategy is the equivalent of the Bologna Process. The two strategic policy frameworks, *albeit* of different continents, have similar ends or goals (common higher education spaces) and objectives (e.g. eliminating the obstacles to free mobility of students and faculty). The marked convergence in the goals and objectives necessitated the similarity of the HE internationalisation practices associated with mobility. Therefore, the HE internationalisation strategies attest to the internationalisation of the Bologna Process in Africa. The policy convergence described above lends credence to the power of the neo-institutional theory in explaining organisational change.

Despite the convergence of these strategies, some of which have been labelled Eurocentric, academic colonialism, and neo-colonial in the scholarly literature (de Wit 2020b), there is a trend in Africa to adapt rather than adopt the strategies. The adaptation is evident in the regional rather than global focus of most of the strategies and is a strategy to decolonise (or de-westernise) some of the Eurocentric templates of internationalisation. The extant studies, especially on the direction of student mobility, lend credence to our earlier observation that student mobility in Africa has a strong intra-continental focus.

Maringe et al. (2013, 19) opine that "[a]lthough we have a fairly good idea of the generic internationalisation strategies…, we have little evidence about the relative importance attached to these strategies…in different parts of the world (p.19)". We contribute to this discourse, though without quantification, by asserting that the AUC attaches great importance to student and faculty mobility because the strategy appears several times in the AQRM and the volume of information elicited on the strategy is incomparable to other strategies. Second, the alignment of this internationalisation strategy with the goal of the Harmonisation Strategy is a proxy indicator of the prestige that it enjoys. Conversely, other internationalisation strategies that appear in the AQRM as standards for quality rating and predominantly focus on the research mission – international research collaboration; and international dissemination –are important but do not enjoy parity of esteem with mobility.

We now delve into the strategy which is implied to be least important: curriculum internationalisation. Whereas internationalisation at home, demonstrated through the internationalisation of the curriculum, has come to

the fore across the globe (de Wit and Altbach 2021), it occupies a backseat in Africa because it is not among the mandatory strategies. The AUC's obsession with physical mobility is partly responsible for the low priority attached to curriculum internationalisation. However, the imperative to promote the internationalisation of the curriculum cannot be overstated. As Jones (2020, 181), in response to the unparalleled focus on physical mobility observes, "Mobility needs to be seen as adding value to an internationalised curriculum, not as the focal point of internationalisation efforts."

Internationalisation at home is a peripheral approach to internationalising HE in the AQRM. The focus on mobile students has the potential to militate against the development of the 14th generic competence of African HE– "Ability to work in an intra and intercultural and/or international context" (Nabaho 2017, 21) – among non-mobile students, which necessitates bringing internationalisation at home to the fore. Therefore, the imperative to blend elitist internationalisation abroad with the less elitist and more inclusive internationalisation at home cannot be overemphasised.

The findings and discussion lead to three conclusions. First, most mobility (of persons and programmes) is integral to most internationalisation practices in the AQRM. Student and staff mobility, academic mobility, and international dissemination of research as HE internationalisation practices have an element of people crossing borders to study, teach, research, and disseminate knowledge. Second, the AQRM from which the HE internationalisation strategies in Africa were gleaned, was designed using the decolonial lens. The decolonial lens repudiates the dominant colonial conception that what is "international" must be associated with Europe and North America. The big doses of intra-Africa mobility, intra-Africa research collaboration, and intra-Africa academic mobility lend credence to this conclusion. Finally, political and academic rationales dominate the internationalisation discourse at the continental level. The political rationales hinge on promoting Africa's academic and political integration. The academic rationales constellate around improving the quality of education.

Upenyu and Ress (2018) and Tight (2021), among a plethora of others, lamented the shocking dearth of studies on the internationalisation of HE in Africa while Maringe et al. (2013) underscored limited evidence about the relative importance attached to internationalisation strategies. This article contributes to both concerns. First, we have added to the limited literature on the internationalisation of HE in Africa from a supranational perspective. Finally, we have shed light on the importance attached to the generic Anglo-Saxon models of internationalisation in Africa. Therefore, the article, in addition to advancing knowledge on one of the most discussed topics in HE,

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doi: https://doi.org/10.18543/tjhe.2899 • http://www.tuningjournal.org/

provides a rich resource who scholars and students who wish to interrogate internationalisation from a comparative/international perspective of Africa and other regions.

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 25-43 •
doi: https://doi.org/10.18543/tjhe.2899 • http://www.tuningjournal.org/

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Academic and non-academic career paths of international and domestic PhD holders

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doi: https://doi.org/10.18543/tjhe.3126

Received: 4 July 2024
Accepted: 13 January 2025
E-published: June 2025

Abstract: Some countries have strong culturally rooted practices and policies to incentivize their PhD candidates to develop their doctoral studies abroad. Their programs provide cultural and methodological diversity opportunities and globally oriented career prospects. In the last years, many of those countries are increasingly developing their own domestic doctoral programs, which may offer career benefits due to their strong connections to the local research and academic environment. The career paths of 126 PhD holders working in Paraguay, a country in which doctoral studies abroad intersect with national-based doctoral programs, were examined using the ECRID survey. The perceptions of those who completed their doctoral studies domestically and those who studied abroad were compared in terms of the usefulness of the skills provided by their respective PhD programs.

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Acknowledgements: This study is part of a cross-national research project on "Early Career Researcher Identity Development: Research within and beyond academia early career researcher identity" (ECRID; for a greater detail on the aims and design of the project see https://www.researcher-identity.com/ecrid-en). The study's aims and procedures were reviewed and approved by the ethics committee and the data protection officer of the hosting institution, ensuring compliance with ethical and legal standards.

Funding: None.

Conflict of interests: None.

The results showed that most PhD holders in Paraguay work full-time in the academic sector. The percentage of PhD holders employed in non-academic roles reflects the diversity of career options available to PhDs holders in the Paraguayan labour market. Furthermore, results indicated how the participants re-signified the skills acquired during the doctoral program to adapt them to various professional settings. This process underscores the emerging demands of the current labour market and the necessity for universities to adjust doctoral training models to better equip graduates for diverse professional paths. This adjustment includes institutional support to reduce cultural shock and subsequent burnout levels. Pioneering results from the Paraguayan context provide empirical evidence to enrich the reflection on the resources and opportunities for PhD holders at both structural and organizational levels.

Keywords: Academic career; non-academic career; PhD holder; domestic PhD holder; international PhD holders; doctoral competences.

I. Introduction

Over the past two decades, economic globalization has led to a remarkable increase in doctoral candidates and graduates, a phenomenon observed in either highly scientifically developed and less developed countries (OECD 2024; Kuzhabekova et al. 2019). Although doctoral training is recognized as essential for acquiring research skills and preparing for academic careers, many domestic universities in less developed countries face limitations in training young scientists both in terms of quantity and quality (Sakurai and Masson 2023). This situation illustrates to what extent upgrading local institutions is a lengthy and costly process, further constrained by the existing scientific workforce (Müller et al. 2018).

In parallel to the growing trend of students remaining in their home country, there has been a significant increase in the number of PhD candidates choosing to continue their studies abroad, especially in less developed countries (OECD 2024; Robertson and Nguyen 2021). The most attractive destinations include countries such as the United Kingdom, the United States, and Australia, where a significant proportion of the student population comprises international (OECD 2024). Other non-anglophone destinations like Spain, have been also traditionally relevant for some candidates. Barcelona has recently become a popular destination within the Latin American and Caribbean (LAC) communities, mainly due to cultural and linguistic similarities (Valls-Figuera et al. 2023).

To support PhD studies abroad, developing countries provide national and international scholarship programs, reflecting their efforts to strengthen their research capacity through international training (Flecha 2018; Huang

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 45-72 •
doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

and Jung 2023). The standard expectation for the governments that provide financial incentives for doctoral students to study abroad is that they will return and contribute to enhancing research productivity and economic development of their countries, in line with the principles of Responsible Research and Innovation (RRI) (Huang and Jung 2023; Sala-Bubaré et al. 2022; Müller et al. 2018; Ramos and Velho 2011).

Transitioning from doctoral training to the labour market can be challenging for PhD holders, as they must re-evaluate the skills and competences, they acquired during their doctoral training to align them with their professional objectives and the new cultural context (Canolle and Vinot 2020). This situation is particularly true for those transitioning to non-academic jobs and those returning to their home universities (Canolle and Vinot 2020; Shmatko et al. 2020). Results from research in the last decade indicate that although a significant proportion of doctoral graduates still enter academia, there is a growing inclination towards non-academic careers (Roach and Sauermann 2017; Germain-Alamartine et al. 2020; Walters et al. 2021; Castelló et al. 2023). The current situation may be attributed to the shortage and instability of academic positions compared to the increasing number of doctoral graduates but also to new trends in research and innovation that increased research job positions in the industry (Germain-Alamartine et al. 2020; Van der Weijden and Teelken 2023) and has prompted a shift in how research and researchers address societal changes (Huang and Jung 2023).

Research has illustrated that post-doctoral career paths are highly dependent on various contextual factors, such as the specific country or institution in which they take place (Sakurai and Mason 2023), and that a combination of factors, such as salary, job stability, social recognition, contribution to the welfare state, satisfaction from developing an innovative activity, and the time commitment required, influence post-doctoral career choices (Canal-Dominguez and Rodríguez-Gutiérrez 2016; Shmatko et al. 2020). Available evidence on international PhD holders' career paths who return to their home context, and the differences with those experienced by domestic PhD holders come from European countries such as Greece (Labrianidis et al. 2022) and Portugal (Tavares et al. 2019), as well as in African and Asian countries such as Ghana (Attom and Eshun 2018) and Pakistan (Baloch et al. 2021), respectively. However, empirical evidence on the reintegration of international and domestic PhDs in the Latin American context is limited, especially when looking for studies that include national and international PhDs in the academic or non-academic sectors.

This study contributes to fulfilling this gap by exploring the career paths of domestic and international PhD holders working in Paraguay[1]. We analysed Paraguayan PhD holders' perceptions regarding the usefulness of the skills provided by their domestic or abroad doctoral training programs. Moreover, we related these perceptions with their current job position within or beyond academia. Increasing our knowledge regarding those issues might provide valuable insights for aligning higher education, doctoral education and research policies with labour market needs, and supporting the PhD holders' reintegration in Paraguay and other similar contexts.

Therefore, this study aimed to examine the career paths of Paraguayan PhD holders who graduated from national and international universities. Specific objectives were:

- Explore the type of professional career pursued by domestic and international PhD holders.

- Identify PhD holders' perceptions regarding which skills acquired during doctoral training were relevant in their current professional contexts.

II. Literature review

II.1. PhD Graduates: Training and employment destinations

Developing an academic career and accessing stable academic positions is an increasingly precarious and uncertain option for newly graduated PhD students (Van der Weijden and Teelken 2023; Castelló et al. 2023). In the last ten years, researcher careers have gradually become multifaceted, and core activities such as planning a project, collecting and analysing data, or managing R&D-related projects are no longer exclusively confined to academia but are also prevalent among non-academic sectors (Shmatko et al. 2020; Kyvik and Bruen Olsen 2012).

Many countries (e.g., UK, USA, Canada, or Australia) have been progressively modifying their doctoral education to guarantee not only research proficiency but also transversal competences to enhance competitiveness in the labour market (Canal-Dominguez and Rodríguez-Gutiérrez 2016; Lamon et al. 2024) and to allow PhD holders to progress in their careers in a range of fields and across sectors, even in non-academic

[1] In Paraguay, with a population of around 7 million, there are 1.832 people involved in research, of whom only 34% hold a PhD (RICYT 2021).

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 45-72 •
doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

research and innovation contexts (Ganapati and Ritchie 2021; Li and Horta 2023).

In contrast, a traditional PhD training model persists in many South American countries, with higher education institutions and research centres serving as the main trainers and employers for most doctoral candidates (Mendoza-Otero et al. 2021). In Paraguay, where this study is based, approximately 60% of PhD holders pursued careers as university teachers a decade ago (Jiménez-Chávez and Duarte-Masi 2013). Current data on the employability rate, destination, and quality of employment of domestic PhDs is not publicly available but trends appear to be similar (Diaz-Villalba and Castelló 2024).

Research on the career paths of PhDs who have crossed borders to further their studies abroad has been prevailing on sending countries, such as China, Saudi Arabia, Kazakhstan, Malaysia, Hong Kong, Macau, Taiwan, and various sub-Saharan African countries. These studies focused mainly on issues such as identity negotiation, the psychological adjustment of academic returnees within their university roles, the intricacies of reintegration into the higher education sector after international doctoral studies, and the use of networks to access the labour market (Ai and Wang 2017; Alkubaidi and Alzhrani 2020; Lu and McInerney 2016; Li and Horta 2023; Kuzhabekova et al. 2019; Eduan 2017; Da Wan et al. 2022). Their results highlight variances in academic cultures between host and home universities, notably when moving to Japan, Australia, and the United Kingdom (Sakurai and Mason 2023; Lamon et al. 2024; Robinson-Pant 2009).

Several studies suggest that the employability opportunities facilitated by networks are related to the place of graduation. On the one hand, foreign-trained PhDs generally have more collaborators in scattered networks, which leads to higher international collaboration possibilities. On the other hand, domestic PhDs usually have stronger relationships and mentor collaborations within their networks (Lu and McInerney 2016). Due to the limited connection with international colleagues, there is minimal collaboration for publication in higher-impact journals, resulting in fewer citations and less visibility, which, in turn, limit professional advancement (Jiménez-Chávez and Duarte-Masi 2013).

Research has also highlighted the relationships between the availability of academic opportunities and the career transitions to non-academic sector (Walters et al. 2021; Li and Horta 2023). A first type of transitions refers to 'involuntary transitioners,' who were primarily interested in academic careers but were forced to explore alternative paths due to the limited number of available academic positions and their high level of precariousness (Van

der Weijden and Teelken 2023; Shmatko et al. 2020). This shift is a direct consequence of the challenging academic job market, where the demand for positions far exceeds the supply (Walters et al. 2021). In contrast, 'voluntary transitioners' did not have a primary interest in pursuing an academic career and some of them usually worked in professional non-academic environments or collaborated with industry during their doctoral training (Pablo-Hernando 2015). This group demonstrates a deliberate inclination toward exploring various professional paths beyond the conventional academic route (Li and Horta 2023).

In a recent study conducted in the Catalan context, data indicate that PhDs pursue a diversity of professional pathways, both within and beyond the academic realm. These roles extend from research and teaching to consulting and entrepreneurship (Sala-Bubaré et al. 2024). It is not uncommon for a PhD candidate to be linked with a research institute, laboratory, or innovation centre, where the individual may occupy a role within the research and development (R&D) department, focusing on a specific project, the development of new technologies or methodologies, or collaboration with other researchers. Furthermore, it is even more common for PhD graduates to join the workforce in private companies, non-governmental organisations (NGOs), or the public sector. They typically occupy roles in project management, data analysis, policy development, consulting, and technical or leadership positions (García-Morante et al. 2024b). Although less prevalent, there is a discernible upward trend towards entrepreneurship or independent consulting, wherein PhD holders deploy their expertise in a practical setting, establishing and overseeing their own enterprises (Sala-Bubaré et al. 2024; García Morante et al. 2024a).

Furthermore, career paths are not always linear, with at least three potential combinations (Castelló et al. 2023). The 'in-out' trajectory represent a perspective in which PhD candidates view the transition as an 'escape' from academia (Rönkkönen et al. 2024), yet maintain an emotional connection with academic work and express interest in returning if conditions are favourable. The 'Out-in-out' group comprises those who view the non-academic sector as a means of consolidating their careers, rather than as a mere exit strategy. They are often motivated by the prospect of enhanced working conditions and professional advancement (García Morante et al. 2025). The 'Hybrid' group comprises individuals who value the opportunity to combine both spheres, viewing the transition as a strategy for professional diversification rather than as a definitive exit (García-Morante et al. 2024).

It is important to note that, in terms of labour conditions, those working outside academia are less likely to have a job that requires a doctoral degree

Tuning Journal for Higher Education
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doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

and to be engaged in research tasks. However, they are more likely to have permanent and full-time contracts, as well as higher salaries than those employed at universities and research centres (Sala-Bubaré et al. 2024).

Researchers career is being reoriented globally as a result of this shift in career paths (Castelló et al. 2023). During the transition to the labour market, PhD holders re-signify the skills and competences acquired during their doctoral training in order to adapt them to their professional goals and contexts (Canolle and Vinot 2020). This adaptability is particularly crucial in certain professional environments or specific cultures, where the assumption of new responsibilities brings additional challenges to their careers (Skakni et al. 2021; Castelló et al. 2017; Al-Nawafleh et al. 2013).

In a recent study, García Morante et al. (2024) analysed the experiences of Spanish PhD holders who had diversified their career paths into non-academic fields, assessing how they perceived the relevance of their doctoral training and the adequacy of the competences acquired in relation to their current professional roles. The results showed that the development of transferable skills and competences is valued as an essential component of doctoral training, as it prepares graduates for the challenges of the labour market and enables them to apply their training in a variety of professional contexts, thereby increasing their employability and effectiveness in non-academic roles.

In certain sectors, these skills and competences are already highly valued Griffiths et al. (2018). In a study conducted in several European countries, academic and food industry employers were asked about the desirable employability skills that PhD students should acquire during their studies. The results showed that competencies related to research skills and techniques, research management, personal efficacy and communication skills were considered most valuable to meet the future needs of the labour market (González-Martínez et al. 2015). Furthermore, a more recent study in 2024 has reinforced the significance of communication skills—both oral and written—as fundamental in their non-academic labour market roles. This study emphasized the centrality of dialogue and comprehension in their jobs, noting that these skills are often not reflected in job specifications, which, in turn, indicates that communication capabilities, which are honed during doctoral training, are crucial for success in non-academic environments (McAlpine and Castelló 2024; Canolle and Vinot 2020).

The evolving career paths of PhD holders are challenging the traditional boundaries between academic and non-academic roles, facilitating a more fluid exchange of knowledge and competencies across sectors (García Morante et al. 2024a). Consequently, this dynamic contributes not only to the

professional development of individuals, but also to the strengthening of research and academia globally (Sala-Bubaré et al. 2024; Müller 2018). Returning PhD holders not only should reframe the competences and skills they have acquired but also experienced a transformed view of the scientific world (Karakaş 2020; McAlpine et al. 2023). Moreover, they can integrate the values, knowledge, and skills acquired abroad into their new context, enriching it rather than compromising it (Kuzhabekova et al. 2019).

II.2. Context

Over the last decade, Paraguay has shown a growing interest in consolidating research and development, and this trend is reflected in the macroeconomic data. From 2014 to 2020, the investment in Research and Development (R&D) as a percentage of Gross Domestic Product (GDP) increased from 0.08% to 0.16%, marking a significant improvement (Conacyt 2022). Although 0.16% of GDP is still a relatively low percentage compared to countries with a long history of scientific development, it is important to consider the implications of this increase in R&D expenditure for the scientific, technological, and economic progress of the Paraguayan nation. This study focuses on one of the strategic pillars of such progress: the training and consolidation of advanced human capital.

One of the scientific policies that has been most successful in increasing research capacity is the training of researchers abroad by granting postgraduate scholarships. Specifically, from 2016 to 2023, it was reported that 300 professionals and researchers started their doctoral training abroad through the BECAL[2]. Approximately 70 have returned, although it remains unclear how many have completed their PhDs. In parallel with the emphasis on training researchers abroad, the promotion of doctoral training in the country has experienced a notable increase in enrolments and graduates. Between 2014 and 2021, 6,148 master's students enrolled in doctoral training programs, and 1,466 graduated, with an annual growth of 4 % (Conacyt 2022).

The consolidation of researchers is being pursued through two programs. First is the National Incentive Programme for Researchers (PRONII), a categorization system for researchers in Paraguay, with different levels ranging from Research Candidate to Level III, each with specific requirements. Second, the Programme for the Return and Relocation of Researchers from

[2] National Programme of Scholarships Abroad for the Strengthening of Research, Innovation, and Education in Paraguay "Don Carlos Antonio López" (BECAL).

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doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

Abroad. However, Paraguay's experience with the return of researchers is relatively recent. It was only in 2022 that the first and only call for proposals was issued to promote the attraction and return of highly qualified professionals to strengthen human capital at the national level. In contrast to other Latin American countries, namely Mexico, Argentina, Uruguay, Ecuador, Colombia, Chile, Paraguay still needs to implement researcher repatriation programs as part of its national science and technology policy (Broitman-Rojas and Rivero 2022).

Research on Paraguayan researchers' career paths has focused on the scientific productivity of specific groups, such as members of national universities or those enrolled in the *Programa Nacional de Incentivos para Investigadores -PRONII-* (Solis et al. 2018; Flecha 2018). Hence, the career paths of highly educated people, specifically those holding a PhD, have received scant empirical attention. The researchers have limited knowledge of the differences between PhD holders who studied in Paraguay and those who returned to the country after completing their PhD abroad.

III. Method

The study adopted a cross-sectional design to analyse the perceptions of Paraguayan PhD holders who graduated from national and international universities and were working in Paraguay, either in academic or non-academic contexts.

III.1. Participants

Altogether, 126 PhD holders who graduated between 2012 and 2022 and are currently working in Paraguay participated in the study. Table 1 shows the characteristics of the final sample. The gender distribution is balanced, with men representing 50.8 % of the sample and women 49.2 %. The majority reside in Asunción (45.2 %) and the Central region (35.7 %), although there were also representatives from other departments[3] in smaller proportions, such as Alto Paraná (7.1 %), Itapúa (5.6 %), among others. They come from different disciplines, with life sciences and biomedicine (35.7 %) and social sciences (38.1 %) being the most predominant, followed by

[3] Paraguay's territorial and administrative organisation includes: two regions (*Oriental* and *Occidental*), departments (17) and municipalities or districts (245). Asunción is a department in its own right (independent), the Central Department is divided into 19 districts, Alto Paraná into 22 and Itapúa into 30, which correspond to provinces or regions in other countries.

technology (20.6 %), arts and humanities (4.0 %) and physics (1.6 %). Regarding family background, 65.1 % of participants have dependents, while 34.9 % do not (see Table 1).

Table 1

Socio-demographic characteristics of the participants of the study

		n	%
Gender	Woman	62	49.2
	Man	64	50.8
Residence Department	Asunción	57	45.2
	Central	45	35.7
	Others Departments	24	19.0
Graduation Area	Life Sciences and Biomedicine	45	35.7
	Technology	26	20.6
	Arts and Humanities	5	4.0
	Physic	2	1.6
Family background	Yes	82	65.1
	No	44	34.9

III.2. Instruments

The instrument used in this study was a reduced version of the cross-national survey: *Early Career Researcher Identity Development: Research within and beyond academia (ECRID)*[4] (Spanish version). The full version of the survey explores different areas of early career researcher career paths and has been used and validated in a previous study to explore the experiences of PhD holders beyond academia (Pyhältö et al. 2024). It was cross-culturally developed and is available in four languages: Catalan, Spanish, Finnish, and English.

The reduced version used in this study included three sections. The first section, "*About You*," collects socio-demographic information (year of birth, place of residence, university, other) (20 items); the second section, "*Your Job*," collects information about the participants' employment situation (7

[4] Available for free download at the project's website: https://www.researcher-identity.com

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doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

items). The third section, *"Professional Competences*," assesses how often PhD graduates carry out a list of activities in their current job (14 items) and whether they acquired the competences to perform these activities during their PhD (14 items) (see annex 1).

III.3. Data collection

A twofold complementary strategy was developed to recruit participants. First, potential participants were identified from two databases: 1) researchers categorized in PRONII at all levels, provided by the National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología - Conacyt), and 2) scholars who have returned to the country and have been registered in BECAL. Second, information about the study was posted on social networks with an email address for potential participants to express their interest. In both cases, interested individuals provided their basic data through a form before being recruited, and some of them shared the information within their networks, facilitating a snowball recruitment effect.

All forms received from interested potential participants were filtered, and those who met the eligibility criteria were included. The inclusion criteria were: 1) having completed a PhD in the last ten years either at domestic or international universities, 2) having a job either within or beyond academia, and 3) living in Paraguay. An email was sent to all eligible PhD holders, inviting them to respond to the ECRID survey.

All participants received written information about the project and gave their consent to participate according to the research ethics clearance procedures in the authors' respective jurisdictions. Completing the survey took 15 to 20 minutes. Data collection took place during May, June, and July of 2023.

III.4. Data analysis

The analytic plan to reach the first objective included two steps. First, descriptive analyses were conducted to explore the main characteristics of PhD holders' employment, whether they graduated from domestic or international universities. Participants were grouped according to their type of job (*academic vs. non-academic*) and their doctoral program *(international vs. domestic)*. This analysis provided a general overview of the career profiling, highlighting overall trends and specific variations based on the current employment sector and the location of the doctoral program. Second, academic and non-academic career paths were assessed for their frequency and distribution.

To address the second objective, we performed a series of Exploratory (EFA) to determine the factor structure of the scale items. This analysis assessed the frequency of use of these skills and competences in the current job. The decision about the number of factors to retain was based on previous factor analysis conducted as part of the ECRID project (García Morante et al. 2024). The analysis resulted in a two factors scale: a) *core research capabilities* and b) *research-related capabilities*. Items related to research skills, knowledge generation, and the application of scientific methodologies were grouped under the '*core research capabilities'* factor, while those related to cross-cutting professional skills were included in the '*research-related capabilities* factor.' Additionally, independent t-tests were conducted to compare the academic and non-academic groups. The two factors previously obtained were used to analyse the responses to the question of whether the respondents had the opportunity to acquire the required skills and competences during their doctoral studies, illustrating regularities in researchers' perceptions of their learning of these competences.

IV. Results

IV.1. Professional career paths of international and domestic PhD holders

The majority of the respondents obtained their PhD from universities abroad (65 %), while 35 % of the participants graduated from domestic universities (Paraguay). Interestingly, the sum of both groups, in terms of the employment sector, showed that only 23.8 % of domestic and abroad graduates were employed outside the academic sector (see Table 2).

The analysis of the age distribution reveals significant differences between those Paraguayan PhD holders with academic and non-academic career paths. Within those with non-academic career paths, the highest percentage is concentrated in the 29-39 age group (12.6 %), while among academics, the majority is in the 40-49 age group. In terms of years since graduation, the majority of Paraguayan academics were in the first group, with 0 to 5 years of graduation representing 46.8 % of the participants. In contrast, respondents with a non-academic career path represent 20.6 % of the sample (see Table 2). These results suggest a trend toward the non-academic sector among early career researchers.

Regarding PRONII levels, 84 % of the participants were classified as researchers in this system. *Level I*, typically indicating the PhD completion and active participation in research projects, included 30.2 % out of those

Tuning Journal for Higher Education
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doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

with academic career paths, while non-academic career paths represented 8.7 %. Additionally, 25.4 % were situated at the *Candidate Leve*l (18.3 % academic and 7.1 % non-academic career paths), suggesting that they may have entered the system as doctoral students and may not have had the opportunity to progress to a higher level due to current organizational or structural factors. Of those classified at *Level II* (19.7 %), most were involved in research projects and have published in high-impact journals. It is noteworthy that 15.8 % (academics and non-academics) have not been categorized, which may indicate non-compliance with entry criteria or a deliberate decision not to categorize, possibly due to being at a different stage in their professional paths or lacking interest in the categorization process.

Table 2

Paraguayan PhD holders' career path

Current main job (n= 126)		Academic (n=96)	Non-academic (n=30)
Graduate	International	57 (45.2 %)	25 (19.8 %)
	Domestic	39 (30.9 %)	5 (3.9 %)
Ages	29 - 39 years old	30 (23.8 %)	16 (12.6 %)
	40 - 49 years old	46 (36.5 %)	12 (9.5 %)
	50 years old	20 (15.8 %)	2 (1.5 %)
PhD holders' years	0 - 5 years	59 (46.8 %)	26 (20.6 %)
	6 - 10 years	37 (29.3 %)	4 (3.1 %)
PRONII level	Candidate	23 (18.3 %)	9 (7.1 %)
	Level I	38 (30.2 %)	11 (8.7 %)
	Level II	22 (17.4 %)	3 (2.3 %)
	No	13 (10.3 %)	7 (5.5 %)
Dual Employment	Yes	66 (52.3 %)	21 (16.6 %)
	No	30 (23.8 %)	9 (7.1 %)
Graduation expectations	Academic	47 (37.3 %)	3 (2.3 %)
	Career beyond academia	3 (2.3 %)	4 (3.1 %)
	Hybrid career	47 (37.3 %)	22 (17.4 %)

Regarding a dual employment, one-third of the participants had more than one job (52.3 % academics and 16.6 % non-academics), while a minority (30.9 %) had only one job at the time of the survey.

In terms of *career expectations*, the majority of Paraguayan PhD holders working in academia expected to pursue an academic career (37.3 %) or to develop a hybrid career (37.3 %) and, to a lesser extent, to work outside academia (2.3 %). Among Paraguayan PhD holders with a non-academic career path, the majority expected to develop a hybrid career (17.4 %) and, to a lesser extent, a career focused on the non-academic sector (3.1 %) and academia (2.3 %).

Table 3

Main job characteristics of the academic career paths

Current main job (n=96)		International (n=57)	Domestic (n=39)
Dedication	Full-time	37 (38.5 %)	25 (26 %)
	Part-time	20 (20.8 %)	14 (14.6 %)
Duration	Permanent	41 (42.7 %)	35 (36.5 %)
	Temporary	16 (16.7 %)	4 (4.2 %)
Vinculation	Employed	34 (35.4 %)	29 (30.2 %)
	Self-employed	23 (24 %)	19 (19.8 %)
Organization Entity	Public	45 (46.9 %)	28 (29.2 %)
	Non-profit	7 (7.3 %)	2 (2.1 %)
	Private	5 (5.2 %)	9 (9.4 %)
PhD required	Yes	12 (12.5 %)	12 (12.5 %)
	No	45 (46.9 %)	27 (28.1 %)

Among *international PhD holders working in academia*, most were employed full-time (38.5 %) and permanent (42.7 %). In terms of type of employment, the majority were employees (35.4 %), while an interesting percentage opted for self-employment[5] (24 %). The distribution by type of

[5] Academic self-employment refers to individuals who work independently in the academic field without formal appointment by an educational or research institution. Their work consists mainly of teaching on an hourly basis but also includes consultancy, private tutoring, and similar activities.

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doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

organisation showed a significant presence in public institutions (46.9 %), and low presence in non-profit (7.3 %) and private organisations (5.2 %). Regarding the job requirements, only one-third of academics (12.5 %) indicated that having a PhD was required for their position (see Table 3).

The employment of *domestic PhD holders working in the academic sector* was predominantly full-time (26 %) and permanent (36.5 %). Regarding the type of employment, the majority were employees (30.2 %), while an interesting percentage opted for self-employment (19.8 %). The distribution by type of organization showed a significant presence in public institutions (29.2 %), followed by private organizations (9.4 %), and, to a lesser extent, non-profit organizations (2.1 %). Regarding the job requirements, only 12.5 % of academics indicated that having a PhD was required for their position (see Table 3).

Table 4

Main job characteristics of the Non-academic trajectory

Current main job (n=30)		International (n=25)	Domestic (n=5)
Dedication	Full-time	19 (63.3 %)	2 (6.7 %)
	Part-time	6 (20 %)	3 (10 %)
Duration	Permanent	14 (46.7 %)	4 (13.3 %)
	Temporary	11 (36.7 %)	1 (3.3 %)
Vinculation	Employed	8 (26.7 %)	2 (6.7 %)
	Self-employed	17 (56.7 %)	3 (10 %)
Organization Entity	Public	11 (36.7 %)	5 (16.7 %)
	Non-profit	4 (13.3 %)	0
	Private	10 (33.3 %)	0
PhD required	Yes	4 (13.3 %)	0
	No	21 (70 %)	5 (16.7 %)

International PhD holders working beyond academia were mainly employed full-time (63.3 %) and, to a lesser extent, part-time (20 %). Moreover, the percentages were close between permanent (46.7 %) and temporary (36.7 %) employment. The majority chose self-employment (56.7 %). Regarding the type of organization, similar results were found between public

(36.7 %) and private (33.3 %) organizations, but no differences were found in non-profit organizations (13.3 %). Most respondents indicated that having a PhD was not a requirement for their current position (70 %) (see Table 4).

Domestic PhD holders working beyond academia tended to be employed part-time (10 %) and a slightly lower percentage (6.7 %) full-time. In terms of employment length, most participants held permanent positions (13.3 %), while a small percentage had temporary jobs (3.3 %). Regarding the types of employment, the numbers were very close, with 10 % being self-employed and 6.7 % being employees. The entire group was employed in public organizations (16.7 %). In addition, all of them stated that having a PhD was not a requirement for their current position (16.7 %) (see Table 4).

IV.2. PhD holders' perceptions about the relevant skills and competences in their current professional contexts

Results regarding which skills and competences acquired during doctoral training were relevant in PhD holders' current professional contexts indicate significant differences in only three of the six skills and competences analysed. Specifically, the skills related to *data analysis* (t(126) 2.09, p=.039, d= 0.43), *data integration* (t(126) 2.11, p=.036, d= 0.42), and *dissemination criteria and priorities* (t(126) 2.61, p=.010, d= 0.53) were considered significantly more relevant in the academic environment than in professional contexts outside the university (see Table 5). The impact size was relatively modest in this context.

Table 5

Comparison of *Core Research Capabilities* between Academic and Beyond Sector

Main Job					
	Academia (n = 96)	Beyond (n = 30)	t	p	d
	Mean (SD)	Mean (SD)			
Data Collection	5.45 (1.23)	5.06 (1.33)	1.48	.141	0.30
Data Analysis	5.58 (1.26)	5.03 (1.24)	2.09	.039	0.43
Information Search and Critical Examination	5.92 (1.16)	5.63 (1.32)	1.16	.245	0.23
Data Integration	5.63 (1.16)	5.10 (1.34)	2.11	.036	0.42
Designing Data Processes	5.06 (1.64)	4.46 (1.59)	1.74	.083	0.37
Dissemination Criteria and Priorities	5.31 (1.49)	4.46 (1.69)	2.61	.010	0.53

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Although mean scores of the academics were higher than the mean scores of the non-academics in all the *research-related capabilities* items (see Table 6), significant differences were restricted to five of the eight skills and competences analysed.

Specifically, the scores of academics regarding *resource management and funding skills* (M=4.83; SD=1.77) were significantly higher than those non-academics (M=3.03; SD=1.71), t(126)=4.88, p=.000, d=1.83; similarly, academics rated the relevance of *training and mentoring skills* significantly higher (M=5.88; SD=1.67) compared to non-academics (M=4.43; SD=1.67), (t(126) 5.02, p=.00, d= 0.97). Significant differences were also found between academic and non-academic PhD holders' perceptions regarding the relevance in their current jobs of skills related to *project management* (t(126) 3.05, p=.003, d= 0.58), *leadership and team management* (t(126) 3.1, p=.002, d= 0.60) and *communication with different audiences* (t(126) 2.78, p=.006, d= 0.56). These differences highlight the value attributed by participants to these activities as particularly relevant in their respective professional fields, with moderate to large effect sizes.

Table 6

Comparison of Research-related Capabilities between Academic and Beyond Sector

Main Job					
	Academia (n = 96)	Beyond (n = 30)	t	p	d
	Mean (SD)	Mean (SD)			
Working in Collaborative Teams	5.58 (1.43)	5 (1.78)	1.83	.069	.35
Project Management	5.53(1.32)	4.6 (1.83)	3.05	.003	.58
Leadership and Team Management	5.21 (1.47)	4.2 (1.84)	3.1	.002	.60
Communication with Different Audiences	5.33 (1.43)	4.46 (1.65)	2.78	.006	.56
Training and Mentoring	5.88 (1.28)	4.43 (1.67)	5.02	.000	.97
Resource Management and Funding	4.83 (1.77)	3.03 (1.71)	4.88	.000	.03
Innovation and Commercialization Ideas	3.13 (1.7)	2.66 (1.76)	1.3	.194	.27
Intellectual Property Rights	2.66 (1.71)	1.96 (1.4)	2.03	.044	.44

When analysing whether or not the competences most demanded in their current jobs were acquired during doctoral training, a small percentage of participants felt that they had not acquired the *core research capabilities* during their doctoral training (see Figure 1). Although the values ranged from 4.8 % to 13.6 %, this figure was interesting since the aim of doctoral training in any context is to train competent researchers.

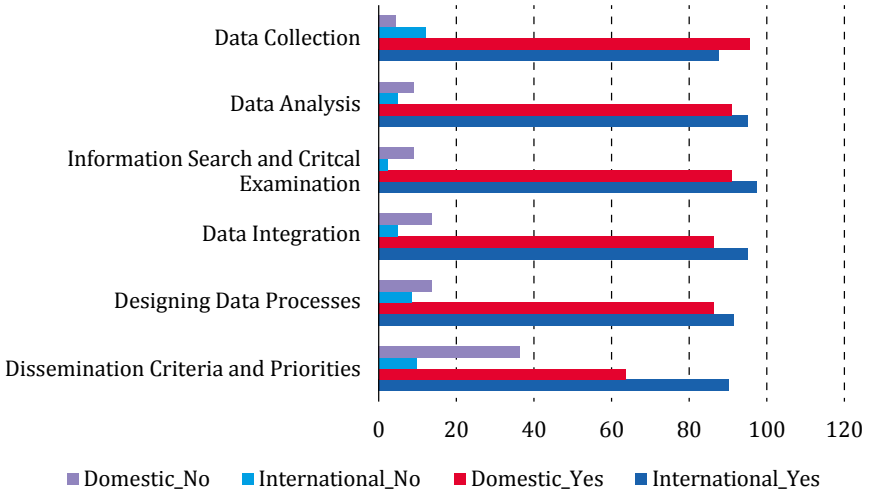

Figure 1

Core Research Capabilities Learning

Regarding *core research capabilities*, the distribution between graduates in domestic and international universities, did not show major differences. However, it was interesting to note that there was a slight difference in skills acquisition between the two groups regarding *dissemination criteria and priorities* skills. 90.2 % of the international PhD holders stated that they had acquired this competence, compared to 63.6 % of the domestic PhD holders (see Figure 1).

Regarding *research-related capabilities*, the distribution between the groups varied in two ways. First, more than half of the respondents acknowledged they did not acquire some skills and competences, such as those related to managing human resources (58.7 %), getting funding (62.7 %), mastering market ideas (78.6 %), or intellectual property (64.3 %). Secondly, international PhD holders were more likely to report having acquired at least two of the analysed competences.

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doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

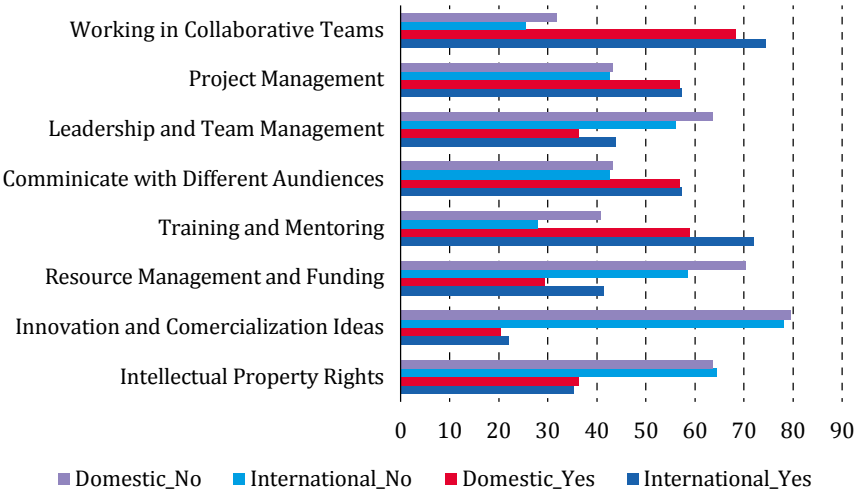

Figure 2

Research-related Capabilities Learning

Specifically, differences were found in mentoring, where 72 % of the international PhD holders stated that they had developed this competence, compared to 59.1 % of the domestic PhD holders. Similarly, differences in funding skills were observed between domestic and international participants. Of the domestic PhD holders, 70.5 % stated that they had not acquired it, compared to 58.5 % of the international PhD holders who stated that they had not acquired it (see Figure 2).

V. Discussion and future directions

This study aimed to explore the career paths of PhD holders working in Paraguay by examining the types of professional careers pursued by domestic and international PhD holders and analysing their perceptions of the relevance of skills and competences acquired during doctoral training in their current academic or non-academic professional contexts.

The results offer novel insights while also raise unresolved questions. Firstly, although a significant percentage of PhD graduates from both domestic and international universities were primarily employed in academic positions, the results regarding PhD holders employed in non-academic jobs reveal the diversity of career options available in the Paraguayan labour market. This diversity includes jobs in public, non-profit, and private

organizations. Interestingly, while a third of the participants' aspirations or expectations during their doctoral training relate to developing a hybrid career, thus combining academic and non-academic positions, two-thirds ended up developing their careers exclusively in academia, albeit with more than one job in the same sector. This pattern reflects trends observed in other Latin American countries and could inform broader regional strategies for integrating PhD talents in diverse economic sectors. These findings highlight that while there is a considerable demand for academic professionals in Paraguay, there is still a significant gap in the recognition of the added value that PhD holders can bring to non-academic sectors, as research in other contexts has also underscored (Shmatko et al. 2020; Kyvik and Bruen Olsen 2012). They also underscore the importance of initiatives that bridge the gap between academia and industry, promoting the benefits of employing highly qualified researchers in various professional settings. Such efforts would not only help to align the career paths available to doctoral graduates with their expectations and interests but also enhance the overall innovation and productivity of the national workforce and could serve as a model for similar initiatives in countries with comparable economic and educational landscapes (García-Morante et al. 2024; Castelló et al. 2023).

Secondly, there is a shift among early career researchers towards the non-academic sector, as shown by age differences and job positions. This growing preference for exploring non-academic career options can either indicate an incipient labour market diversification to adapt to the emerging demands of knowledge societies, as observed in other countries (Shmatko et al. 2020; Canolle and Vinot 2020) or the Paraguayan academic positions saturation and precariousness. Hence, having a quarter of international PhDs working as self-employed in the academic sector is a clear indicator of the precarious nature of Paraguayan academic positions. These self-employed PhDs work independently in the academic field without formal appointment by an educational or research institution, although their work primarily includes teaching on an hourly basis, consultancy, private tutoring, and contract research.

Furthermore, and related to the previous statement, while some participants mentioned that their current position required a PhD, the majority acknowledged it was not mandatory for developing their professional roles. This implies that, in many instances, holding a PhD was viewed as a valuable asset rather than an indispensable credential. While this is a common situation in several countries for non-academic positions (Ganapati and Ritchie 2021; Li and Horta 2023), what is surprising is that, in some cases, PhD holders appear to be overqualified even in academia. In Paraguayan

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doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

universities, it is possible to have a teaching position without a PhD (Diaz-Villalba and Castelló 2024). This fact indicates a significant flexibility in academic requirements, shared by other countries in the region, which diverges from many international regulations where a doctorate is required for developing an academic career. It seems necessary to raise awareness of expert academics with consolidated positions in Paraguayan universities regarding the added value that the increasing number of early career researchers with a PhD might bring to Paraguayan universities, both in terms of contribution and presence of research in Paraguay and international contexts. Exploring diverse career paths aligned with various research responsibilities can also offer universities an opportunity to strengthen their faculty careers. This, in turn, could enhance Paraguayan universities' outcomes in both teaching and research.

Regarding the usefulness of skills and competences acquired during the PhD in current jobs, Paraguayan PhD holders employed in academia demonstrate a better match than their non-academic counterparts. As expected, the results suggest that competences related to core research capabilities are crucial in academia. However, the differences between academic and non-academic profiles indicate a clear mismatch between doctoral training and non-academic job requirements (Canal-Dominguez and Rodríguez-Gutiérrez 2016; Lamon et al. 2023), which is more significant for those who graduated from domestic universities. These results, aligned with previous research in different contexts (García-Morante et al. 2024; Castelló et al. 2023), have important implications regarding the training of doctoral candidates in an evolving landscape, not only in Paraguay but also internationally. In general, graduates from international programs tend to report higher levels of research-related capabilities, including transversal skills such as mentoring and financing, compared to domestic graduates. This finding suggests that domestic doctoral programs may show less diversification and adaptation to the evolving landscape than the training opportunities available in other national contexts (Karakaş 2020).

In light of the findings, we conclude that integrating doctoral graduates into roles directly linked to research has faced challenges in Paraguay's scientific context. While a significant percentage of doctoral graduates are located within academia, the difficulties in navigating alternative career options, the limitations of professional networks outside academia, and the lack of adequate preparation and support for career transitions contribute to the challenges of securing non-academic employment after graduation in the studied context (Diaz Villalba and Castelló 2024). These challenges are not unique to Paraguay but are reflected in other developing countries trends. There is a clear need, and also an opportunity

to expand and diversify career support and networking opportunities for PhD graduates, which could significantly impact their professional integration (Castelló et al. 2023). Overcoming the restrictive notion that doctoral graduates should exclusively pursue careers within academia is central to this paradigm shift. Preparing them for developing research-related competences in an evolving research landscape is also relevant particularly for those trained in domestic PhD programs.

V.1. Limitations, significance and implications of the study

The study is not without limitations. First, the fact that 65% of participants graduated from international universities, while only 35% completed their PhDs at domestic institutions, may restrict the generalizability of the findings to the entire population of PhD holders in Paraguay. Second, the relatively low proportion of graduates employed outside the academic sector (23.8%) may skew the analysis regarding transitions to non-academic careers, potentially underrepresenting the experiences of those who pursue such paths. Third, the study focuses exclusively on the perspectives of PhD holders regarding the utility of the skills they acquired. Future studies could expand this scope by examining the impact of dual employment on career paths and incorporating employer perspectives to evaluate the relevance of acquired skills in the labour market.

This study, pioneering in the Paraguayan context, offers empirical evidence that enriches the necessary reflection on at least three crucial aspects to enhance the success of doctoral studies and early career researcher careers. While Paraguay is the primary focus, the insights gained are equally relevant to other countries facing similar educational and economic challenges.

Firstly, it is crucial to provide resources and opportunities tailored to the needs of doctoral students, both from Paraguay and internationally. This inclusive strategy might ensure a smoother transition between academic and non-academic settings. Additionally, to mitigate the cultural shock often associated with international PhD holders coming back home and transitioning to the labour market, it is imperative to develop clear policies that facilitate reintegration and support doctoral graduates' professional development in their respective fields (Skakni et al. 2021).

Second, efforts should be made at two levels: structural and organizational (McAlpine et al. 2023; Castelló et al. 2017). At the public policy level, there is a call for institutions to adopt more responsive structures that recognize and value the skills and competences acquired during doctoral training,

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doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

supporting early career researchers. At the organizational level, it is crucial to develop working environments that promote work-life balance, provide professional support, and recognize the diversity of doctoral career paths.

Finally, these recommendations lay the groundwork for future initiatives to enhance the positive impact of doctoral graduates in different sectors (Shmatko et al. 2020). The implementation of these practices on an international scale has the potential to accelerate global efforts to integrate doctoral training more effectively into national development strategies. In particular, this approach will contribute to broader initiatives to build societies based on responsible research and innovation.

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 45-72 •
doi: https://doi.org/10.18543/tjhe.3126 • http://www.tuningjournal.org/

Understanding of Algebra of secondary school mathematics teachers from different generations: A qualitative comparative analysis of the answers

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doi: https://doi.org/10.18543/tjhe.2680

Received: 16 January 2023
Accepted: 24 October 2024
E-published: June 2025

Abstract: When the challenges faced in the transition period from arithmetic to algebra are considered, it is important to research the differences between secondary school mathematics teachers from Generations X and Y, and their awareness levels. This study aims to compare the algebraic operation skills of mathematics teachers from Generations X and Y and their awareness levels. The content was analyzed in the study that was designed as a case study. The study participants were 118 secondary school mathematics teachers, 53 teachers from Generation X, and 65 teachers from Generation Y. The findings were evaluated under algebraic skills and algebraic awareness topics. The study results revealed that secondary school mathematics teachers from Generation Y had higher mean scores than teachers from Generation X in terms of the difference between the variable and unknown, algebraic operations, quantification, algebra and patterns, quantification, and inequality subjects in the algebra learning field.

Keywords: Algebra learning field; misconception; mathematics education; values in mathematics education; generations X and Y.

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Acknowledgements: None.
Funding: None.
Conflict of interests: None.

I. Introduction

I.1. Introduce the problem

Developing algebraic thinking early on in life can increase success significantly, contribute to algebra, and eliminate the problems in the transition period to algebra (Gamoran and Hannigan 2000). Algebraic thinking is the ability to focus on the relationship between the numbers (Kieran 2004; Kieran 2018). Algebra has its grammar and syntax with standardized symbols, signs, and rules (Drijvers et al. 2011). Algebraic reasoning comprises two fundamental elements: Generalizing or articulating concepts through progressively formal and traditional symbolic systems, and manipulating symbols within a structured symbolic framework using an established syntax (Kaput et al. 2008). It is stated that the concepts of generalization, representation, justification, and reasoning become prominent in the mathematical structure and relations related to algebra. It has also been stated that children can think more algebraically at an early age than it is generally believed (Blanton et al. 2018). Algebra facilitates logical thinking, cognitive and logistical growth, the use of mathematical models for solving algebraic problems, the formulation and visualization of patterns, and the development of algebraic language (Dekker and Dolk 2011; Hendroanto et al. 2018; Murray 2010). Better learning of mathematical concepts depends on understanding the meaning of the letters that represent numbers in equations (Clements and Sarama 2004; Moss and Lamberg 2019). Algebraic expressions and equations act as a model to interpret the data and syllogize. In addition, algebra is the foundation of mathematical reasoning that individuals need their whole life (Blanton et al. 2018).

Teaching algebra varies in different periods, and these periods are now referred to as generations. The idea of a generation pertains to individuals and communities born during a specific era, influenced by the social, cultural, economic, and political events of their time, as well as their prevailing values (Altıntuğ 2012). Classification and definition of the concept of a generation that is the subject of various interdisciplinary research vary culturally (Üstün and Taş 2021). Generation X generally refers to the people born between 1968 and 1979, but sometimes the lower limit can also be 1963, and the upper limit can be 1982. Generation Y refers to the people born between 1980 and 1999. The lower limit for Generation Y is 1978, and the upper limit is 2002. Generation Z refers to the people born between 1997 and 2012 (Tolbize 2008). It is natural that the methods and techniques of teachers from different generations who show different characteristics, differ when the description of the generation concept and the different periods of generations are considered. Evaluating and comparing the thinking styles and conceptions of teachers from

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 73-95 •
doi: https://doi.org/10.18543/tjhe.2680 • http://www.tuningjournal.org/

different generations and their perspectives on the lesson, especially in algebra lessons that require abstract thinking skills, are important. While scientists conducted comparisons across various generations, the scarcity of studies in the field of mathematics education underscores the uniqueness of this research.

I.2. Teaching Algebra

Teachers must consider teaching methods at different levels and adapt to changes in teaching to improve and develop students' algebra learning (Litke 2020). In addition to efficient assessment techniques, educators require impactful teaching approaches and resources to gauge the progress of students in algebra (Genareo et al. 2020). The teachers' decisions while responding to student feedback affect how students learn mathematics (Kassel, 2020). It is stated that mathematical modeling or relational tasks established between numbers can be useful in learning algebra (Kaput et al. 2008). Even though it holds significant importance, algebraic thinking remains a formidable skill in both the realms of education and learning (Capraro and Joffrion 2006; Jupri et al. 2014). Learning mathematics includes learning ways of thinking. However, the artificial separation of arithmetic and algebra prevents strong mathematics interpretation and makes learning algebra difficult. If individuals possess a deep understanding of arithmetic, allowing them to articulate and substantiate its properties in the context of mathematics, they will have acquired essential underpinnings for the study of algebra (Carpenter et al. 2003). One of the reasons for the difficulties in learning algebra is that the individuals' over-generalizing the mathematical rules acquired while learning the subject using their previous knowledge (Barbieri et al. 2019; Stagylidou and Vosniadou 2004).

I.3. Misconceptions in Algebra

Misconceptions are erroneous ideas that individuals have on any phenomenon that is inconsistent with scientific concepts (Kieran 2014). It is possible to define misconception as incorrect applications or generalization of a rule (Drews 2008). Individuals harboring mathematical misconceptions typically possess an inaccurate or partial comprehension of fundamental mathematical concepts (Barbieri et al. 2019). Proper understanding of the concepts is important in understanding the concepts to be learned later. Incomplete or incorrectly learned concepts can affect the following subjects to be learned (Nasution 2019). It is essential to understand the reasons for misconceptions that hinder learning and clarify them (Irawati and Ali 2018). Misconceptions can make developing algebraic problem-solving skills

a challenge (Booth and Koedinger 2008). Algebraic misconceptions obstruct the acquisition of crucial concepts for algebra success (Russell et al. 2009).

I.4. Aim and sub-problems

The research aims to compare the algebraic operation skills and awareness levels of secondary school teachers from Generations X and Y. The answers to the following questions were sought in accordance with this aim:

1. How do mathematics teachers from different generations perceive algebra?
2. What is the awareness of mathematics teachers from different generations about algebra?

II. Method

The study was designed using the phenomenological approach, a qualitative research method. Phenomenology focuses on phenomena that we are aware of but do not have a deep or detailed understanding of. Therefore, when considering the aims and objectives of the research, it is clear that the phenomenological design is appropriate for this study. Indeed, in phenomenological research, the primary data collection tool is the interview (Yıldırım and Şimşek 2016). In phenomenological research, data sources are individuals or groups experiencing the phenomenon that is the focus of the research. Interviews are conducted to uncover the experiences associated with the phenomena (Büyüköztürk et al. 2016). Accordingly, in this study, the algebraic abilities and awareness of teachers from different generations were taken and compared by asking their opinions.

II.1. Data collection tools

The data collection instrument utilized in this study consisted of three sections: the first section gathered demographic information about the teachers, the second section measured their algebraic abilities, and the third section assessed their algebraic awareness. The "Algebra Learning Area Questionnaire" employed in the study received ethical approval from the Bingöl University Scientific Research and Publication Ethics Committee under the reference number 92342550/108.01/11276. While developing the form, five academicians who are experts in the field of mathematics education were consulted to ensure its validity. As a result of the interviews, the algebra learning field questionnaire was finalized. The study data collection was conducted online.

Tuning Journal for Higher Education
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doi: https://doi.org/10.18543/tjhe.2680 • http://www.tuningjournal.org/

II.2. Participants

The study was conducted with 118 secondary school mathematics teachers in total (52 males, 66 females), 53 teachers from Generation X, and 65 teachers from Generation Y. Teachers' ages were considered as a determining factor of their generations. The participants were included in the study based on the convenience sampling method. The convenience sampling method is adopted as a method that provides convenience in time and effort, in terms of economy and usefulness (Büyüköztürk et al. 2016). The teachers from Generation X were coded as TX, and teachers from Generation Y were coded as TY. Table 1 provides information about the participants.

Table 1

Descriptive statistics about the participants

Generation	Gender	Years of teaching experience	n
Generation X	Female	20-23 Years	7
		24-27 Years	5
		28-30 Years	10
		30+Years	8
	Male	20-23 Years	4
		24-27 Years	9
		28-30 Years	6
		30+Years	4
Total			53
Generation Y	Female	1-4 Years	10
		5-8 Years	9
		9-12 Years	10
		13+ Years	7
	Male	1-4 Years	9
		5-8 Years	10
		9-12 Years	5
		13+ Years	5
Total			65

II.3. Data analysis

The data underwent analysis through the method of content analysis. The data obtained through content analysis should be conceptualized first, and then arranged according to the concepts, and the themes about the data should be identified accordingly (Yıldırım and Şimşek 2016). Content analysis, a method facilitating indirect exploration of human behavior and nature, is characterized as a systematic, replicable approach. It involves summarizing specific words within a text into smaller content categories through coding, following predefined rules. This analytical process is employed to ascertain the presence of particular words or concepts within a single text or a cluster of texts (Büyüköztürk et al. 2016). Initially, the qualitative analysis tool NVivo was utilized, and ongoing analytic memos were crafted to document emerging patterns (Miles and Huberman 1994). During data analysis, repetition of a teacher recounting the same narrative regarding a response or if two individuals mentioned identical accounts were treated as a single case. Additionally, the reliability of the qualitative data was gauged using the formula devised by Miles and Huberman (1994): Consensus Percentage (P) = Consensus / [Consensus + Disagreement]. Three researchers independently analyzed the data, revealing a reliability score of 0.91 among the coders. Instances of disagreement were deliberated upon by the researchers, leading to a recoding process to derive findings. Direct quotations from the interviews are incorporated in the findings section to substantiate the obtained data.

III. Results

III.1. Algebraic skills

In the research, the themes of knowing the difference between the unknown and the equations, operation skills, quantifying verbal expressions, the concept of patterns, identity, minimum and maximum values, and inequality of mathematics teachers from Generations X and Y were discussed. Figure 1 shows the findings.

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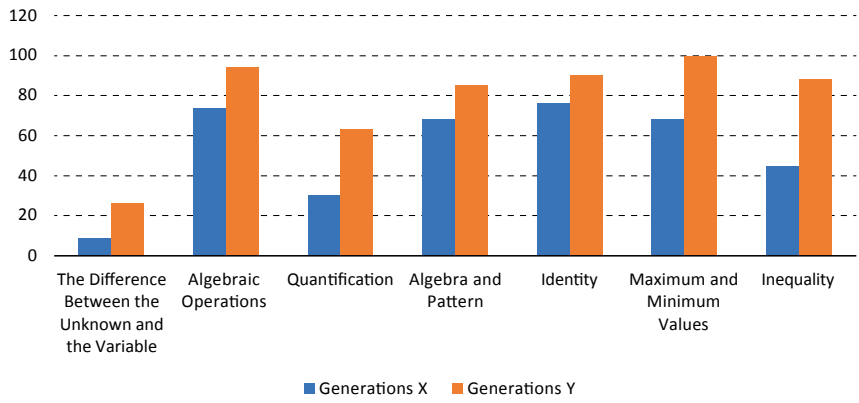

Figure 1
Algebraic skills

III.2. The Difference between the unknown and the variable

The teachers were asked to explain the difference between the unknown and variables and asked to find the unknowns and variables by being provided with several premises. Approximately 9% (f = 5) of the mathematics teachers from Generation X and 26% (f = 17) of mathematics teachers from Generation Y know the difference between unknown values and variable concepts in algebraic expressions. On the other hand, most teachers from both generations (X; 91%, Y; 74%) do not know the difference.

III.3. Algebraic operations

A problem statement with premises that can cause misconceptions was given to the mathematics teachers from Generations X and Y to identify their misconceptions about their algebraic operation skills. Approximately 74% (f = 39) of the mathematics teachers from Generation X and 94% (f = 61) of the mathematics teachers from Generation Y know the operations in algebraic expressions flawlessly. Approximately 17% (f = 9) of the teachers from Generation X, and 6% (f = 4) of the teachers from Generation Y who answered incorrectly, did not realize the division by the coefficient of the unknown in the $(4 + 3x) - (2 + 5x) = 0$ operation, and answered incorrectly. Approximately 9% (f = 5) of the teachers from Generation X stated that the correct answer was not among the options and answered incorrectly. In general, calculation errors in the incorrect answers given by the teachers were observed.

III.4. Quantification

In the study, the following two multiple-choice problems were asked to the mathematics teachers from Generations X and Y to determine their skills of quantifying verbal expressions into algebraic expressions: "A student has a weekly allowance of X TL. She divides the allowance equally per the weekdays during which she goes to school. However, since the last two days of school are the International Day of Persons with Disabilities, she first donates half of her money and puts one-third of her remaining money in her piggy bank. How much is the allowance of the student who saves 40 TL at the end of a week?" and "An individual who wants to measure the area of her rectangular field with a string of y unit length, measures the long side of the field as $5y$ length and the short side as $3y + \frac{y}{2}$ length. How many y^2 units is the area of the field?" Approximately 30% (f = 16) of the teachers from Generation X and 63% (f = 41) of the teachers from Generation Y can quantify verbal expressions into algebraic expressions. However, approximately 8% (f = 4) of the teachers from Generation X and 31% of the teachers from Generation Y (f = 20) did not notice the inverse operations in the problem statement and answered incorrectly. Similarly, approximately 17% (f = 9) of the teachers from Generation X and 13% (f = 7) of the teachers from Generation Y had misconceptions in the inverse operation point by choosing one of the incorrect options. In addition, approximately 17% (f = 9) of the teachers from Generation X made a calculation error and found the answer twice as much, hence, answering incorrectly. When the answers of the teachers who answered incorrectly were evaluated, it was determined that they made an error in the quantification of "However, since the last two days of school are the International Day of Persons with Disabilities, she first donates half of her money and puts one-third of her remaining money in her piggy bank." sentence while forming the equation.

III.5. Algebra and pattern

In the study, the two following questions were asked to the mathematics teachers from Generations X and Y to determine their skills to express the general term of an arithmetic pattern and the general term of the shape pattern algebraically: "Express the general term of the arithmetic pattern of which the first five terms are 5, 12, 19, 26, 33 algebraically." and "What is the algebraic rule of the relationship between the number of octagons and the total number of sides in the shape pattern created by adding the octagon so that it has a common edge with only one of the existing octagons at each step?". Approximately 91% (f = 48) of the teachers from Generation X, and 100% (f = 65) of the teachers from Generation Y have the skill to express the general

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doi: https://doi.org/10.18543/tjhe.2680 • http://www.tuningjournal.org/

term of a pattern algebraically. However, approximately 9% (f = 5) of the teachers from Generation X tried one or a few steps of the pattern through trial and error and did not think that all steps should be applied for the general term and made a misconception error. Approximately 45% (f = 24) of teachers from Generation X, and 69% (f = 45) of the teachers from Generation Y can express the general term of a shape pattern algebraically. However, approximately 47% (f = 25) of the teachers from Generation X, and 14% (f = 9) of the teachers from Generation Y thought that the 8n-1 distractor was correct based on the number of sides of the octagon, and they misunderstood by not considering the common edges. Similarly, approximately 8% (f = 4) of the teachers from Generation X, and 17% (f = 11) of the teachers from Generation Y had a misconception while expressing the general term of the shape pattern algebraically and stated that the correct answer was not among the options.

III.6. Identity

In the study, the following questions were asked to the mathematics teachers from Generations X and Y to determine their skills to expand squared brackets, and knowing the difference of two squares identity, and quadratic equations: *"Please expand* $(3a\text{-}2b)^2$" and "*What is the sum of x integer values in the expression* $x^2 - 64 = 3x - 2(x + 4)$*?"*. Approximately 83% (f = 44) of the mathematics teachers from Generation X, and 92% of the mathematics teachers from Generation Y (f = 60) know expanding squared brackets. However, approximately 8% (f = 4) of teachers from Generation X and 8% of teachers from Generation Y (f = 5) miscalculated the twofold of two terms multiplied in brackets expansion. Similarly, approximately 9% (f = 5) of the teachers from Generation X made a sign error when calculating twice of the two terms in bracket expansion. When the answers given to the problem were examined, it was seen that the teachers who answered incorrectly did not know the proposition "no simplification with zero" and simplified the factors $(x - 8)$ with each other, so they did not consider one root of the equation. When the answers given to the question about the squared bracket expansion were examined, it was seen that some of the teachers who made mistakes did not notice that twofold of the first and second statements in the series should be considered.

III.7. Maximum and minimum values

In the study, the following question was asked to determine the skill of calculating the greatest and smallest value in algebraic expressions of

mathematics teachers from Generations X and Y: "*Find the maximum and minimum values of the product x.y for the natural numbers x and y in the expression* $3x + 2y = 18$". Approximately 68% (f = 36) of the mathematics teachers from Generation X, and 100% (f = 65) of the mathematics teachers from Generation Y know how to calculate the maximum and minimum values in algebraic expressions. Misconceptions about the definition of natural numbers were observed when the answers of teachers from Generation X were analyzed.

III.8. Inequality

In the study, the following question was asked to determine the inequality in algebraic expressions skills of mathematics teachers from Generations X and Y: "If x is an integer, and $x + 2x + 3x + \ldots + 10x > 55$, then what is x^2 at least?". Approximately 45% (f = 24) of the mathematics teachers from Generation X and 88% (f = 57) of the mathematics teachers from Generation Y know the concept of inequality. When the incorrect answers were analyzed, it was seen that teachers used x instead of x^2 or overlooked the fact that x being an integer.

III.9. Algebraic awareness

To investigate teachers' algebraic awareness, the study compared responses to questions about variable and unknown concepts, misconceptions and values between Generation X and Generation Y. Results detailing common and divergent responses are categorized into clusters. Figure 2 shows the themes identified regarding the awareness of mathematics teachers from different generations regarding variable and unknown concepts, misconceptions and values relevant to algebra education.

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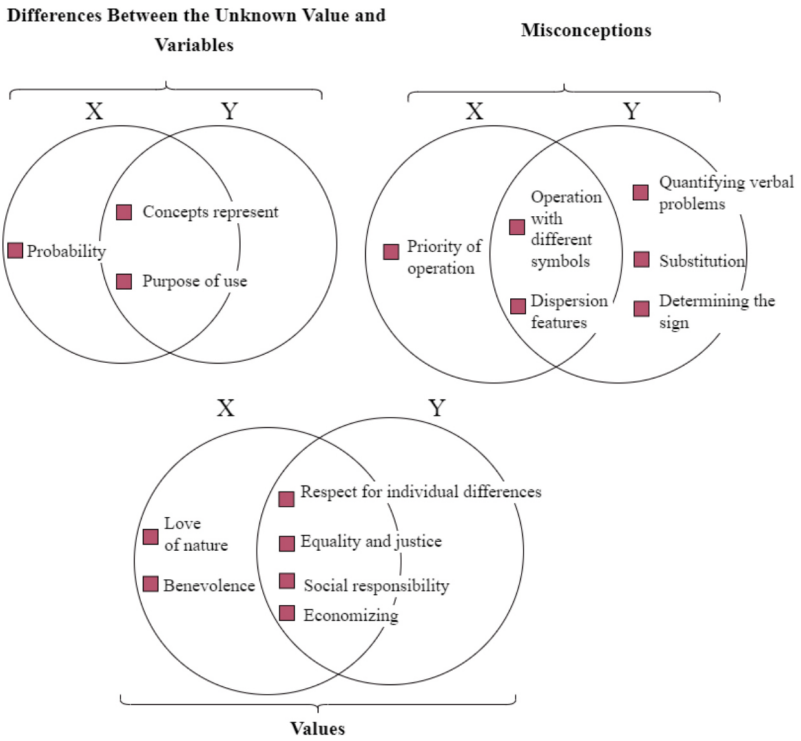

Figure 2

Awareness in algebra education

III.10. Awareness about the differences between the unknown value and variables

While explaining the differences between the unknown value and variables, teachers from Generation Y highlighted the value and purpose of use that these concepts represent, and teachers from Generation X also explained the concept of probability. Sample expressions of teachers who have an awareness of this issue are given below:

TX2: "Variable: A symbol or a cardinality that represents any element of a set of at least two elements. The unknown value corresponds to the cardinality concept defined in mathematics but whose value is unknown."

TX16: "The variables are used for identity in equations with unknown values".

TX24: "While the concept of variable symbolizes the possible potential outcomes in an algebraic expression, the concept of unknown variables symbolizes that the probability is 1."

TY22: "Unknown value is an unchanging letter expression with only one numeric value. Variables are letter expressions whose numerical value can change."

TY25: "In an equation, x is the unknown value. However, x is a variable in identity or algebraic expressions."

III.11. Awareness about misconceptions

Regarding the difficulties encountered in algebra teaching and the misconceptions observed in students, teachers from Generation X stated that the priority of operation, operation with different symbols, and dispersion features became prominent. Teachers from Generation Y expressed the problems they encountered as difficulties in processing with different symbols, processing priority, assigning the equality to the opposite side of the equation, determining the sign, and quantifying verbal problems. Sample expressions are given below:

TX4: "Students usually make mistakes while expanding the brackets. For example, such as $-(2x + 3) = -x + 3$."

TY52: "When distributing algebraic expressions into brackets in multiplication, multiplying only by one element, and forgetting the other one: $2.(3x + 4) = 6x + 4$."

TY56: "Carrying out the operation as if the exponents are not going to be distributed, like in the following example: $2.(3x + 5) = 6x + 5$."

TX32: "Generally, students add different values, like $2a + 2b = 4ab$."

TY36: "For example, the students can calculate as $2a + 3b = 5ab$."

TY12: "Multiplying different terms: $2y.3x = 6x$ *or* $6y$."

TX64: "There are misconceptions about operations with brackets."

TX3: "Difficulties about solving equations due to sequence or priority."

TY1: "For example, if a student cannot calculate the values in brackets, then she has misconceptions about the order of operations."

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TY88: "They have misconceptions while quantifying verbal statements. Let's say that "*f*" denotes females and "*m*" denotes males in the statement that males are 3 times more than females in a class. They can have misconceptions due to misplacing variables like *m=3f*."

TY112: "Students have misconceptions while assigning values to the other side of the equations by changing sign of the terms."

TY20: "Students think that 5 in the statement 5*x* will be assigned to the other side of the equation as a positive value, this is a misconception about the coefficients in algebraic statements."

TX48: "Trying to solve equations without knowing the order of operations."

TX8: "Making an error in the direction of the inequality symbol when multiplying or dividing both sides of the inequality in negatively signed coefficients."

TY20: "The student does not use brackets and creates a misconception when multiplying the excess."

III.12. Awareness about values to be taught

Teachers from Generation X stated that they could teach concepts about equality and justice, social responsibility, respect for individual differences, economizing, benevolence, and love of nature to students, while teachers from Generation Y stated that they could teach equality and justice, social responsibility, respect for individual differences and economizing. Sample statements of teachers from Generations X and Y are given below:

TX2: "Equality and Justice: We have x number of walnuts. We divide x number of walnuts to 5 siblings equally as x divided by 5. In this way, some values can be taught to our students in the lesson."

TX84: "Equality as a requirement of justice and social principles is the first value that comes to my mind."

TY14: "The greengrocer being honest and fair while weighing fruit emphasizes the value of equality in the equations."

TY88: "I associate the concepts of justice, social sensitivity, and responsibility with the concept of equality in the equations."

TX64: "For example, social responsibility values are taught in a problem statement that expresses the amount of blood donated as liters on World Health Day."

TX44: "Different values teach about respecting individual differences."

TY22: "Especially in questions about sharing, we can emphasize social sensitivity and responsibility by emphasizing that they should protect equality, justice, and sensitivity towards their shares against people."

TY72: "A ratio of going out and using masks teaches values of social responsibility."

TY100: "Expressing the amount of water used as x can teach the importance of saving water to students."

TY76: "Simplification can teach about economizing and getting rid of excess materials."

TX24: "The problem statement asking the students to write down the equation showing the amount of bread waste per day in the phrase "At least 5 million bread are wasted per day" can teach about economizing."

TY10: "If there are positive and negative values in an equation, the change in the direction of the inequality in the equation can be explained by the changing the responses given in the current situation due to changing responsibilities in social life."

TY88: "In some optional shopping questions, for example, a mobile operator's monthly tariff options, fixed fee and which option would be more economical in per-minute pricing can teach about economizing to the students."

TX15: "By saying that the pattern has a certain rule and all terms can be found according to these rules, obedience to the rules and social responsibility values can be taught."

TY72: "In a pattern of numbers whose first term is one, the 15th term will be the definitive result for every student. This can teach the value of equality."

TX84: "The value of benevolence can be taught by setting up a problem sentence with the related concepts."

TX24: "A simple subject of the equation can be taught together with the value of economizing."

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doi: https://doi.org/10.18543/tjhe.2680 • http://www.tuningjournal.org/

TX3: "Examples such as the sunflowers can be given as examples so that the students explore the mathematics in nature. Therefore, love of nature can be taught."

IV. Discussion

Upon evaluating teachers' responses regarding their opinions on the distinction between the unknown value and the variable, the research determined that Generation Y educators exhibited greater proficiency, while their Generation X counterparts demonstrated a lower awareness of this distinction. While teachers from Generation Y highlighted the values and purpose of using the unknown values and variable concepts in explaining the difference, teachers from Generation X also explained the probability concept. The increasing importance of the explanations of mathematical terms and the more aware use of these terms are the reasons for these results. The unknown value and variable terms are employed to explain different uses of characters in algebraic expressions and equations. Generally, the unknown value term is used for explaining a certain amount, and even though a person does not know the value yet, it refers to a numerical value that can be identified using the information provided. A variable is not definite but indefinite. For example, in an equation dependent on x and y variables, equality is provided for the infinite values of x and y. On the other hand, together with the y value found for a value to be given x, the pair (x,y) represents a part of the general set (Ely and Adams 2012). In addition, learning different meanings of characters and variables was stated as important (Blanton 2008; Blanton et al. 2017). In algebra, understanding how algebraic equations are solved and understanding which situations algebra represents are necessary (Moss and Lamberg 2019). Using symbols correctly and establishing a correct relationship between the symbols are important while learning algebra (Malara and Navarra 2012).

When the misconceptions of mathematics teachers from Generations X and Y were researched, it was concluded that teachers from Generation Y had fewer misconceptions than teachers from Generation X. Teachers from Generation X had more misconceptions while dividing by the coefficient of the unknown while doing mathematical operations compared to the teachers from Generation Y. In addition, teachers from both generations made calculation errors. Mistakes made in the process of associating and retrieving cognitive information could be the reasons for calculation errors. As a matter of fact, in cognitive information processing, individuals focus on associating the information with data in memory, storing new information in memory,

and retrieving information when needed (Schunk 2008). Mathematics teachers from Generation Y were more successful in quantifying verbal statements into algebraic expressions than mathematics teachers from Generation X. However, mathematics teachers from Generation X had fewer misconceptions than mathematics teachers from Generation Y in terms of inverse operations. The fact that a semantic relationship is established through symbols and the development of awareness through mental processes such as inverse processing are the reasons for this result. Knuth et al. (2006) stated that learning the meanings of symbols and variables is necessary for algebraic competency.

Teachers from Generation Y were more successful in expressing the general term of an arithmetic pattern and the general term of a shape pattern algebraically. Teachers from Generation X try one or several steps of a pattern via trial and error and have misconceptions by not thinking that all the steps should be carried out for finding the general term. Teachers from Generation X had more misconceptions than teachers from Generation Y while considering the common sides of a shape while expressing the general term of the shape pattern algebraically. Patterns are important for algebra and require advanced cognitive skills. As a matter of fact, difficulties experienced while learning algebra can also make it hard to learn advanced algebra subjects (Herriott and Dunbar 2009).

It was concluded that teachers from Generations X and Y had similar skills of expanding squared brackets, knowing the difference of two squares identity and quadratic equations, and teachers from Generation Y experienced fewer misconceptions. Among the teachers of both generations, some teachers had misconceptions in expressing the twofold of the two terms multiplied. When the solutions were analyzed, it was seen that teachers who answered incorrectly did not know the proposition of "no simplification with zero", and overlooked one root of the equation. In addition, teachers also had misconceptions about negativity. Correctly understanding the meaning of the equals sign is necessary for learning algebraic equations and solving questions (Carpenter et al. 2003). It has been mentioned that individuals who misinterpret or have an incomplete understanding of the negative sign in algebra are prone to employing incorrect strategies when solving algebraic equations (Booth and Koedinger 2008). While teachers from Generation Y calculate the maximum and minimum values in algebraic expressions without any misconceptions, most teachers from Generation X were also successful. When the incorrect answers given by teachers from Generation X were analyzed, misconceptions about the definition of natural numbers were identified. While teachers find the maximum and minimum values, they

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 73-95 •
doi: https://doi.org/10.18543/tjhe.2680 • http://www.tuningjournal.org/

cognitively force their mental schemas and may have misconceptions. As a matter of fact, misconceptions are expressed as commonly accepted situations among different generations and cause mathematics to be considered a challenging course (Blanton et al. 2018).

Teachers from Generation Y were more successful in their skills of inequality in algebraic expressions than teachers from Generation X, and it was observed that teachers overlooked forces of x or x being an integer. Misconceptions need to be corrected to know the inequality concept in the best way possible. As a matter of fact, learning equals sign completely is stated as important for developing algebraic problem-solving skills (Knuth et al. 2006). In addition, one of the biggest difficulties faced while transitioning to algebra from arithmetic's is understanding how a mathematical equation is formed (Lee et al. 2018). Teachers from Generation X highlighted the order of operations, solving operations using different symbols and distributive property in terms of difficulties faced during algebra teaching and misconceptions of teachers. Teachers from Generation Y deemed the problems they face in solving operations using different symbols, order of operations, assigning the values to the other side of the equation, determining signs, and quantifying verbal problems as important. Lack of algebra can cause problems and misconceptions (Apsari et al. 2020) of calculation (Müller et al. 2014), mathematical proof (Güler, 2016), and solving problems (Ferryansyah et al. 2018).

Teachers from Generation X stated that equality and justice, social responsibility, respect for individual differences, economizing, benevolence, and love of nature could be taught to students while teaching algebra and expressed that these values are important. Teachers from Generation Y stated that values of equality and justice, social responsibility, respect for individual differences, and economizing could be taught via algebra education and stated verbally that these values should be highlighted. The importance given to the concept of value in the recent education curricula, and highlighting mathematical values in national and international exams are the reasons for these results. Another reason for these results can be the fact that values are important for both generations, they adopt these values and pass them on to Generation Z while teaching. As a matter of fact, in the literature, Generation X is generally described as a generation that has continuity in learning, has strong technical skills, attaches importance to individuality and values, and is result-oriented, and while Generation Y shares many characteristics of Generation X, they are also defined as a generation that values teamwork, optimistic, can take flexible decisions and individuals with high sense of self-esteem (Bova and Kroth 2001; Crampton and Hodge 2006; Glass 2007; Martin 2005; Tolbize 2008; Üstün and Taş 2021).

V. Limitations and future directions

The applications were carried out using online forms due to the pandemic, but teachers were contacted individually to avoid this limitation. While preparing the questionnaire, it was stipulated that each question should be solved and open-ended questions should be answered, and data loss was prevented in this way. The teachers who participated in the study agreed to participate in the process voluntarily, and declared their choices, and ethical permission was obtained. Teachers were asked to solve multiple-choice problems and write down their solutions. Hence, the data were analyzed in detail. The results obtained show that teachers lack in certain areas in terms of similarities, differences and definitions of important concepts such as unknown values and variables. To overcome these failings, studies on teacher training programs can be carried out. Academic projects can be prepared to develop the skills of in-service teachers. In the study, important results were obtained regarding the misconceptions of the teachers from Generations X and Y. The differences show that there is a need for new studies on this subject. To reduce the current generation differences, lifelong learning programs for teachers can be developed. These programs can increase the teachers' awareness of the values of mathematics education. Based on the research findings, policymakers can develop professional development programs tailored to the needs of mathematics teachers and prospective teachers. These programs can equip teachers with the knowledge and skills they need to effectively teach algebra. Additionally, education stakeholders can facilitate the creation of collaborative learning environments adapted to the characteristics and needs of Generation X and Y teachers.

VI. Conclusions

This study reveals discrepancies in the knowledge and skills of mathematics teachers across generations. These variations could potentially impact the teaching of algebra. The findings emphasize the necessity of reviewing teacher education and policies. The need to develop new strategies tailored to the identified challenges, problems, and needs has been frequently emphasized (Adamu 2021; Özmutlu 2022). It is expected to encounter differences among teachers with diverse backgrounds and experiences. The crucial aspect lies in identifying and acknowledging these differences, and utilizing them to promote the development of effective learning and teaching methods.

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 73-95 •
doi: https://doi.org/10.18543/tjhe.2680 • http://www.tuningjournal.org/

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 73-95 •
doi: https://doi.org/10.18543/tjhe.2680 • http://www.tuningjournal.org/

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 73-95 •
doi: https://doi.org/10.18543/tjhe.2680 • http://www.tuningjournal.org/

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Teaching methods through the eyes of Bulgarian students from three generations

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doi: https://doi.org/10.18543/tjhe.2870

Received: 27 October 2023
Accepted: 3 April 2025
E-published: June 2025

Abstract: This article aims to identify the attitudes of different generations regarding certain aspects of the teaching approaches used during the education of economic disciplines. The analysis primarily draws on a scientific review of previous studies in both international and Bulgarian contexts, focusing on the attitudes of lecturers and the perceptions of students from the three generations involved in the educational process. A descriptive research strategy is employed to support the thesis. A survey was conducted using a questionnaire to implement the descriptive method. With a population size of 37,403 students, the respondents formed a sample size of 662 respondents, achieving a confidence level of 99.056% and a margin of error of 3.78%. The results are presented using two-dimensional distributions in the form of cross-tabulations. The ordinal relationships between the categories of a given variable are represented using ordinal (rank) scales, applying Kendall's tau-b and Spearman's rank correlation coefficients. The calculations were carried out using

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Acknowledgements: None.

Funding: This research was supported by the Project № 5-2023 "Challenges and opportunities for digital economics education of Generation Z", funded by the Institute for Scientific Research of the "D. A. Tsenov" Academy of Economics Svishtov, Bulgaria.

Conflict of interests: None.

IBM SPSS software. The study found no significant correlation between the characteristics of different generations and their preferred teaching methods. At the same time, generational traits did not influence attitudes towards acquiring new knowledge and skills during the educational process.

Keywords: Teaching methods; methods of presentation; lecturer's behaviour; generations; education; Gen Z; Gen Y; Gen X.

I. Introduction

The development of human society takes place through knowledge and learning. Various factors can describe the essence of a human individual during his life journey. One of them is the "generation" factor. The representatives of Generation Z are young people between the ages of 18 and 26, most of whom are studying at various universities.

Education is a process of acquiring knowledge, new skills and abilities and is considered a lifelong activity. The learning style of different generations is an essential topic as it is influenced by society, technology and psychology (Djiwandono 2017). Unlike others, Generation Z is characterized by creativity, flexibility, independence and increased environmental concern (Sugahara and Boland 2012; Giray 2022).

A comprehensive analysis of generational problems appeared for the first time in 1991 when the American scientists Howe and Strauss published their joint work on the generations of the future America (Strauss and Howe 1991). Today, topics related to generations and their characteristics are explored by authors such as Tapscott (2008), Prensky (2001), Bauerlein (2009), and Carr (2008).

Generation Z is the first generation to have achieved complete interaction with technology and perceive digital resources as an ordinary reality. Numerous studies have focused on their behaviour as individuals, customers, and attitudes towards environmental products and others (Tobler et al. 2011; Barber et al. 2014; Maichum et al. 2017). However, some studies have focused on their learning (Kohut et al. 2010; Povah and Vaukins 2017; Cilliers 2017; Pringle 2018; McNeil 2018; Poláková and Klímová 2019; Iftode 2019; Nicholas 2020; Szymkowiak et al. 2021). Single studies on this topic can be found in Bulgaria (Alexandrov et al. 2022).

Independence and the desire to learn many things are distinctive characteristics of Generation Z, which must be emphasized. The availability of countless online tutorials to teach you "how to make…" or "how to prepare..." to "how to use a certain software" or device is enough fact that the young generation wants to carry out their activities independently.

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 97-124 •
doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

Communication is another distinguishing characteristic of Gen Z compared to other generations. More than ever, young people need to communicate constantly through all the possible means. They use social networks to communicate with each other and technology to spend more of their time online. This generation follows the Millennials; compared to them, they fully understand new technologies and online channels.

They have unique characteristics and expectations, and their lives are inextricably linked with technology. For this reason, educational resources and teaching methods need to be in harmony with the attitudes of this generation's learners.

Education is a lifelong process of acquiring knowledge, new skills, and abilities. The learning style of different generations is an important topic, as it is influenced by society, technology, and psychology (Djiwandono 2017; Smith 2012). Educational consultant and author Tom Hierck write, "We have 21st-century students being taught by 20th-century adults using 19th-century pedagogy and tools on an 18th-century school calendar." (2014, 1) He calls this a "System Dilemma." This term illustrates the disconnect between teaching methods, the generation from which most educators come, and the recipients of the educational service.

The evolutionary changes in recent years have impacted the social and cultural aspects of the environment, which significantly influence the behaviour of learners. Students trust that the educational process meets their requirements, thereby ensuring their professional success and the expected quality of life. Their attitudes are multidimensional, and the specificity of the academic environment allows for the acquisition of knowledge and skills and the development of the individual. Seeking opportunities for intergenerational activities increases the sense of value, creativity, flexibility, self-esteem, and confidence. However, relationships between different generations can also be identified as sources of difficulties and conflicts (Rupčić 2018). The essential characteristic of a productive academic environment is a strong "teacher-student" relationship (Opdenakker et al. 2012).

The multitude of tasks performed makes the profession of an academic lecturer demanding. The academic lecturer is simultaneously a scholar, a teacher, and an organizer (Ayllon et al. 2019). In their teaching role, academic lecturers convey knowledge that is the result of their scientific work. However, their most significant task is to motivate students to use a diverse set of knowledge and skills, thereby establishing an interpersonal connection with the learners (Bainbridge-Frymier and Houser 2000). Various scientific studies show that interpersonal relationships are essential for

students to realize their skills, self-confidence, and effectiveness (Brinkworth et al. 2018; Pennings et al. 2018).

During the pandemic, a study was conducted on the perceptions of lecturers regarding Generation Z based on its characteristics (Cickovska 2020). A survey method was applied, concluding that finding appropriate teaching approaches and ensuring quality mastery of the educational content must involve the multimodal and personalized use of technology. In this regard, lecturers are encouraged to be "at least one step ahead of the times and constantly learn how to adapt to the didactic process" (Cickovska 2020, 288). The study concluded that, in most cases, lecturers perceive technology as a tool for researching and presenting information. In contrast, for students, technology teaches them what it is, how it works, and where it can be found. Students prefer independent and interactive learning, and in this context, digital tools are primarily used for communication, interaction with other learners, and demonstrating their perceptions through multimodal interaction.

Several studies indicate that written texts, manuals, traditional graphics, notes, and whiteboards are the most commonly used conventional resources in the classroom (Edyburn 2011; Moon et al. 2012). Currently, technological resources are becoming increasingly significant, and the use of such tools should enhance the educational process. The application of virtual learning platforms is also growing, serving various purposes such as training, communication, administration, and supporting lecturers (Chowdhury 2020).

A team of authors examined the impact of technology and the internet on different forms of learning and knowledge acquisition (Szymkowiak et al. 2021). The study's findings underscore the unique characteristics of Generation Z learners, who exhibit a strong preference for learning through mobile applications and video content over traditional teaching methods. This preference, largely shaped by technology, is driven by their shorter attention span, impatience, global information consumption habits, digital media preference, and constant need for diverse information (Szymkowiak et al. 2021).

One of the latest studies in global literature on the "teaching-learning" relationship explores the role of interactive approaches in educating digital generation students (Kalnitskaya and Maksimochkina 2023). The study identifies learners' priorities based on their characteristics, and from this, it derives the main features that lecturers should consider when presenting educational content. The authors conclude that using an interactive teaching approach aligns with the digital generation's characteristics, leading to positive effects (Kalnitskaya and Maksimochkina 2023). It is mainly due to the increased potential for enhancing interaction between lecturers and students in the learning environment.

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 97-124 •
doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

Currently, academic lecturers are expected to introduce innovative forms of teaching while maintaining a positive attitude towards novelties and changes and, at times, adopting unconventional work methods.

The concept of generations and their differences is familiar, but current realities lead us to question whether we truly understand the new generation. Individuals within a generation are shaped not only by their temporal position but also by the socio-economic characteristics of their environment. The heterogeneity among individuals of the same generation raised in different countries makes foreign research partially applicable to Bulgarian conditions.

In recent years, higher education in Bulgaria has faced criticism regarding the quality of student preparation. Lecturers motivate, stimulate, and teach students according to their views on effective teaching, but more and more report that engaging students actively is difficult or impossible. Consequently, the results of education decline, affecting lecturers' enthusiasm as well (Iliev et al. 2023). Both lecturers and students increasingly note that the teaching approaches used must align with today's learners' aspirations and expectations.

Therefore, it is crucial to find an appropriate approach for students from different generations, improve teaching styles, and optimize the flow of information during their economics education.

II. Methodology

With its 88-year history, the D. A. Tsenov Academy of Economics has established itself as one of the leading universities in Bulgaria, offering higher education in economics. Based on the strategic mission of the Academy for continual improvement of education quality through modern educational technologies and its own 'know-how' in the training of economists, a team of researchers (including the authors of this article) implemented Project № 5-2023 "Challenges and opportunities for digital economics education of Generation Z," funded by the Institute for Scientific Research of the D. A. Tsenov Academy of Economics, Svishtov, Bulgaria.

II.1. Research objectives and hypotheses development

The research team aimed to investigate whether the lecturers teaching economic disciplines in Bulgarian higher education institutions are applying appropriate methods and approaches to enhance the quality of education and student satisfaction in economics. Additionally, the team sought to identify

the attitudes of different generations towards certain aspects of the teaching approaches used in the education of economic disciplines.

Four hypotheses were built based on the review of literary sources, including research on the behaviour of Generation Z.

First hypothesis: Generation Z students prefer to present new knowledge accompanied by "evidence"—examples from practice, figures, illustrations, video content, etc.

Second hypothesis: Generation Z students prefer the lecturer's behaviour to involve them in the use of technology and to have the freedom of two-way instructor-learner communication.

Third hypothesis: There is a relationship between the characteristics of different generations, the preferred learning methods, and the acquisition of new knowledge in economics.

Fourth hypothesis: The methods of teaching economic subjects need to catch up to the development of technology and correspond to the ways of learning of Generation Z.

II.2. Methods and instruments

A descriptive research strategy was used to determine whether there are any dependencies between belonging to a specific worship group and one's attitude toward the learning process. The data were collected directly from the study participants. The most suitable descriptive method for gathering primary quantitative data was chosen to be a survey conducted among the respondents. The data were collected through an online survey with a structured questionnaire and pre-formulated answers.

The survey consists of 21 questions. Five describe the characteristics of the surveyed population (age, gender, course, type of education, educational institution). The remaining questions were divided into three groups.

The first group, which includes nine questions, aims to assess students' preferences regarding methods of presenting the educational content and includes the following questions:

Question 1: Do you accept the method where the teacher dictates and you take notes?

Question 2: Do you accept the method where the teacher uses presentations with a predominant text part during lectures?

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Question 3: Do you accept the teacher's use of presentations with relevant figures and illustrations on each slide to reinforce your visual memory?

Question 4: Do you accept the method where the teacher uses video content developed by him/her or freely available on the Internet (for example, on YouTube)?

Question 5: Do you accept the teacher's method of using case studies that he/she sets to solve during class?

Question 6: Do you accept the method where the teacher includes practical examples in his/her presentations?

Question 7: Do you accept the method where the teacher includes links to additional information during lectures in his/her presentations?

Question 8: Do you accept the method where the teacher uses short tests (up to 1-2 questions) to check whether you have mastered the current material?

Question 9: Do you accept how the teacher makes the presentations and materials freely available to you?

The second group, which includes four questions, aims to assess students' preferences regarding the lecturer's behaviour during lectures and includes the following questions:

Question 1: Do you accept the approach where the teacher takes short breaks with a change of topic?

Question 2: Do you accept the approach where the teacher encourages (allows) you to interrupt him/her and ask him/her questions?

Question 3: Do you accept the approach where the teacher divides extended topics (lectures) into smaller parts?

Question 4: Do you accept the approach where the teacher encourages you to use your phones for educational purposes during lectures?

These two groups, responses were based on balanced rating scales with a neutral position (Yes; Rather yes; I cannot decide; Rather no; No).

In **the third group**, students were asked to rate their level of agreement with the following three statements:

Statement 1: Higher school teaching methods must suit my way of learning.

Statement 2: Teaching methods in higher education must catch up to technological development.

Statement 3: Teachers do not use new technologies for interactive lecture learning.

A balanced rating scale with a neutral position (Totally agree; Agree; I cannot decide; Disagree; Totally disagree) was used to assess the level of agreement.

Two-dimensional distributions in the form of cross-tabulations were used to present the results. In these tables, responses to the questions were presented in rows, and generations were represented in columns. The ordinal (rank) scales were used to represent the order relationships between categories of a given variable. Kendall's tau-b and Spearman's rank correlation coefficients were used to measure the dependencies between generations and responses to the questions. The following scale was employed for interpreting the coefficient values: $0<R<0.3$ – weak correlation; $0.3<R<0.5$ – moderate correlation; $0.5<R<0.7$ – significant correlation; $0.7<R<0.9$ – high correlation; $0.9<R<1$ – very high correlation. IBM SPSS software was used for the calculations.

II.3. Sample population and description

The study's target population consists of students enrolled in economics-related programs at higher education institutions in Bulgaria. According to data from the National Statistical Institute (National Statistical Institute – NSI 2023), for the academic year 2022/2023, there were 37,403 students enrolled in programs in the "Business and Administration" field, and these students represent the study's target population.

The survey was conducted at the end of the academic year, from June to September 2023. The questionnaire was administered online using Google Forms through a profile of a research team member.

After receiving permission from the administrations of universities offering economics programs, letters were sent to the students' official email addresses, inviting them to participate in the survey. Along with the provided link to the questionnaire, students were informed that the results would be used solely for research purposes and that completing the survey was voluntary. The questionnaire is anonymous, does not collect personal information, and the respondent cannot be identified through it.

With a population size of 37,403 students, the respondents formed a sample size of 662 respondents, achieving a confidence level of 99.056% and a margin of error of 3.78%.

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doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

The gender distribution reveals that 72.81% (482 respondents) are female, while 27.19% (180 respondents) are male. There is a balanced distribution across academic years: 15.71% are in the first year, 27.79% in the second year, 20.85% in the third year, 23.26% in the fourth year, and 12.39% are enrolled in master's programs. Regarding the mode of study, 47.43% are in full-time programs, 22.05% in part-time, and 30.51% in distance learning.

III. Results

The respondents were divided into three generations (Table 1.) based on their indicated age. Generation Z includes students up to 26, including those born between 1997 and 2010. They represent 48% (318 respondents). Generation Y includes students between the ages of 27 and 42 or those born between 1981 and 1996. They are 40% (264 respondents). Generation X consists of students over 43 years old or those born between 1965 and 1980. They are 12% (80 respondents). On the one hand, the results prove the already mentioned ageing, but on the other hand, they allow comparisons to be made between generations.

Table 1

Distribution of respondents by generation

Generation	Years	Born between	Number of respondents	Percentage
Gen Z	up to 26	1997 and 2010	318	48%
Gen Y	between 27 and 42	1981 and 1996	246	40%
Gen X	over 43	1965 and 1980	80	12%
Total	-	-	**662**	**100%**

The first group includes nine questions (*Table 2*.) concerning different methods of presenting new knowledge by the lecturer – taking notes, text, illustrations, video, the use of examples and case studies from practice, links with additional information, control questions, providing for free use of the materials from the lecture.

Table 2

Methods of presentation of learning content

Question 1: Do you accept the method where the teacher dictates and you take notes?								
Answer	Generation X		Generation Y		Generation Z		Total	
Yes	30	38%	146	55%	186	58%	362	55%
Rather yes	34	43%	64	24%	72	23%	170	26%
I cannot decide	6	8%	24	9%	14	4%	44	7%
Rather, no	10	13%	22	8%	34	11%	66	10%
No	0	0%	8	3%	12	4%	20	3%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Question 2: Do you accept the method where the teacher uses presentations with a predominant text part during lectures?								
Answer	Generation X		Generation Y		Generation Z		Total	
Yes	38	48%	152	58%	174	55%	364	55%
Rather yes	24	30%	62	23%	74	23%	160	24%
I cannot decide	10	13%	20	8%	20	6%	50	8%
Rather no	8	10%	24	9%	32	10%	64	10%
No	0	0%	6	2%	18	6%	24	4%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Question 3: Do you accept the method where the teacher uses presentations with relevant figures and/or illustrations on each slide to reinforce your visual memory?								
Answer	Generation X		Generation Y		Generation Z		Total	
Yes	58	73%	190	72%	232	73%	480	73%
Rather yes	20	25%	62	23%	60	19%	142	21%
I cannot decide	0	0%	10	4%	18	6%	28	4%
Rather no	2	3%	0	0%	4	1%	6	1%
No	0	0%	2	1%	4	1%	6	1%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 97-124 •
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Question 4: Do you accept the method where the teacher uses video content developed by him/her or freely available on the Internet (for example, on You tube)?								
Answer	Generation X		Generation Y		Generation Z		Total	
Yes	52	65%	194	73%	198	62%	444	67%
Rather yes	18	23%	42	16%	74	23%	134	20%
I cannot decide	8	10%	20	8%	28	9%	56	8%
Rather no	2	3%	6	2%	10	3%	18	3%
No	0	0%	2	1%	8	3%	10	2%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Question 5: Do you accept the method where the teacher uses case studies that he/she sets to solve during the class?								
Answer	Generation X		Generation Y		Generation Z		Total	
Yes	42	53%	170	64%	210	66%	422	64%
Rather yes	26	33%	52	20%	68	21%	146	22%
I cannot decide	8	10%	32	12%	20	6%	60	9%
Rather no	4	5%	6	2%	10	3%	20	3%
No	0	0%	4	2%	10	3%	14	2%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Question 6: Do you accept the method where the teacher includes practical examples in his/her presentations?								
Answer	Generation X		Generation Y		Generation Z		Total	
Yes	72	90%	216	82%	276	87%	564	85%
Rather yes	8	10%	36	14%	32	10%	76	11%
I cannot decide	0	0%	8	3%	6	2%	14	2%
Rather no	0	0%	2	1%	0	0%	2	0%
No	0	0%	2	1%	4	1%	6	1%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**

Question 7: Do you accept the method where the teacher includes in his/her presentations links to additional information during the lectures?								
Answer:	Generation X		Generation Y		Generation Z		Total	
Yes	42	53%	184	70%	172	54%	398	60%
Rather yes	22	28%	34	13%	48	15%	104	16%
I cannot decide	10	13%	32	12%	54	17%	96	15%
Rather no	6	8%	8	3%	28	9%	42	6%
No	0	0%	6	2%	16	5%	22	3%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Question 8: Do you accept the method where the teacher uses short tests (up to 1-2 questions) to check whether you have mastered the current material?								
Answer:	Generation X		Generation Y		Generation Z		Total	
Yes	44	55%	166	63%	172	54%	382	58%
Rather yes	26	33%	66	25%	76	24%	168	25%
I cannot decide	8	10%	22	8%	46	14%	76	11%
Rather no	2	3%	6	2%	8	3%	16	2%
No	0	0%	4	2%	16	5%	20	3%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Question 9: Do you accept the method by which the teacher makes the presentations and/or materials freely available to you?								
Answer:	Generation X		Generation Y		Generation Z		Total	
Yes	68	85%	214	81%	244	77%	526	79%
Rather yes	10	13%	34	13%	40	13%	84	13%
I cannot decide	2	3%	14	5%	14	4%	30	5%
Rather no	0	0%	0	0%	10	3%	10	2%
No	0	0%	2	1%	10	3%	12	2%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**

The calculated correlation coefficients between the generations and the answers to the questions did not show the presence of such (*Table 3*.). All the coefficients have a weak correlation dependence with values below 0,2.

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 97-124 •
doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

Table 3

Correlation coefficients between generations and the answers to the questions

Questions …: Do you accept the method where the teacher …	Kendall's tau-b	Spearman's (R)
1: … dictates and you take notes?	.069*	.077*
2: … uses presentations with a predominant text part during lectures?	-.006	-.007
3: … uses presentations with relevant figures and/or illustrations on each slide to reinforce your visual memory?	-.005	-.005
4: … uses video content developed by him/her or freely available on the Internet (for example, on You tube)?	-.072*	-.079*
5: … uses case studies that he/she sets to solve during the class?	.056	.061
6: … includes practical examples in his/her presentations?	.017	.018
7: … the teacher includes in his/her presentations links to additional information during the lectures?	-.099**	-.112**
8: … uses short tests (up to 1-2 questions) to check whether you have mastered the current material?	-.075*	-.083*
9: … makes the presentations and/or materials freely available to you?	-.077*	-.082*

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Ranking in order of approval of the various methods of presentation of the learning content by the lecturer (*Table 4*.), in the first place, students put the use of examples from practice with 96% positive answers (summed answers "yes" and "rather yes"). They are followed by the use of more figures and illustrations with 94%. The last two places are presentations with predominant text with 79% and links with additional information during a lecture with 76% approval.

Table 4

Ranking of methods for presenting the learning content, according to the percentage of positive responses

Rank	**Questions …:** Do you accept the method where the teacher …	Positive answers (yes + rather yes)
1	**6:** … includes practical examples in his/her presentations?	96%
2	**3:** … uses presentations with relevant figures and/or illustrations on each slide to reinforce your visual memory?	94%
3	**9:** … makes the presentations and/or materials freely available to you?	92%
4	**4:** … uses video content developed by him/her or freely available on the Internet (for example, on You tube)?	87%
5	**5:** … uses case studies that he sets to solve during the class?	86%
6	**8:** … uses short tests (up to 1-2 questions) to check whether you have mastered the current material?	83%
7	**1:** … dictates and you take notes?	81%
8	**2:** … uses presentations with a predominant text part during lectures?	79%
9	**7:** … includes in his/her presentation's links to additional information during the lectures?	76%

The second group includes four questions analysing the lecturer's behaviour during a lecture, shown in Table 5. Four aspects of behaviour were investigated such as short breaks to change the topic, tolerance of students asking questions, dividing the big topics into small parts, the use of mobile phones in the educational process during a lecture.

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doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

Table 5

Acceptance of the lecturer's behaviour during a lecture

Question 1: Do you accept the approach where the teacher takes short breaks with a change of topic?								
Answer:	Generation X		Generation Y		Generation Z		Total	
Yes	30	38%	106	40%	126	40%	262	40%
Rather yes	12	15%	66	25%	48	15%	126	19%
I cannot decide	22	28%	60	23%	68	21%	150	23%
Rather no	14	18%	20	8%	50	16%	84	13%
No	2	3%	12	5%	26	8%	40	6%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Question 2: Do you take the approach where the teacher encourages (allows) you to interrupt him/her and ask him/her questions?								
Answer:	Generation X		Generation Y		Generation Z		Total	
Yes	40	50%	126	48%	206	65%	372	56%
Rather yes	30	38%	86	33%	66	21%	182	27%
I cannot decide	6	8%	26	10%	28	9%	60	9%
Rather no	2	3%	20	8%	10	3%	32	5%
No	2	3%	6	2%	8	3%	16	2%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Question 3: Do you accept the approach where the teacher divides long topics (lectures) into smaller parts?								
Answer:	Generation X		Generation Y		Generation Z		Total	
Yes	60	75%	174	66%	250	79%	484	73%
Rather yes	16	20%	68	26%	46	14%	130	20%
I cannot decide	4	5%	10	4%	14	4%	28	4%
Rather no	0	0%	8	3%	4	1%	12	2%
No	0	0%	4	2%	4	1%	8	1%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**

Question 4: Do you accept the approach where the teacher encourages you, during lectures, to use your phones for educational purposes?								
Answer:	Generation X		Generation Y		Generation Z		Total	
Yes	28	35%	122	46%	182	57%	332	50%
Rather yes	22	28%	62	23%	52	16%	136	21%
I cannot decide	20	25%	42	16%	46	14%	108	16%
Rather no	4	5%	26	10%	20	6%	50	8%
No	6	8%	12	5%	18	6%	36	5%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**

This group of questions is needed to differentiate responses between different generations. The calculated Kendall's tau-b and Spearman's (Rs) coefficients for correlation between generations and the questions' answers did not show such presence (Table 6.). All coefficients show weak correlation dependence with values below 0,2.

Table 6

Correlation coefficients between generations and the answers to the questions

Questions …: Do you accept the approach where the teacher …	Kendall's tau-b	Spearman's (R)
1: … takes short breaks with a change of topic?	-.041	-.048
2: … encourages (allows) you to interrupt him/her and ask him/her questions?	.121**	.134**
3: … divides long topics (lectures) into smaller parts?	.081*	.087*
4: … encourages you, during lectures, to use your phones for educational purposes?	.112**	.126**

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Ranking in order of approval the various aspects of the lecturers' behaviour (*Table 7.*), in the first place, the students divided extended topics into smaller parts with 93% positive answers (summed answers "yes" and "rather yes"). After that, the lecturer's approval is ordered to be interrupted during a lecture, and questions are asked by 83%. In the last two places are respectively the use of mobile phones for educational purposes during a lecture with 71% and the use of short breaks (breaks) with a change of topic

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doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

during a lecture with only 59% approval, which is the lowest of all elements of the presentation and the lecturer's ideas during the lecture.

Table 7

Ranking of the teacher's behaviour according to positive responses

Rank	Questions …: Do you accept the approach where the teacher …	Positive answers (yes + rather yes)
1	**3:** … divides long topics (lectures) into smaller parts?	93%
2	**2:** … encourages (allows) you to interrupt him/her and ask him/her questions?	83%
3	**4:** … encourages you, during lectures, to use your phones for educational purposes?	71%
4	**1:** … takes short breaks with a change of topic?	59%

Respondents were asked to rate to what extent they agreed with three statements regarding teaching methods and using new technologies in the educational process (Table 8.). About a quarter of the students need help deciding on all three statements. The three statements were purposefully set with a negative connotation – the teaching methods did not suit their learning style, teaching methods lag behind technology, and teachers do not use new technologies. Guided by the understanding that people more readily agree with positive statements, to avoid responses given on impulse, were purposefully reversed in the negative connotation, requiring careful reading and understanding of the question.

Table 8

Degree of agreement with the statements

Statement 1: The teaching methods in higher schools do not suit my way of learning.								
Degree of agreement:	Generation X		Generation Y		Generation Z		Total	
Totally agree	2	3%	14	5%	12	4%	28	4%
Agreed	2	3%	24	9%	50	16%	76	11%
I cannot decide	18	23%	52	20%	98	31%	168	25%
Disagree	48	60%	144	55%	116	36%	308	47%
Totally disagree	10	13%	30	11%	42	13%	82	12%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**

Statement 2: Teaching methods in higher education are lagging behind the development of technology.								
Degree of agreement:	Generation X		Generation Y		Generation Z		Total	
Totally agree	2	3%	18	7%	40	13%	60	9%
Agreed	8	10%	40	15%	76	24%	124	19%
I cannot decide	22	28%	56	21%	78	25%	156	24%
Disagree	40	50%	124	47%	96	30%	260	39%
Totally disagree	8	10%	26	10%	28	9%	62	9%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**
Statement 3: Teachers do not use new technologies for interactive learning in lectures.								
Degree of agreement:	Generation X		Generation Y		Generation Z		Total	
Totally agree	2	3%	12	5%	30	9%	44	7%
Agreed	8	10%	44	17%	54	17%	106	16%
I cannot decide	26	33%	52	20%	88	28%	166	25%
Disagree	42	53%	128	48%	118	37%	288	44%
Totally disagree	2	3%	28	11%	28	9%	58	9%
Total	**80**	**100%**	**264**	**100%**	**318**	**100%**	**662**	**100%**

Compared to the previous ones, this group of questions shows a slight difference in answers between different generations. The values of the calculated coefficients Kendall's tau-b and Spearman's (Rs) for correlation between generations and the answers to the questions are the highest in this group compared to the others (Table 9.); however, the coefficients show a weak correlation dependence with values below 0,2.

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doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

Table 9

Correlation coefficients between generations and the answers to the questions

Statements	Kendall's tau-b	Spearman's (R)
Statement 1: The teaching methods in higher schools do not suit my way of learning.	.125**	.142**
Statement 2: Teaching methods in higher education are lagging behind the development of technology.	.169**	.194**
Statement 3: Teachers do not use new technologies for interactive learning in lectures.	.090**	.104**

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

The positive sign of the correlation coefficients shows that older students show more significant disagreement with the statements than Generation Z; however, even among the younger generation, the share of those who disagree exceeds those who agree (*Table 10*.).

Table 10

Agreed v/s Disagree in answers to the statements

Statements	Agreed (totally agree + agreed)		Disagree (totally disagree + disagree)	
	Gen X	Gen Z	Gen X	Gen Z
1: The teaching methods in higher schools do not suit my way of learning.	6%	20%	73%	49%
2: Teaching methods in higher education are lagging behind the development of technology.	13%	37%	60%	39%
3: Teachers do not use new technologies for interactive learning in lectures.	13%	26%	56%	46%

IV. Discussion

The distribution of the respondents based on the indicated age showed a relatively high percentage of students over the age of 43, who are classified as Generation X. Recently, a kind of "ageing" has been observed, i.e.

increasing the average age of active students in Bulgaria. This trend, on the one hand, is due to the efforts made in the National Strategy for Lifelong Learning (Ministry of Education and Science 2014), motivating adults to get involved in different forms of learning (including higher education). On the other hand, the ageing of the population as a whole and the increasingly small number of young people graduating from secondary education leads to a reduction in the competitive pressure for university places and motivates people who did not originally intend to pursue higher education to start studying in graduate school at a later stage in their lives.

There is a clear separation of age groups in the primary and secondary levels of education, which are obligatory for all students. Students in these levels are typically of the same age or closely aligned in age, with any age discrepancies typically limited to one or two years, as mandated by regulatory norms established by the state. In contrast, higher education is not mandatory, and individual student choices entirely drive the composition of graduation classes and student groups within universities. As a result, the intermingling of different generations becomes possible and increasingly prevalent. Until about 25-30 years ago, a relatively stable age homogeneity was observed in higher education in Bulgaria. However, the prevailing trend of an "ageing" student population has transformed this landscape.

This "ageing" trend opens up new opportunities to analyse generational differences from a different perspective. Suppose representatives of different generations are studied independently. In that case, each is in their environment, and then comparisons are made, and the results will be the same. However, if representatives of generations are studied and placed in the same natural environment, the results will be different. The objects of research (students of the three generations), placed in the same learning environment in the higher educational institution, interact unnameable, subsequently leading to a change in themselves. That is why the results differ.

The first hypothesis was categorically confirmed. Students prefer visualizing the presented knowledge using visual elements (figures, illustrations, video content). They want the learning content to be presented and shown (proven) with an example from practice, graphic, illustration, or video. That is why visual elements are positioned in the first four positions in Table 3.

The second group of questions is related to the lecturer's behaviour during the lecture. They aim to check to what extent the generations (mainly Generation Z) adopt behaviours that conform to some of the main characteristics of the younger generation. The characteristic of Generation Z is their short attention span and preference to receive information divided into smaller parts

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 97-124 •
doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

in smaller volumes. Answers to questions 1 and 3 showed a preference for breaking long lectures into smaller parts, but breaks with topic changes could have been better received. The freedom to interrupt and ask questions of the lecturer was placed second as approval (see Table 6.). The shortening of the distance, through the freedom for two-way communication between lecturer and students, incentivizes real inclusion in the learning process, not just reporting presence in the classroom. Incorporating their smartphones into the learning process is rated highest by Gen Z compared to their older counterparts. There are already plenty of apps (e.g. Kahoot!) that lecturers can use to make their lectures engaging and interactive using students' electronic devices. All of this confirms the second hypothesis. Of course, going to extremes does not always lead to a positive result.

The analysis of the results did not confirm the initial expectations of the third hypothesis. On the contrary, they were categorically refuted.

The survey results give reason to reject the third hypothesis categorically. There are no differences between generations regarding preferences for one or the other methods lecturers use to present the learning content. It is seen from the shares of the different responses and the calculated correlation coefficient values. Arguments in support of the third hypothesis were the result of the many publications describing a new, different way of learning about Generation Z compared to the preceding Generations Y and X. If each generation is considered in its time slice, such differentiation will be found, but if they are placed in current conditions, under the same circumstances, differences between them would hardly be detected. The reason for this can be the overall development of technologies and teaching methods. The drive has always been to improve and facilitate users by adapting to new technologies and discovering new teaching methods. The goal is to make learning content as accessible and valuable as possible, regardless of which generation the economics students belong to. A problem would arise in the reverse situation if we used methods and techniques from a quarter of a century ago. It may be suitable for the elderly Generation X and give the expected results, but for the young Generation Z, it will give negative ones.

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The positive sign of the correlation means that as age increases, positive responses decrease, and the negative sign shows us that as age increases, positive responses increase. Consequently, note-taking and case studies during lectures are preferred by younger generations slightly more than their older counterparts. For questions 2 to 4 and 7 to 9, the negative sign proves that they are more preferred, albeit slightly, than the older generations.

Rejecting the third hypothesis should eliminate the concerns of lecturers who face an audience of representatives of different generations. If the lecturer has prepared his/her presentation of the educational content well and the methods used are correctly selected, the information he presents will be accepted by all generations. In such a case, the choice of methods of presenting the learning content should be tailored to the attitudes of the younger generation in the audience.

Attention can also be directed to the answers to the question, "Do you accept the method where the teacher dictates and you take notes?" By its nature, this is an archaic teaching technique, and it was here that the research team expected that this method would be firmly rejected or have a small number of supporters, mainly among Generation X. The results show a very high percentage of approval among all three generations (see Table 2.). If we sum up the answers "yes" and "rather yes", we will see that 81% of representatives of generations X and Z approve of the method, and 79% of generation Y. If for older people this percentage is acceptable, then for Generation Z it is shocking. If 20-30 years ago, information was not so easily accessible and students had to take notes, now Generation Z has access to all kinds of information. In this regard, it does not make sense for Gen Z to keep notes. It is where the answer to the question, "Why do they tend to keep notes?" lies. One reason is the desire for two "sheets" of notes (more likely in e-version, on a laptop or tablet). They have synthesized knowledge provided by the teacher. It eliminates the need to sift through numerous Internet sources from which to select and process the relevant content.

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 97-124 •
doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

The fourth hypothesis did not receive full proof, but it must be rejected, too. Yes, let us compare the responses between the different generations. Z are the ones who agree to the greatest extent that teaching methods lag behind the development of technology and do not correspond to their ways of learning (see Tables 7. and 9.). However, the relative shares of disagreement with the statements also exceeded those of agreement.

It may seem reassuring to Bulgaria teachers that their students receive their teaching methods relatively well and that the technological lag is not too significant, or perhaps the myth that Generation Z is on the cutting edge of technology is only partially true for Bulgarian students.

Upon reviewing the literature, no entirely analogous studies were found. However, the research conducted by Nina Pološki and Ana Aleksić can be mentioned, in which the preferences for active and passive teaching methods among Generation Y students were analysed, with a focus on the role of creativity and learning styles. The results reveal that students with higher creativity prefer active methods such as internships and interactive exercises that stimulate their imagination and develop problem-solving skills. In contrast, students with theoretical preferences find lectures with examples and teacher feedback more useful. The study emphasizes the importance of adapting teaching strategies to the individual characteristics of students (Pološki and Aleksić 2020). The authors note that educators should create flexible learning environments that balance active and passive methods to meet the needs of all students. For example, reflectors benefit from individual projects, while pragmatists prefer practical training.

However, developing an effective strategy to cater to students from diverse age groups has consistently remained a paramount concern for educators in their professional endeavours. In recent years, the enhancement of pedagogical methods and the refinement of the dissemination of information during the educational process for economics students have assumed a growing significance.

V. Conclusion

In conclusion, this study emphasizes the need for a flexible teaching approach that meets the diverse needs and expectations of different generations of students in Bulgaria. The main goal of the research was to identify relationships between generations and their preferences for specific teaching methods in economics disciplines. By examining the attitudes of students from various age groups, the study explores the extent to which teaching methods need to be adapted to the specific characteristics of each

generation, particularly Generation Z, which shows a preference for visual and interactive learning approaches.

Members of Generation Z anticipate that knowledge should be readily accessible and easily attainable. Lengthy texts, which may lead to disorientation or the provision of supplementary information, while theoretically accessible in their digital surroundings (via Internet links), tend to elicit less enthusiasm from them.

The results confirm the hypothesis that Generation Z students favour visual elements and practical examples in learning. Young students exhibit a strong need for learning materials enriched with figures, illustrations, and video content, which help them absorb new information more effectively. The second hypothesis is also confirmed, as Generation Z prefers two-way communication with instructors, opportunities for active participation in discussions, and the use of digital devices in the learning process. This reflects their desire to take an active role in knowledge acquisition.

The third hypothesis, suggesting significant differences between generations in terms of preferred teaching methods, is decisively rejected. Data shows no significant relationship between generational affiliation and preferences for teaching methods. This indicates that well-designed, modern teaching methods can meet the needs of students from all ages if effectively planned and implemented. This finding is particularly valuable for educators, as it demonstrates that visual and interactive methods, if properly adapted, can be effective for all generations in the classroom.

The fourth hypothesis, which posits that teaching methods in economics disciplines lag behind technological development and the needs of Generation Z, did not receive categorical support. Although some Generation Z students feel that a greater degree of digitalization is needed in the learning process, the majority do not share the view that teaching is significantly lagging behind technological trends. This may be because, while young people are oriented towards technology, they also value direct contact and the clear structuring of knowledge offered by instructors.

In summary, the study offers important insights for educators in economics and other disciplines. To meet the demands of today's students and ensure an effective learning process, educators should integrate visual and interactive approaches that enable active engagement and involvement of the audience. Such adaptability would not only increase student satisfaction and motivation but would also facilitate intergenerational dialogue, fostering a conducive environment for the exchange of knowledge and experience across age groups.

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 97-124 •
doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 97-124 •
doi: https://doi.org/10.18543/tjhe.2870 • http://www.tuningjournal.org/

Determinants of the successful graduation of undergraduate students from a Peruvian university dental school over six years

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doi: https://doi.org/10.18543/tjhe.3057

Received: 21 May 2024
Accepted: 28 February 2025
E-published: June 2025

Abstract: Terminal efficiency is an indicator that evaluates the productivity of a higher education institution and reflects a crucial aspect of the quality of its offered programmes. This study aimed to determine the successful graduation of undergraduate students from a dental school at a Peruvian university over six years, using the terminal efficiency indicator. The database was created using information

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Acknowledgements: Authors would like to thank the Facultad de Estomatología de la Universidad Peruana Cayetano Heredia (UPCH), Peru.

Funding: None.

Conflict of interests: None.

from the institutional repository of the Universidad Peruana Cayetano Heredia; graduates from 2017 to 2022 were selected, their data was downloaded, and statistical analyses were performed. Considering the graduates with documents to qualify for degrees and titles published in the institutional repository (n=291), 70.10% (n=204) of the graduates demonstrated a categorised terminal efficiency as "Up to 1 year", with a mean terminal efficiency of 1.23 years (SD=0.78). The analysis revealed a statistically significant association between the categorised terminal efficiency and the graduation year ($p<0.001$). Furthermore, a statistically significant difference was observed when examining the mean terminal efficiency across different graduation years ($p<0.001$). This study reveals a positive trend in the successful graduation of undergraduate students from a Peruvian university dental school, with a notable improvement in recent years.

Keywords: Education; efficiency; students; dental; universities.

I. Introduction

Higher education plays a vital role in economic development through the provision of advanced knowledge, skills, and competencies beyond secondary education. Universities, as the primary delivery institutions of higher education, are crucial in training highly qualified professionals who contribute significantly to the labour market and, consequently, to national development. The efficiency of these educational institutions is largely determined by their ability to successfully graduate students (Hernández-Falcón, Vargas-Jiménez, and Almuiñas-Rivero 2020, 4).

The conceptual foundation of this study is grounded in established literature on educational efficiency and university trajectories. Terminal efficiency (TE) is an indicator used to evaluate the training activity and, to some extent, the success of a higher education institution, especially in terms of its performance as part of the educational system (Hernández-Falcón, Vargas-Jiménez, and Almuiñas-Rivero 2020, 5). In this context, TE is recognised as the main recommended indicator for evaluating the efficiency of a higher education institution (Hernández-Falcón et al. 2015, 57). However, since it has been calculated in different ways over time, it has given rise to a series of conceptualisations, including those described in the studies by Hernández-Falcón et al. 2020, which defines TE as a percentage proportion between the total number of graduates from a study programme and the total number of students who entered the study programme "n" years earlier, where "n" is the number of years proposed for the completion of said study programme; and Girano-Arévalo et al. 2021, which defines TE as the time that elapses from graduation from a university study programme until obtaining the corresponding professional title.

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 125-144 •
doi: https://doi.org/10.18543/tjhe.3057 • http://www.tuningjournal.org/

Although there is a great variation in the way TE is measured, it can be said that it is optimal when all students complete an academic programme within the established time and that it will not be when they do so over a longer period (Pérez-Reveles 2016, 136). This indicator is used by higher education institutions to measure their productivity and determine how well they are functioning; it also shows the achievements obtained by the educational institutions and reflects, in some way, the quality of the programs offered by the institution (Vanegas-Pissa and Sancho-Ugalde 2019).

The Peruvian higher education system has historically grappled with a myriad of challenges, particularly in the domains of quality assurance and regulatory oversight, prompting recent reforms aimed at establishing more rigorous standards, especially in the training of health science professionals (Asencio Aguedo et al. 2019, 9). Within this context, dentistry assumes a pivotal role in the nation's healthcare infrastructure, making substantial contributions to the prevention, diagnosis, and treatment of oral diseases that affect a significant proportion of the populace (Congreso de la República de Perú 2002). Nevertheless, the persistently high prevalence of dental caries, periodontal diseases, and edentulism across various age cohorts within the Peruvian population raises pertinent questions about the efficacy of current dental education programmes and the prioritisation of oral health within the broader public health agenda (Ministerio de Salud 2015; Ministerio de Salud 2017; Ministerio de Salud 2019). These epidemiological indicators suggest potential inadequacies in both the educational processes designed to produce competent dental surgeons and the establishment of public health priorities at a national level, thereby underscoring the pressing need for dental professionals who are not only technically proficient but also deeply committed to addressing the complex oral health needs of the population (Castillo, Palma, and Cabrera-Matta 2019).

Since 2014, with the approval of Law No. 30220 - University Law, the Peruvian higher education system has instituted a policy whereby the conferment of academic degrees and professional titles is conducted in strict adherence to the academic requirements delineated by individual universities within their respective internal regulations. The minimum prerequisites for attaining a professional title encompass two primary components: firstly, the prior acquisition of a bachelor's degree, and secondly, the successful defence of a thesis or the completion and approval of a professional sufficiency dissertation. Although universities with accreditation may establish additional modalities to those mentioned, and the professional title can only be obtained from the universities where the bachelor's degree was obtained (Congreso de la República de Perú 2014). Thus, within the current legal framework, the

Universidad Peruana Cayetano Heredia, for example, established in 2021 the following modalities for obtaining the professional title of dental surgeon: professional sufficiency dissertation, professional sufficiency exam, research, thesis and publication of original research (Universidad Peruana Cayetano Heredia 2021, 3).

Undergraduate academic programmes in dentistry in Peru are characterised by their comprehensive approach, combining a solid theoretical base with extensive clinical practice. Typically, these programmes span five to six years and have a curricular structure that usually comprises two years of basic and preclinical sciences, followed by three years of intensive clinical training, and culminates with a year of rural and hospital internship. This organisation allows students to progressively acquire the knowledge and skills necessary for their professional practice (Komabayashi et al. 2008, 342). Upon completion of the academic programme, the student graduates with a Bachelor's degree in Stomatology. Then, after the approval of a thesis or professional sufficiency dissertation, or through an additional modality in the case of the Universidad Peruana Cayetano Heredia, they obtain the Professional Title of Dental Surgeon (Komabayashi et al. 2008; Congreso de la República de Perú 2014; Universidad Peruana Cayetano Heredia 2021).

Students who have completed secondary education can access these dentistry programmes through a rigorous selection process, which generally includes an admission exam and, in some cases, the assessment of academic performance in a pre-university study centre. This selectivity seeks to ensure that admitted students have the necessary aptitudes to face the demands of the programme (Komabayashi et al. 2008, 342). Regarding financing, undergraduate dentistry students in Peru have various options available. These include government scholarship programmes such as Beca 18, educational credits offered by government institutions, and self-financing, which promote equity in access to higher education in private and public universities (Komabayashi et al. 2008; Guzmán Centeno 2024). Enrolment in dental schools or faculties of public universities is free; however, an investment is required for the purchase of educational materials, as well as dental supplies and instruments necessary for theoretical and practical academic activities. In private universities, such as the Universidad Peruana Cayetano Heredia, the costs of enrolment and fees per semester or academic year vary, reaching approximate figures of $10,000 per year (Komabayashi et al. 2008, 342).

Thus, these academic programmes are oriented towards developing technical and behavioural competencies that aim to train professionals

Tuning Journal for Higher Education
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doi: https://doi.org/10.18543/tjhe.3057 • http://www.tuningjournal.org/

capable of preventing, diagnosing and effectively treating the most common pathologies of the stomatognathic system, implementing oral health promotion strategies, conducting research that contributes to the advancement of the discipline, and managing dental services efficiently and ethically (Ministerio de Salud 2023). To achieve these objectives, many Peruvian universities invest in modern infrastructure, including laboratories, simulation equipment and public care clinics. This investment in resources and infrastructure is fundamental to provide students with the necessary tools and experiences for their professional development (Komabayashi et al. 2008, 342).

The university journey that a student or a group of students from the same cohort undertakes, from admission to the completion of their university studies, is called the university trajectory. This concept is associated with the monitoring that higher education institutions carry out on the academic performance of their students, including metrics such as approvals and failures. This monitoring allows universities to evaluate various indicators, thus facilitating informed decision-making through effective planning (Gonzáles-Tirado et al. 2019, 2).

The university trajectory has been the subject of extensive research from both the perspective of the educational system and that of the student. However, despite the various approaches to this topic, special attention has been paid to issues such as university dropout rates, additional time required to complete university programmes, the use of ineffective study techniques, among other factors. While studies that focus specifically on university graduation, or research aimed at determining whether students successfully obtain their professional titles, are relatively less common (Petric 2019, 62).

It is known that planning is of utmost importance for any higher education institution, as it ensures the fulfilment of institutional objectives. In this way, effective planning involves the evaluation of various indicators that demonstrate the functioning of the educational system and provide information on the state of the teaching-learning process. This includes the evaluation of university plans and programmes, educational infrastructure and other related factors (Gonzáles-Tirado et al. 2019, 3). Thus, the terminal efficiency indicator is used to evaluate university phenomena and attempt to measure the completion of academic programmes within the time suggested by the university curriculum (Petric 2019, 65).

Graduation from a university programme occurs when an enrolled student accumulates the total credits required by the curriculum and qualifies as a graduate (Román-Gálvez 2023, 2). This status is achieved even if the student has not yet met all the requirements to obtain a degree or a professional

title (Gonzáles-Tirado et al. 2019, 3). Studies conducted in different countries indicate that many students who complete their university programmes do not obtain a professional title due to a series of factors. These factors include the students' prior academic preparation, the quality of teaching and available educational resources, socioeconomic and personal factors of the students, and the complexity and demands of the academic programme. Understanding these factors is essential to develop strategies that improve student retention and academic success (Millo and González 2016, 42).

Successful graduation can be defined as the achievement of all academic and administrative requirements established by an educational programme within the expected or reasonable time frame, as determined by the curricular structure. This achievement reflects both the student's academic preparation and the programme's efficiency in supporting progress towards obtaining a professional title (Hernández-Falcón, Vargas-Jiménez, and Almuiñas-Rivero 2020; Gonzáles-Tirado et al. 2019).

In the case of dentistry, TE has significant implications not only for educational institutions but also for the health system and society in general (Komabayashi et al. 2008). High TE rates suggests that the programme is effective in training professionals, while low rates may indicate the need for interventions to improve the educational process (Pérez-Reveles 2016, 136).

The importance of TE in quality assurance is evidenced by its inclusion in evaluation guidelines across regional accreditation agencies. However, there remains a lack of clarity in defining this concept, which implicitly refers to a quantitative estimation (Herrera et al. 2024). Despite the importance of this indicator, there is a scarcity of updated studies on successful graduation, using the TE, in dentistry programmes in Peru (Girano-Arévalo et al. 2021). This lack of information hinders informed decision-making to improve educational quality and resource planning in the sector. Thus, it is recognised that obtaining professional titles on time is essential, as prolonged delays can harm graduates' employment opportunities and financial security. Therefore, higher education institutions have a great responsibility in optimising the processes that lead to obtaining a professional title. This includes providing adequate academic support, reducing bureaucratic obstacles, and offering guidance to help students meet requirements efficiently.

In this context, the institution's ability to facilitate the process of obtaining a professional title effectively is a critical measure of its overall performance and commitment to student success. In the same vein, the present study seeks to fill this gap by aiming to determine the successful graduation of undergraduate students from a dental school at a Peruvian university over six years, using the terminal efficiency indicator.

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II. Materials and methods

II.1. Study design and population

This cross-sectional study analysed records of undergraduate students from the Dental School of the Universidad Peruana Cayetano Heredia (UPCH) between 2017 and 2022. This timeframe was selected to provide a comprehensive six-year analysis period, following established methodologies from previous studies in dental education (Girano-Arévalo et al. 2021; Carrizales-Poma et al. 2024). The study population comprised all undergraduate dental students who met the inclusion criteria, eliminating potential selection bias that might arise from sampling.

The inclusion criteria were precisely defined to ensure the quality and relevance of the analysed data. Records of all students enrolled in the UPCH's dental academic programme between 2017 and 2022 were included, provided they contained complete information on their current academic status (graduated, or not graduated), and, for students who completed the programme, the graduation date. It is important to note that, due to the public nature of the information used, personal student data such as date of birth, previous educational institution, or other similar details were not accessible.

On the other hand, exclusion criteria were established to ensure the integrity and consistency of the analysed data. Records with incomplete or inconsistent information in any of the fields mentioned in the inclusion criteria were excluded. Additionally, records of exchange students or those who transferred from another university during the study period were not considered, as their academic trajectories might not be representative of the typical experience in UPCH's dental academic programme.

II.2. Variables

The present research considered publication in the UPCH institutional repository as qualitative variable and terminal efficiency as both quantitative and qualitative variables. This metric was selected as a key indicator of successful programme completion, consistent with previous research in dental education (Girano-Arévalo et al. 2021; Carrizales-Poma et al. 2024). Additionally, several covariables were examined, including graduation year, type of document to qualify for degrees and titles, modality for obtaining the professional title of dental surgeon and sex.

Publication in the UPCH institutional repository, as a qualitative variable, comprised two categories: "No", when the document to qualify for degrees and titles was not published at the UPCH institutional repository and "Yes",

when the document to qualify for degrees and titles was published at the UPCH institutional repository. Terminal efficiency (TE), as a quantitative variable, was calculated as the difference in years between the year of submission of the document to qualify for degrees and titles, verified by publication in the UPCH institutional repository, and the graduation year. As a qualitative variable, TE was categorised as "Up to 1 year", when the TE was less than or equal to 1 and "2 years and older", when the TE was greater than or equal to 2. The study period spanned from the first graduate of 2017 to the last graduate of 2022.

Graduation year, a quantitative variable, indicated the year of programme completion at the UPCH Dental School. The type of document to qualify for degrees and titles, a qualitative variable, was categorised as "Individual", when the document to qualify for degrees and titles was prepared by only one university dental school undergraduate student and "Collective", when the document to qualify for degrees and titles was prepared by two or more university dental school undergraduate students.

The modality for obtaining the professional title of dental surgeon refers to the various mechanisms through which the students who have completed the university study programme can obtain their professional title, as a qualitative variable, included several categories as per UPCH regulations. These categories encompass the "professional sufficiency dissertation", an in-service teaching program through which the bachelor demonstrates the graduation competencies acquired throughout the career in a practical way; the "professional sufficiency exam", an exam by which the bachelor demonstrates the professional competences acquired during studies in a theoretical and practical way; "research", a work of an academic nature, through which the graduate must demonstrate that he/she has a general domain of the central aspects developed in the curriculum; "thesis", a work that aims to evaluate and quantify professional competencies within a particular scholarly domain or discipline, it specifically focuses on areas where a knowledge deficit or a practical requirement for professional practice has been identified, thereby addressing crucial gaps in the field; and "publication of original research", which refers to an original research developed by students with the participation of a university professor that has been accepted for publication or published in an indexed scientific journal (Universidad Peruana Cayetano Heredia 2021, 4-7).

Sex, a qualitative variable, denoted the biological and physiological characteristics of university dental school undergraduate students, categorised as "Man" or "Woman".

Tuning Journal for Higher Education
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doi: https://doi.org/10.18543/tjhe.3057 • http://www.tuningjournal.org/

II.3. Statistics

The database was constructed using information obtained from the UPCH Dental School and the UPCH institutional repository. Descriptive analysis was employed to calculate absolute and relative frequencies, whilst associations were assessed using the Chi-square statistical test. In conducting the bivariate analysis, to evaluate whether the data followed a normal distribution, the Kolmogorov-Smirnov test was applied, ensuring the appropriateness of subsequent statistical analyses according to the distribution characteristics. Subsequently, the nonparametric Mann Whitney U and Kruskal Wallis tests were applied as appropriate. These were complemented by relevant post hoc analyses to further elucidate significant findings and explore specific group differences within the dataset. The study adhered to a 95% confidence level, with statistical significance being identified through the application of a p-value threshold of less than 0.05. All statistical analyses were performed using the Stata v. 18.0 software package.

II.4. Ethics

Prior to commencing the administrative processes, approval was obtained from the UPCH Integrated Unit of Research, Science and Technology Management of the Schools of Medicine, Dentistry, and Nursing. The study was conducted in strict accordance with the ethical principles set forth in the Declaration of Helsinki and received formal approval from the Institutional Research Ethics Committee at UPCH (ethics file CONSTANCIA-CIEI-427-39-23, approved on 2 October 2023). It is important to note that the data were published in the UPCH institutional repository. All records were coded to ensure anonymity, this approach guaranteed the confidentiality of the information whilst allowing for comprehensive analysis of the data.

III. Results

Between 2017 and 2022, 86.87% of students (n=291 graduates) from a Peruvian university dental school published some type of document in the institutional repository to qualify for degrees and titles. In 2017, 100% of the students (n=59) complied with repository publication, whilst 2022 saw the lowest percentage, with only 47.83% (n=22) publishing. The 92.10% (n=268) of graduates prepared some type of document to qualify for degrees and titles collectively, whilst 7.90% (n=23) did so individually. For professional title obtainment, 72.16% (n=210) choose research, with professional sufficiency dissertation being the least adopted modality with 2.41% (n=7). Among graduates, 254 were women, of whom 87.40% (n=222)

published some document to qualify for degrees and titles in the institutional repository. Of the male graduates (n=81), 85.19% (n=69) also published. A statistically significant association was found between the publication of some document to qualify for degrees and titles in the institutional repository and graduation year (p<0.001) (Table 1).

Table 1

Peruvian university dental school undergraduate students over six years, with publication in the institutional repository of documents to qualify for degrees and titles

Variables		n	%	Publication in the institutional repository				P*
				No		Yes		
				n	%	n	%	
Total		335	100.00	44	13.13	291	86.87	
Graduation year								
	2017	59	17.61	0	0.00	59	100.00	<0.001
	2018	56	16.72	2	3.57	54	96.43	
	2019	67	20.00	4	5.97	63	94.03	
	2020	55	16.42	7	12.73	48	87.27	
	2021	52	15.52	7	13.46	45	86.54	
	2022	46	13.73	24	52.17	22	47.83	
Type of document to qualify for degrees and titles								
	Individual	23	7.90	0	0.00	23	7.90	-
	Collective	268	92.10	0	0.00	268	92.10	
Modality for obtaining the professional title								
	Research	210	72.16	0	0.00	210	72.16	-
	Thesis	64	21.99	0	0.00	64	21.99	
	Professional sufficiency dissertation	7	2.41	0	0.00	7	2.41	
	Publication of original research	10	3.44	0	0.00	10	3.44	
Sex								
	Man	81	24.18	12	14.81	69	85.19	0.607
	Woman	254	75.82	32	12.60	222	87.40	

n: Absolute frequency. %: Relative frequency. p: Statistical significance.

* Chi-square test.

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Table 2

Categorised terminal efficiency of Peruvian university dental school undergraduate students over six years

Variables		Terminal efficiency (Categorised)				
		Up to 1 year		2 years and older		P*
		n	%	n	%	
Total		204	70.10	87	29.90	
Graduation year						
	2017	58	98.31	1	1.69	<0.001
	2018	45	83.33	9	16.67	
	2019	31	49.21	32	50.79	
	2020	24	50.00	24	50.00	
	2021	24	53.33	21	46.67	
	2022	22	100.00	0	0.00	
Type of document to qualify for degrees and titles						
	Individual	19	82.61	4	17.39	0.172
	Collective	185	69.03	83	30.97	
Modality for obtaining the professional title						
	Research	151	71.90	59	28.10	0.433
	Thesis	41	64.06	23	35.94	
	Professional sufficiency dissertation	6	85.71	1	14.29	
	Publication of original research	6	60.00	4	40.00	
Sex						
	Man	44	63.77	25	36.23	0.188
	Woman	160	72.07	62	27.93	

n: Absolute frequency. %: Relative frequency. p: Statistical significance.

* Chi-square test.

Considering only the graduates with some document for the qualification of degrees and titles published in the institutional repository, 70.10% (n=204) presented a categorised terminal efficiency (TE) of "up to 1 year". In 2022, 100.00% (n=22) of graduates achieved this TE, whilst 2019 saw the lowest percentage at 49.21% (n=31). Among graduates who collectively prepared some document to qualify for degrees and titles, 69.03% (n=185) had a TE of

"up to 1 year", compared to 82.61% (n=19) of those who worked individually. Research, as a modality for obtaining the professional title, presented the highest percentage of TE of "up to 1 year" at 71.90% (n=151), whilst publication of original research showed the lowest at 60.00% (n=6). Of female graduates with some document published in the institutional repository (n=222), 72.07% (n=160) had a TE of "up to 1 year", compared to 63.77% (n=44) of male graduates (n=69). A statistically significant association was identified between categorised TE and graduation year ($p<0.001$) (Table 2).

The mean TE of graduates between 2017 and 2022 was 1.23 years (SD=0.78). The year 2022 recorded the lowest mean TE at 0.55 years (SD=0.74), whilst 2020 presented the highest at 1.60 years (SD=0.68). Graduates who published some documents individually in the repository had a mean TE of 1.13 years (SD=0.81), compared to 1.24 years (SD=0.77) for those publishing collectively. The professional sufficiency dissertation modality showed the lowest mean TE at 1.14 years (SD=0.38), whilst the thesis had the highest mean TE at 1.27 years (SD=0.78). Female graduates with some documents published in the institutional repository to qualify for degrees and titles presented a mean TE of 1.21 years (SD=0.76), compared to 1.28 years (SD=0.82) for male graduates. Upon analysis, a statistically significant difference became evident when examining the graduation year. Specifically, the mean TE in 2022 exhibited a statistically significant difference compared to the preceding years ($p<0.001$) (Table 3).

Table 3

Terminal efficiency in years of Peruvian university dental school undergraduate students over six years

Variables		Terminal efficiency (In years)		
		X	SD	p
Total		1.23	0.78	
Graduation year				
	2017	1.02abcd	0.13	<0.001*
	2018	1.09efg	0.73	
	2019	1.44aeh	1.01	
	2020	1.60bfi	0.68	
	2021	1.29cj	0.76	
	2022	0.55dghij	0.74	

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doi: https://doi.org/10.18543/tjhe.3057 • http://www.tuningjournal.org/

Variables		Terminal efficiency (In years)		
		X	SD	p
Type of document to qualify for degrees and titles				
	Individual	1.13	0.81	0.422**
	Collective	1.24	0.77	
Modality for obtaining the professional title				
	Research	1.22	0.78	0.903*
	Thesis	1.27	0.78	
	Professional sufficiency dissertation	1.14	0.38	
	Publication of original research	1.20	1.03	
Sex				
	Man	1.28	0.82	0.492**
	Woman	1.21	0.76	

X: Mean. SD: Standard deviation. p: Statistical significance.

* Kruskal-Wallis test; post hoc Mann Whitney U test, same letters show statistically significant difference ($p<0.05$).

** Mann Whitney U test.

IV. Discussion

The findings of this study reveal notable patterns in terminal efficiency (TE) at the Dental School of Universidad Peruana Cayetano Heredia, with a mean TE of 1.23 years and a marked improvement trend culminating in an optimal value of 0.55 years in 2022. These results demonstrate a more favourable outcome compared to previous studies in Peru, such as that conducted by Girano-Arévalo et al. (2021), which reported a mean TE of 1.67 years.

The observed fluctuations in TE rates, particularly the decline between 2018 and 2020, can be attributed to multiple factors, including institutional preparations for the National System for Evaluation, Accreditation and Certification of Educational Quality (SINEACE) accreditation and the unprecedented impact of the coronavirus disease (COVID-19) pandemic. This period coincided with restrictions in modalities for obtaining the professional title and disruptions to clinical practices and research activities, which inherently affected graduation timeframes (Liu and You-Hsien Lin

2021). The subsequent improvement in TE rates, especially the marked enhancement in 2022, suggests the effectiveness of institutional adaptations and potentially reflects the positive influence of technological innovations implemented during the pandemic period.

The relationship between TE and educational quality merits careful consideration. As Herrera et al. (2024) emphasise, high TE rates alone do not necessarily indicate educational quality, nor do lower rates automatically suggest poor quality. Rather, TE serves as a valuable tool for academic monitoring and institutional improvement, encompassing both quantitative and qualitative aspects of educational delivery. This perspective aligns with contemporary approaches to higher education assessment, where TE is viewed as one component within a broader framework of quality indicators.

In the context of accreditation, the findings gain additional significance. Latin American accreditation systems, including Peru's SINEACE, incorporate diverse quality indicators that reflect both institutional effectiveness and societal impact (Carvalho and Malavasi 2020). The improvement in TE rates at our institution coincides with successful accreditation efforts, suggesting effective alignment between institutional practices and quality standards. However, as Duarte and Vardasca (2023) note, accreditation approaches vary significantly across regions, emphasising the importance of contextualising performance metrics within local educational frameworks whilst maintaining international standards.

The absence of significant differences in TE across various parameters—including individual versus collective work, different modalities for obtaining the professional title, and student gender—suggests that other factors may more substantially influence graduation timing. This observation aligns with Millo and González's (2016) findings regarding the complex interplay of individual and institutional factors affecting degree completion. These factors may include socioeconomic circumstances, academic support structures, and institutional processes, aspects that warrant further investigation.

The study's limitations, particularly regarding the use of aggregated data, echo concerns raised by Herrera et al. (2024) about the traditional approach to TE calculation. The inability to control for individual variables that significantly impact TE calculations suggests the need for more nuanced evaluation methods. Future research would benefit from incorporating individualised data and considering additional variables that might influence graduation timing.

The substantial improvement in TE observed in 2022 deserves particular attention within the broader context of institutional quality assurance. As

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doi: https://doi.org/10.18543/tjhe.3057 • http://www.tuningjournal.org/

Gerón-Piñón et al. (2021) argue, such indicators are crucial for improving educational quality and achieving accreditation standards. The positive trend in our institution's TE rates may reflect successful implementation of quality improvement initiatives, though sustained monitoring is necessary to confirm this trend's stability.

The implications of this study extend beyond mere statistical analysis. As emphasised by Herrera et al. (2024), TE should be viewed as an instrument for academic monitoring and improvement rather than solely as a quality metric. This perspective suggests that institutions should investigate not only their TE rates but also the underlying factors affecting these outcomes, regardless of whether the quantitative measures appear satisfactory.

For dental education specifically, our findings contribute to the broader understanding of professional training efficiency in health sciences. The improvement in TE rates suggests successful adaptation to changing educational demands whilst maintaining academic standards. However, as Liu and You-Hsien Lin (2021) note, professional training extends beyond knowledge transmission to include research capabilities and scientific competencies, aspects that may influence the time required for degree completion.

Future research should address the current study's limitations by incorporating more detailed individual student data and examining additional variables that might influence TE. This could include socioeconomic factors, previous academic preparation, and specific institutional interventions, providing a more comprehensive understanding of the factors affecting successful graduation in dental education.

V. Conclusion

This study demonstrates a positive trajectory in the successful graduation of undergraduate students from a Peruvian university dental school, with marked improvement observed in recent years. These findings highlight the critical importance of continuous terminal efficiency (TE) indicator monitoring as a fundamental measure of dental education programme quality and productivity.

The results yield significant practical implications for university management and curriculum development. Educational institutions would benefit from implementing analogous monitoring systems to identify areas requiring enhancement and evaluate the effectiveness of educational interventions. Furthermore, increased attention should be directed towards factors potentially influencing TE, including academic programme structure, student support mechanisms and institutional resources.

This research contributes meaningfully to the existing knowledge base regarding dental education in Peru and Latin America, offering valuable insights into TE and its potential determinants. However, it also underscores the necessity for more comprehensive investigations exploring these determinants and assessing the efficacy of specific interventions aimed at improving TE indicator.

Several recommendations emerge from this study. First, future research should employ mixed-methods approaches, combining robust quantitative analyses with qualitative investigations to capture the perspectives and experiences of both students and academic staff. Second, longitudinal studies incorporating dropout and academic delay indicators are essential for developing a comprehensive understanding of programme performance. Third, comparative analyses between institutions and academic programmes are recommended to identify best practices and facilitate knowledge exchange.

Additionally, future investigations should consider either extending data collection periods to increase sample sizes for less common modalities or focusing analyses on primary modalities with more balanced sample distributions. The incorporation of qualitative methodologies would provide deeper insights into factors influencing TE rates.

Ultimately, enhancing successful graduation rates, as reflected in favourable TE indicator rates, should be recognised as a crucial component of educational quality in health sciences. This has direct implications for the training of competent professionals and the optimisation of educational resources. The sustained commitment to evaluating and improving this indicator will not only benefit higher education institutions and their students but will also contribute to strengthening healthcare systems through the timely and efficient preparation of qualified professionals.

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 125-144 •
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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 125-144 •
doi: https://doi.org/10.18543/tjhe.3057 • http://www.tuningjournal.org/

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 125-144 •
doi: https://doi.org/10.18543/tjhe.3057 • http://www.tuningjournal.org/

Different university model approach in the field of earth sciences: 'University of Geological Sciences' in Uzbekistan

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doi: https://doi.org/10.18543/tjhe.2764

Received: 21 May 2024
Accepted: 28 February 2025
E-published: June 2025

Abstract: The intellectual potential of a nation is a critical determinant of its human resource capabilities, with higher education serving as the foundation for cultivating such potential. Traditionally regarded as a public service, higher education has evolved in recent decades to incorporate diverse models that blend public and private sector roles. These models, including state-centered, research-oriented, and market-driven approaches, highlight the multifaceted nature of modern education systems. This study examines the University of Geological Sciences (UGS) in Uzbekistan, established in 2020, as a unique case within this framework. UGS was founded to address the country's need for specialized expertise in geology and mining, sectors deemed pivotal for Uzbekistan's economic growth and geopolitical positioning. By analyzing the university's structure, objectives, and operational strategies, this paper evaluates how UGS aligns with global higher education trends while maintaining its state-centered foundations. The research explores the

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Acknowledgements: None.

Funding: None.

Conflict of interest: None.

institution's integration of theoretical and practical education, the role of research-oriented initiatives, and its gradual engagement with market-driven imperatives. Furthermore, the study emphasizes UGS's adaptability to global trends, including technological advancements, demographic changes, and international collaboration. These efforts position UGS as a potential global leader in earth sciences education. Ultimately, the paper underscores the importance of developing a hybrid educational model that balances state priorities with global competitiveness, ensuring that UGS fulfills its mission of advancing geological education and research in Uzbekistan and beyond.

Keywords: Higher education; university model; earth sciences; geology; mining sector; Uzbekistan.

I. Introduction

The year 2020 has been declared the "Year of Development of Science, Education and Digital Economy" in Uzbekistan, and the priority targets are detailed in the decision of the President of the Republic of Uzbekistan dated August 12, 2020 and numbered PQ-4805 (Official Gazette 2020). Taking into account the potential of developing science schools in the country, national interests and developments in the global field, it was decided to develop mathematics, chemistry, biology and earth sciences (geology) in 2020.

To achieve strategic objectives, efforts are directed toward establishing a comprehensive methodological foundation for the adoption and implementation of a new national personnel training model. This initiative is supported by legal frameworks, including the "Training Law" and the National Personnel Training Program. A defining characteristic of this methodology is its emphasis on cultivating intellectually capable individuals who are not only socially engaged and spiritually enriched but also possess a strong competitive mindset.

The continuity of education and training can be ensured by the coordination of theoretical knowledge and practical activity. With this approach, it is aimed to provide the conditions that will reveal the progress of the society and the happiness of the people in the education process (Karimov 2015).

Historically, universities were primarily established to address societal needs in disciplines such as theology, medicine, and law, particularly before the onset of modernization in the 19th century. During this period, higher education institutions also emerged in technical fields like engineering and architecture, aimed at providing vocational education to meet practical, day-to-day requirements (Gürüz 2003, 74-107). In contemporary academic

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 145-162 •
doi: https://doi.org/10.18543/tjhe.2764 • http://www.tuningjournal.org/

discourse, Burton Clark's framework, introduced in 1983, is widely utilized to analyze university models (Ekinci et al. 2018, 781) . This framework evaluates the various factors influencing university performance and is commonly referred to as "Clark's Triangle" or the "triangle of coordination." It categorizes universities based on their structural alignment, identifying three primary orientations: state-centered, academy-centered, and market-centered (Lang 2015, 1-17) .

The institution primarily responsible for higher education in Uzbekistan is the Ministry of Higher Education, Science and Innovation. Apart from the higher education institutions that are directly affiliated with the Ministry of Higher Education, Science and Innovation, there are also specialized higher education institutions for which other ministries are responsible. For example, there are 7 specialized higher education institutions affiliated to the Ministry of Health, 4 affiliated to the Ministry of National Education, and one affiliated to the Ministry of Foreign Affairs. There are also academic high schools and vocational high schools to strengthen and support higher education.

Higher education in Uzbekistan is mainly carried out with an academic approach according to the 'National Personnel Training Program'. In the light of this program, the main duties of the relevant ministry are as follows:

1. To ensure the implementation of a unified state policy in the field of higher and secondary vocational education, which aims to train personnel who can think, produce and have qualified characteristics with an innovative approach;

2. To ensure the integration of international practices in a beneficial and effective way towards the development and improvement of the higher and secondary vocational education system in the country;

3. To coordinate the higher and secondary specialized educational institutions of the country;

4. Researching and providing the demand for education services from all segments of the society in line with the current and future educational needs of the country in accordance with the socio-economic development priorities;

5. In the light of developing technology and new trends, to ensure the implementation and effective use of progressive education forms, including distance education, new teaching and information and communication technologies, in the education process;

6. To ensure the education and development of all the stakeholders of the education system with the continuous education system approach;
7. To enable research and development activities in higher education and to ensure close cooperation between science and industry.

Apart from official higher education institutions, there are also private higher education institutions with both local and global origins. The education models of all these higher education institutions, both public and private, differ from each other.

The restructuring of higher education in Uzbekistan commenced after the nation achieved independence in 1991, marking a significant turning point in the development of its academic and institutional framework. However, due to its relatively recent establishment, the system has not yet reached the level of maturity or institutional depth observed in countries with more longstanding traditions of higher education. While substantial progress has been made in aligning the system with national priorities and global trends, it continues to evolve, addressing structural and operational challenges inherent in its formative stages. This ongoing development reflects the dynamic nature of Uzbekistan's efforts to build a robust and competitive higher education sector.

University of Geological Sciences under the Ministry of Mining Industry and Geology established in 2020, when defined according to the models mentioned in the literature, is state-centered in theory, but also has an academic-centered approach with its practical applications.

Considering that the country has a surplus of underground resources and mining is a sector that concerns not only regional but also global stakeholders, it can be defined as a mixed model, considering that it will have a market-oriented setup over time .

II. Earth Sciences - Geology and Mining in Uzbekistan

After its independence in 1991, especially with the New Uzbekistan vision, the state's approach to the geology and mining industry has been primarily to ensure the country's mine and raw material security and to protect its geopolitical interests in the regional and global arena. To enhance the mining sector's contribution to the economy and public finance, the Uzbekistan administration has implemented a series of comprehensive innovative decisions to advance state policy in the field of geology (Official Gazette 2020).

Mineral resources play an important and major role in the economy of Uzbekistan. With the efficient and effective processing of raw materials and

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 145-162 •
doi: https://doi.org/10.18543/tjhe.2764 • http://www.tuningjournal.org/

the production of high value-added products based on them, the contribution of mineral resources in the country to budget revenues increases significantly.

According to the International Energy Agency (IEA), natural gas is the predominant energy source in Uzbekistan, accounting for approximately 85% of both the country's total energy supply and electricity generation (IEA 2022, 12). Approximately 2.3% is coal and the remaining 0.7% is hydroelectricity. In addition, when other underground resources are examined, Uzbekistan is among the few countries in the world in the supply of certain minerals: gold, uranium, copper, phosphate, molybdenum, etc. It is among the top five countries in terms of total gold reserves in the world and among the top 10 countries in terms of gold production.

Geology and mining have undoubtedly been determined as one of the most basic dynamic pillars of the developing economy of the country. Meeting the raw material needs of all sectors, particularly those related to scientific and technological progress, requires accessing underground resources and utilizing them efficiently.

On the basis of the new vision, 2 main objectives related to geology and mining were determined. These:

1. Determining the underground resources effectively and efficiently and establishing the necessary operating infrastructure and making it salable;
2. Effective and efficient production of underground resources and taking steps towards export by turning them into value-added end products

The steps to be taken to achieve the above-mentioned main goals are determined as follows:

1. It is aimed to complete the necessary mapping and to reveal the picture of the underground resources of the country by carrying out extensive mineral exploration studies throughout the country.
2. As a result of determining the priorities of the world's raw material needs, bureaucratic improvements have been planned that will enable both domestic and foreign investors to carry out the necessary activities for the determination of production priorities in underground resources and the production of end products.
3. It is aimed to take the right steps especially in the fields of secondary and higher education for the training of the personnel needed to carry out the geology and mining activities. It is important to organize and implement the necessary training programs in the fields that are thought to be

needed both in the short and long term in education policies. Since the activities to be carried out in these programs are intertwined with basic sciences such as physics, chemistry, biology and mathematics, a multidisciplinary education policy should be integrated.

As one of the developing countries, industrialization is the priority of Uzbekistan. More than 2,000 mineral deposits of more than 70 mineral species have been discovered in Uzbekistan until now. However, there are other potential areas that can easily be developed. Besides having the world's leading gold and uranium deposits, it also produces main minerals such as copper, silver and coal it is also an important producer of hydrocarbons (NEA 2022, 11; IEA 2022, 61-66; USGS 2021, 1-10).

The primary objectives of taking these decisions were to reveal the mineral resources in the territory of Uzbekistan, to ensure the rational use of these resources in an effective and efficient way, and to further increase the investment attractiveness for this purpose.

It is necessary to take the important steps to ensure that the applied activities to be carried out after the right planning in human resources are carried out at the same time in the current and advanced technological infrastructure. To enhance the global market appeal of mineral resources and their derived end products, it is imperative to ensure that adequate human resources and technological infrastructure are in place. This effort should be complemented by the implementation of appropriate legal regulations and the development of effective marketing strategies. The relevant presidential decrees for these goals have already entered into force and the details of these decrees have been made accessible on the official website of the Presidential Administration for the accessibility of all segments of society.

III. Establishment of University of Geological Sciences (UGS)

The University of Geological Sciences was established in Tashkent under the Geology and Mineral Resources State Committee to provide sufficient and effective human resources in the field of geology and mining. As of 2023, within the scope of the restructuring of Uzbekistan state institutions, the State Committee of Geology and Mineral Resources was renamed the Ministry of Mining Industry and Geology (Official Gazette 2020). Therefore, the University of Geological Sciences has become a higher education institution directly affiliated to the relevant ministry.

Although there are 2 faculties and 7 departments for educational purposes in the university structure, there are institutes named as the

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 145-162 •
doi: https://doi.org/10.18543/tjhe.2764 • http://www.tuningjournal.org/

Institute of Geology and Geophysics, the Institute of Mineral Resources, the Institute of Hydrogeology and Engineering Geology, the Institute of Geology and Oil and Gas Field Exploration, the Institute of Advanced Education and Retraining of Geology Personnel and the State Geological Museum.

Apart from these, the establishment of the Geoinnovation Technologies Center, which has a scientific and technological infrastructure, has been going on to further advance research and development in the field of geological research, rational use and protection of mineral resources. The center, equipped with state-of-the-art methods and technologies for the examination of mineral resources, will provide opportunities for training and employment of expert personnel across multiple levels. These include Bachelor's, Master's, and Doctorate programs, as well as Continuous Professional Development (CPD) initiatives, ensuring a comprehensive approach to skill development and specialization in the field.

The University of Geological Sciences, aligned with the vision of the new Uzbekistan, aims to activate an innovative educational framework and cultivate talent by 2030. With a focus on fostering collaboration between academia and industry, the university will provide an environment where diverse disciplines operate under a unified global vision and approach to international cooperation, positioning itself as a world-renowned research and practice center in its field. It aims to ensure that human resources effectively take part in the country's goals.

When the activities carried out by the University of Geological Sciences since its establishment are examined, it is explained below which model can be defined within the scope of higher education models.

State Model approach: The state model approach corresponds to the model in which the authority is at the center in Clark's triangle of coordination regarding higher education (Cohen and Sapir 2016, 607; Fındıklı 2017, 393-394). In this model, there is a single-centered and constantly controlled approach, in which the central government aims to educate individuals within the framework of patterns determined by it, while preserving the public order and structure (Meray 1971, 13-40). Since the University of Geological Sciences was established under the Ministry of Mining Industry and Geology, which is a public authority, there is a state model approach. In this context, it can be said that the state is active in the structuring of the university and that there is a rector appointed by the state as the academic leader of the university. With this approach, it is clearly seen that the primary duty of the university is to serve the state.

With the vision of a new Uzbekistan and the goal of becoming a stronger nation, the state has positioned itself as a dominant actor in the field of earth sciences, driven by a focus on developing strong human resources as a primary objective. The staff and students of the university actually function directly as part of the bureaucracy.

The University of Geological Sciences is in a position to train the necessary manpower for the realization of the short-medium and long-term plans of the State Administration, as well as to carry out practical activities together with other relevant ministry institutes and organizations as part of the Ministry.

Research Oriented Model approach: The main purpose of this approach is to ensure that academics provide research-based education and the autonomy of the university. (Muller 1985, 253-256). In addition, the university is expected to produce knowledge by conducting basic scientific research and to convey what it produces to everyone with a general understanding of education and training without being directed towards a specific profession. Therefore, the University of Geological Sciences is not suitable for this definition as a model in its early stages. However, in the future, the management of the university by a rector and faculty deans elected by the academicians and approved by the central government may create an opportunity to become more compatible with the research-oriented model (Doğramacı 2007, 3-13).

However, although it does not fully comply with this model, the fact that the institutes within the university carry out projects and make international cooperation shows that it also has a research-oriented side.

In fact, both academic and industrial projects will be carried out with the Geoinnovation Technologies Center, which will be established as an indicator of a research-oriented understanding. This center will enable both theoretical and practical studies to be carried out thanks to its high-tech devices and equipment.

Market Driven Model approach: In this model, the university is a model that develops people's abilities and skills by providing "liberal formation", and also finds solutions to the problems of society and is highly accepted in countries such as England and America (Meray 1971, 13-40). Therefore, the reason why the market-oriented model is classified as such is that research services are conducted and funded in a market-oriented manner. In this way, universities both create the necessary funds for research and conduct research in the direction demanded by the market.

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This approach, which is based on research activities carried out to meet the needs of markets for the services provided by universities, does not fully match the Geological Sciences University, since the purpose of its establishment is primarily to achieve public goals. In this model, the aim is to reveal the personal potential of individuals, that is, individuals do not have to worry about finding a job after they graduate and acquire a certain profession. Because graduates are offered the opportunity to work directly in the public sector. Therefore, it does not seem possible for the Geological Sciences University, whose main purpose is to create the human resources needed in the field of earth sciences, to exhibit a market-oriented approach, that is, on behalf of the private sector.

So far, different higher education models have been mentioned above, but it can be said that new model approaches may emerge from different factors operating in the developing and changing world. Considering the "10 Trends That Will Shape Higher Education" report published in 2012 by the British Council, the organization that responsible for the international education activities of the United Kingdom, it may be envisaged that models will become much more intertwined with new trends. The four main trends that will cause drive change in Uzbekistan are:

1. *Change in demographic structure:* It will be inevitable that universities, which take their human resources from the society, will also be affected by changes in the social structure. The increase in population, the prolongation of life expectancy, the limitation of manpower needs in the digitalized and automated industry, and the change in production and consumption needs will also cause changes in universities. It should not be forgotten that the demands of future generations will be different from today and universities will need to keep themselves ready for this change.

2. *Increasing demand for higher education:* Depending on the human resources they need at primary, secondary and higher education levels, states make plans in accordance with the education policies they have determined, but it will be inevitable for the demands of future generations to change. As the demand for higher education increases, the supply situation and accordingly the higher education structure will change. Because there has been an intense pressure for quality education, namely higher education, in societies.

3. *Sectors becoming more involved in the education process:* Since the classical research and education approaches cannot adequately adapt to the changes that the industry has undergone, the sectors may make their

own education plans. This may cause that they will establish their own higher education institutions over time. This process can turn into a structure in which the market-oriented process mentioned above is now dominated by market determinants. First of all, there will be a model in which the university-industry partnership is more intense and opportunities such as internships are more and more effective, and in this way, the employment of graduates is ready.

4. *Technological change, development and digitalization:* Change and progress in technology also directly affect education. Especially after the pandemic, the importance of digital infrastructure has attracted attention and alternative education applications such as distance education have become a little more important. It is not yet sufficient for applied sciences today. But when there is sufficient infrastructure in the future, there will be distance education for all professions and therefore higher education institutions that will realize this.

In addition to the basic trends mentioned above, the budget needed in the supply-demand balance and how this budget will be provided will be a criterion for university models. Another point is that with the emergence of the concept of universal citizenship, education will evolve from local to international platforms. This evolution will also take place under the control of a more international mechanism instead of local rules, that is the control of the international authority.

IV. Review of University of Geological Sciences

The effectiveness of an individual's education in the modern age is determined by the content of education, its practical applications and the necessary infrastructure to have up-to-date technologies. Under the conditions of contemporary civilization, no society can develop in isolation from the world. Therefore, the quality of the education system today must transcend narrow local borders and possess international, global significance, requiring integration and communication with the world.

The quality of higher education should be directed towards the training of specialists ready for professional activity in accordance with the requirements of economic progress. Achieving this requires a comprehensive evaluation of the educational content, teaching methods and formats, infrastructure, as well as the knowledge and skills of educators.

The structure and activities of the University of Geological Sciences are examined in the light of the concepts mentioned above. The University of

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 145-162 •
doi: https://doi.org/10.18543/tjhe.2764 • http://www.tuningjournal.org/

Geological Sciences consists of 6 main departments providing academic education; Department of General Geology, Department of Geology and Geophysics of Mineral Deposits, Department of Technique and Technology of Geological Exploration, Department of Oil and Gas Geology, Hydrogeology and Geoecology, Department of Economics and Social Sciences, Department of Exact and Natural Sciences. The principle in academic education is to transfer the basic and theoretical knowledge in higher education to individuals with a universal approach. The main purpose of academic departments is to train geologists who have basic knowledge about mineral resources and priorities in the economy of Uzbekistan, who can conduct theoretical and practical studies and who can do practical work. Apart from these, there are institutes such as the Institute of Geology and Geophysics, Institute of Mineral Resources, Institute of Hydrogeology and Engineering Geology, Institute of Geology and Oil and Gas Field Research, Institute of Advanced Education and Retraining of Geological Personnel (see Figure 1).

The primary objective of the institutes is to undertake extensive research focused on forecasting and identifying emerging areas of potential, guided by scientific assessments within their respective fields of expertise, as well as the digitization of maps. While there is no direct link between the academic departments and the institutes, students are offered opportunities to engage in professional internships at the institutes. Furthermore, academically qualified personnel employed at the institutes are eligible to contribute to the academic departments by delivering lectures.

These institutes conduct research and development activities through projects aligned with the vision of the Republic of Uzbekistan in the field of earth sciences. The Ministry of Mining Industry and Geology has outlined specific priorities for these initiatives, including mineral exploration, sustainable resource management, and technological innovation. Within this framework, academics and researchers are encouraged to design and implement projects that address these priorities while also contributing to the broader goals of the ministry.

Additionally, individuals pursuing academic education are actively involved in these projects, providing them with valuable opportunities to engage in practical activities, such as fieldwork and laboratory analysis, and to gain hands-on experience in their areas of study. For example, students at the Institute of Geology and Geophysics participate in mineral mapping projects and hydrogeological surveys, which are key priorities identified by the ministry.

In addition, a Geoinnovative Technologies Center is established within the university to carry out academic and industrial activities with scientific

methods. The center will have a structure where the most advanced methods and technologies can be accessed for the examination of mineral resources, qualified personnel will work, and creative ideas will be produced.

Because faculties and departments fulfill the theoretical mission, the institutes fulfill their practical mission, and the Geoinnovative Technologies Center will support the former missions in a scientific infrastructure, it can be said that the 'University of Geological Sciences' carries out its activities in both a state-centered and research-oriented model structure. Considering that this center is candidate to the ISO 17025 Laboratory accreditation, that can be also occasion for implementation of a market-oriented approach. Because the accreditation required to gain an advantageous position in competitive conditions is preferred in the market-oriented approach model (Fındıklı 2017, 393-394).

When the University of Geological Sciences is examined within the scope of new trends in education, the points that draw attention are as follows.

As of mid-2024, Uzbekistan's population is estimated at approximately 36.36 million, accounting for about 0.45% of the global populace (CIA 2024). This positions Uzbekistan as the most populous nation in Central Asia, comprising nearly half of the region's total population. The country's demographic profile is notably youthful, with a median age of 27 years and approximately 30.1% of the population under 14 years old. Urbanization trends indicate that 48.4% of the population resides in urban areas, reflecting a significant rural demographics. This diverse and youthful demographic landscape presents both opportunities and challenges for Uzbekistan's socio-economic development. Since Uzbekistan's where population is young and has a small dimension according to its geography, it will be inevitable for new generations to increase with the increase in population and therefore to have new demands. The new world is accepted as an information society, education model in this understanding; it keeps both individual research and teamwork approach together. However, the rapidly changing flexible content and understanding based on diversity in higher education will also be valid for Uzbekistan.

The University of Earth Sciences is committed to adapting its institutional infrastructure and education policies to align with the evolving demographic structure of Uzbekistan. To proactively address these changes, its organizational structure includes key departments such as the "Institute of Advanced Training and Retraining of Geological Staff," the "Education Quality Control Department," and the "Department for Youth Affairs, Spirituality, and Enlightenment." These departments play a critical role in preparing for demographic shifts by focusing on staff development, quality assurance, and fostering a supportive academic environment.

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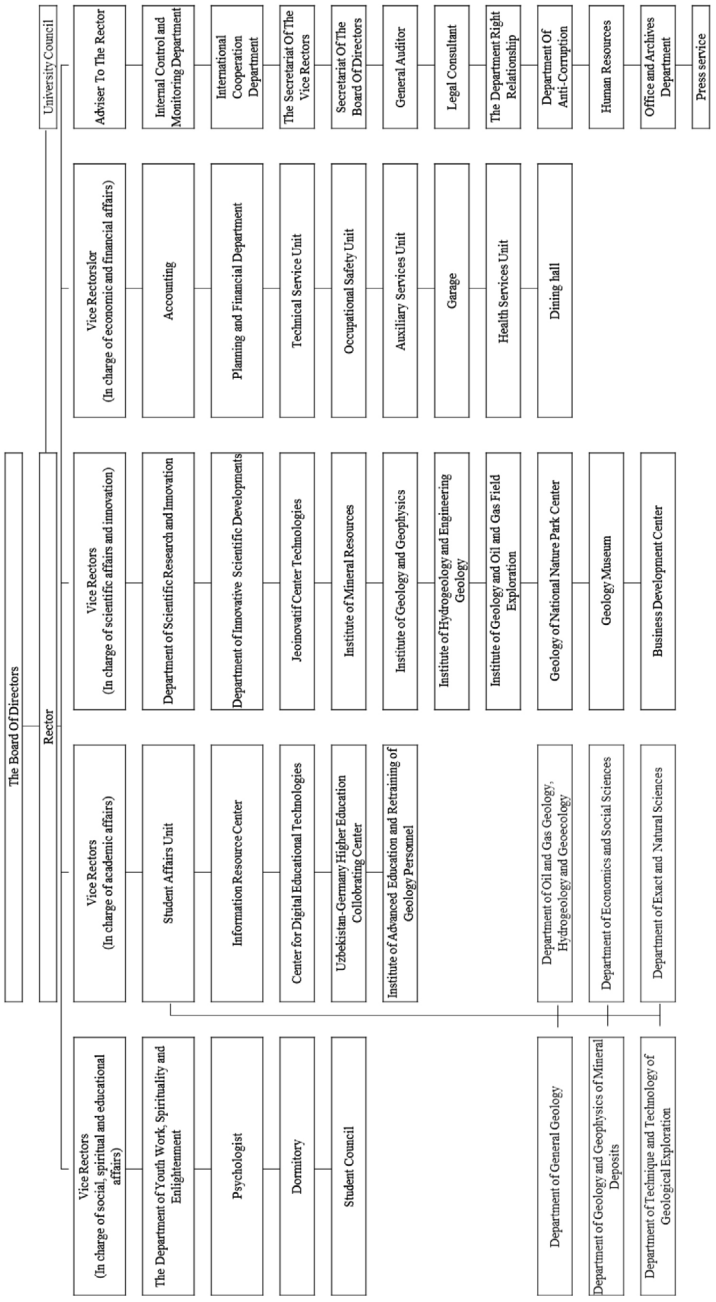

Figure 1
Organizational Chart of University of Geological Sciences

To enhance clarity and demonstrate the proactive missions of these departments, a visual representation outlining their specific roles and objectives has been developed. This graphic highlights how each department contributes to the university's overarching strategy and its positioning within the global academic community. For example, the "Institute of Advanced Training" emphasizes continuous skill enhancement for geological staff, while the "Education Quality Control Department" ensures adherence to international standards in curriculum design and teaching methodologies. Meanwhile, the "Department for Youth Affairs" focuses on creating a vibrant academic culture through initiatives that promote student engagement and holistic development.

Having such units within the university provides a clear and concise overview of the university's strategic approach and commitment to addressing future challenges with a forward-looking perspective.

It has been stated before that the purpose of its establishment is primarily to provide the necessary human resources to the state staff. However, at the end of a certain period of time, it will be inevitable to make plans to train human resources both locally and globally, especially in the private sector, instead of human resources that have become stable in government staff. In this context, the 'Department of Marketing and Student Practice' established within the university is already making plans for the future and showing a proactive approach.

Considering the rapid technological development and digitalization, it can be said that University of Geological Sciences has built a structure that will keep itself ready for change. First of all, it searches for the possibilities of integrating the applications used in the world into its own structure by following the current technologies and developments with the departments such as the 'Center for Digital Learning Technologies' that it has established. In addition, it has made it a continuity to equip its physical infrastructure with state-of-the-art facilities. It provided the establishment of well-equipped laboratories to carry out applied activities, which are an important part of education, and made the planning of new ones.

Leveraging modern technologies such as the internet, access to electronic resources, and diverse learning networks, universities can provide individuals with flexible, efficient, and lifelong learning opportunities tailored to their specific needs. This approach enables learners to pursue education on topics of their interest at any time, from any location, and to the extent they desire. As traditional classroom-based instruction is no longer sufficient to meet the evolving demands of education, this model ensures access to a wide array of diverse and high-

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quality resources. The University of Geological Sciences is well-equipped with the necessary infrastructure to support these advancements and foster a dynamic learning environment.

Since its establishment in 2020, the University of Geological Sciences has aimed to transfer both knowledge and technology through bilateral cooperation with higher education institutions of countries such as Turkey, China and America, especially European countries. It is aimed to have a say in global platforms and to be effective and competent by carrying out international joint projects.

V. Conclusion and evaluation

Uzbekistan's underground resources, with many unexplored fields, position geology and mining as key sectors for the foreseeable future. To support the advancement of these industries, the law aims to ensure the rational use of mineral resources, environmental protection, and safe operations. The Ministry of Mining Industry and Geology oversees these efforts, with preliminary studies conducted between 2017 and 2021. Looking ahead, the focus is on new discoveries targeting 2030 and 2035. Achieving these goals requires investment in human resources, technology, and infrastructure. In this context, the University of Geological Sciences was established within the Ministry to train the necessary workforce aligned with these objectives.

Higher education in University of Geological Sciences is similar to the central model, but a research model approach can also be considered. In addition, considering the objectives of having international standards, it also partially provides the market-oriented approach model.

When the education models of developed countries are examined, it is seen that they have mixed models that have become integrated with each other rather than a single model according to today's conditions. As the University of Geological Sciences, it would be more accurate to develop itself in parallel with the world and to be managed with a unique model, with the priority of its founding goals.

First of all, it should be a priority for it to establish its academic standards and to have a certain academic tradition. In addition, by examining the world-recognized higher education institutions in the field of earth sciences, its own model will be created, where the most suitable ones in Uzbekistan conditions will be represented in the international arena, participatory, academic independence, universal values are considered.

To achieve all these, targets should be determined in priority and sequentially, and a calendar should be established accordingly. These goals are:

1. Making due diligence on geology and mining issues of the Republic of Uzbekistan,
2. Determining short, medium and long-term goals based on the due diligence,
3. Determining the necessary human resources for the determined targets,
4. Preparing qualified trainers to develop the required human resources,
5. Providing appropriate educational infrastructure,
6. Providing education by selecting qualified individuals from the society,
7. Creating the necessary environment for trained individuals to carry out research and development activities, can be said as all these processes need to be carried out patiently and financially supported accurately and adequately.

The University of Geological Sciences was established with a successful organizational structure by making detailed examinations of similar examples in the world and considering the values unique to Uzbekistan. It has an organization that can constantly renew itself and keep up with change, thanks to the many sub-units it has established, especially with the foresight that new trends in education will also have an impact on the future. To achieve its goals and attain greater success, the institution will first fulfill its primary mission of supplying human resources to the public. After that, it should be more academically independent, more in contact with the market. But the most important is that it should be more integrated with world which will help to be in a different approach where models are intertwined.

The establishment of a unique higher education model in the field of earth sciences in Uzbekistan, as well as ensuring the independence of the academy, will increase the quality and quantity of education, research and scientific publications. It should not be forgotten that the main task of universities is to play an active role to meet the expectations of the society in line with the needs of the age.

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doi: https://doi.org/10.18543/tjhe.2764 • http://www.tuningjournal.org/

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 145-162 •
doi: https://doi.org/10.18543/tjhe.2764 • http://www.tuningjournal.org/

Peer tutoring programmes: Comprehensive training and generic competences from the experience of tutors in a Chilean university

Camila Véliz and Oscar Navarrete*

doi: https://doi.org/10.18543/tjhe.2983

Received: 28 February 2024
Accepted: 28 February 2025
E-published: June 2025

Abstract: Like other countries, higher education in Chile still has important socio-economic gaps to be addressed. As part of the strategies to attend this challenge, peer tutoring programmes have developed considerably in recent years. Much of the research on peer tutoring in higher education has focused primarily on the impact on the students being tutored, and only a small part of that research has focused on the benefits or contributions to the student-tutors themselves. Based on a case study of peer tutoring programmes in a Chilean university, the experience of tutor participation and its relationship to comprehensive training competences is collected from interviews. The information was analysed based on the following categories: understanding of comprehensive training, perceptions of their role, motivation and learning from their experience. The main results aim to highlight the relationship between generic interpersonal, instrumental and systemic competences and their link to comprehensive training. It is concluded that interpersonal competences amount to the main benefit self-perceived by the tutors, where self-motivation, learning orientation, planning strategies and strengthening their autonomy

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Acknowledgements: The authors would like to thank the Alberto Hurtado University of Chile for funding the research project "Learning and challenges of first-year tutoring programmes in the Faculty of Social Sciences and Education at the Alberto Hurtado University: a look at the experience of student-tutors in higher education" (2022-2023). They also thank Pablo Navarrete for his collaboration by the revision of the manuscript.

Source of funding: Alberto Hurtado University, Chile – Vicerrectoría de Investigación.

Conflict of interest: The authors declare that they have no potential conflict of interests.

and identity emerged as the main competences developed. While both students and tutors benefit from peer tutoring, tutors are a key participant in the integral formation, strengthening their social commitment.

Keywords: Peer tutoring; higher education; tutor's experiences; comprehensive training; generic competencies.

I. Higher Education in Chile

Since 1990, with the return to democracy, Chile has practically quintupled the coverage of students entering Higher Education. In the last five years alone (2020-2024), national undergraduate enrolment has increased by 10.9% (Subsecretaría de Educación Superior 2024). According to Williamson and Sánchez (2024) this has led to a higher number of graduates and a smaller economic return due to increased competitiveness in accessing employment opportunities.

For Mella and Moya this great expansion is considered a case study at international level, particularly what happened with the implementation of neoliberal policies that increased this educational offer, but also the expansion of student credit systems, where access and financing policies have been prioritised, but that has also led to an indebtedness crisis, to which the authors point out a new challenge: the "need for public policies of retention and effective graduation" (Mella and Moya 2024, 38).

In the national context, Chile's Higher Education offer is made up of two main areas of training: university and technical-professional, distributed among 51 universities, 37 technical training centres (CFT), 29 professional institutes (IP) and 3 military academies and schools. According to official data, universities account for 58.8% of the total enrolment in higher education in 2024 (Subsecretaría de Educación Superior 2024).

In the last decade, higher education in Chile has faced significant difficulties associated with the inequity of its education system. The OECD considers that educational outcomes are insufficient and that maintaining inequities in the system continues to have direct consequences for students and Chilean society in general and has recommended that the country must provide support to students from disadvantaged sectors, strengthening specific support programmes, and adapting to student diversity by incorporating diverse approaches and learning objectives (OECD 2017). In this scenario, there are legitimate questions about the real contribution of the higher education system to social mobility in the country, considering that it has been reproducing these inequalities (Quaresma and Villalobos 2022).

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doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

In terms of dropout, it remains high, and dropout is inversely proportional to socio-economic status; inequalities persist in access to higher education and study success (OECD 2017; PNUD 2017). In this regard, some measures to address these inequalities have been 'affirmative action' policies in higher education, which are strategies that "seek to produce greater representation in higher education of historically excluded social groups, and in turn, allow these subjects to have significant social and learning experiences in their university trajectories" (Leyton 2014, 11). These measures, together with other national policies such as free access to higher education for students from the most poverty-stricken segments, the Programme for Access to Higher Education (In Spanish: PACE), among others - in one way or another - are aimed at reversing the reproduction of the inequalities that are present in the Chilean education system.

In the same line, Mella and Moya point out that, despite progress, social origin continues to be a determining factor in access to Higher Education, and that therefore one of the main challenges of public policy is to strengthen student welfare programmes: "that recognise not only the barriers to access, but also the barriers to transit in the education system" (Mella and Moya 2024, 49). For example, in Chilean universities, student peer tutoring programmes have emerged strongly as an initiative to address such challenges (Narro and Arredondo 2013; Santelices, Catalán, and Horn 2018; Véliz and Navarrete 2023; Venegas-Ramos and Gairín 2020; Yucra 2021).

II. Competence orientation

Moreover, with regard to the broader dimension of university training, the transition of education from a teaching-centred perspective to a student-centred learning focus has challenged educational institutions to ask themselves in greater depth how students learn (Zabalza 2007), which leads to an understanding of the social, economic and cultural contexts from which students entering higher education come, and the competences that students develop in their educational trajectories.

Along these lines, the Tuning Project on the challenges in higher education from the Bologna process facing 21st century training, "came to offer a methodology to innovate the curriculum and connect higher education to the needs given by social context" (Sandoval and Ormazábal 2021, 57), and has promoted a reflective and critical framework on the comprehensive training of competences (generic and specific) in higher education through seeking consensus on the achievement of learning through the development of skills that entail internalised, mobilised and applied knowledge (Beneitone et al. 2007).

This orientation towards competence development is particularly important to address the socio-economic stratification and educational inequalities already noted. Villa and Poblete consider the great paradox in education, where the advancement of knowledge is inversely proportional to the gap between more developed and less developed countries. Faced with this, the authors consider that universities should be aware of this phenomenon: "it is necessary to enhance students' awareness and social commitment so that they will place their capacities and competences at the service of others" (Villa and Poblete 2008, 31). The development of these competences makes it possible to contribute to the narrowing of socio-cultural and economic gaps.

One strategy that has connected the idea of student-centred learning and the understanding of this learning from the social context has been peer tutoring programmes, which is the main object of analysis in this paper. These programmes constitute "a privileged space for effective and affective bonding of students in Higher Education. The peer methodology reinforces the sense of belonging and identity of the student body and allows for a more holistic approach to learning" (Véliz and Navarrete 2023, 55).

The research presented in this paper was carried out at the Universidad Alberto Hurtado (UAH), a higher education institution founded in 1997 by the Society of Jesus in Chile, which, despite being a private university, is recognised as a non-profit organisation with a vocation for public service, a fact that is reflected in an academic project that focuses on the Humanities and Social Sciences.

The university has a total enrolment of 8,772 students, distributed in 7 doctoral programmes, 29 master's programmes, and 49 undergraduate programmes. The latter are the ones with the highest number of students enrolled: 82.9% (CNED 2024).

On the other hand, the UAH participates in several public policies aimed at reversing inequalities in the Chilean education system, including the PACE programme (which allows access to Higher Education for secondary students with high social vulnerability and who come from municipal schools), and the Free Higher Education policy (which benefits students from the lowest 60% of the country's income bracket).

Since 2015, the University has been encouraging the standardisation of all its undergraduate training programmes to the Transferable Credit System (SCT in Spanish), which makes it possible to better measure the time students need to dedicate to the development of the competences stated in the academic programmes. In addition, and mainly due to the initiatives of the specific programmes, there was implemented more than 20 peer tutoring

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programmes for its undergraduate programmes (around 50% of the total number of programmes at the university), which facilitates the transition and permanence in higher education, accompanying students in their academic trajectory.

III. Comprehensive training and peer tutoring programmes

It is important to understand that university education goes far beyond specific academic training in certain fields of knowledge, and it has become increasingly necessary to understand it from the paradigm of lifelong learning. Delors points out that this type of understanding must be broadened "because in addition to the necessary adaptations related to the mutations of professional life, it must be a continuous structuring of the human being, of their knowledge and skills, but also of their faculty of judgement and action" (Delors 1996, 20).

This idea alludes to a much more comprehensive notion of education in general, and for Higher Education in particular, it implies a series of challenges. In the words of Zabalza (2007), the incorporation of students with different educational trajectories, the flexibilization of the educational offer, a more professionalising orientation of university education, or the diversification of the exclusively academic paradigm of the educational offer in Higher Education.

Comprehensive training points precisely to this broader perspective of education, which ensures the growth of the human person as a whole. In the words of Nova, comprehensive training "seeks harmonious development, although all the dimensions of the individual unfold in different ways, with different intensity, at different times" (Nova 2017, 186).

With a focus oriented rather to permanence than to entry to higher education, peer tutoring programmes have had notable development in recent years (Araneda-Guirriman et al. 2020; Gómez et al. 2002; Huircalaf and Rodríguez-Gómez 2020; Rahmer, Miranda and Gil 2016; Vásquez 2015; Véliz and Cruz 2023; Venegas-Ramos and Gairín 2020), and it has been a strategy that, together with others, allows higher education institutions to take charge of the new training scenarios, in which Chile, like other countries, has found itself at the crossroads produced by the great increase of coverage -which impacts the number of students and academic teams- and the consequent changes in the entrance-profile to higher education, where the great challenge has been to sustain institutional strategies that guarantee quality, but that can also ensure conditions of equity and training relevance (Pey et al. 2012).

Comprehensive training emerges here as a connecting bridge between the immediate quality purposes of the training process (graduate profile, development of professional skills, among others) and the higher purposes of training, associated with the promotion of equity, and the concern for all other dimensions of the human being.

The understanding of training towards integral human development -as a coherent and interrelated whole- is perhaps the most studied idea on educational theories. One of the referents in this discussion is -without a doubt- the declaration in the UNESCO Report chaired by Delors (1996), which establishes that 21st century education must be understood from four fundamental pillars: i) learning to know; ii) learning to do; iii) learning to live together, and iv) learning to be. In this sense, comprehensive training "promotes the multidimensional growth of human beings, developing in them all their characteristics, conditions and potential to achieve their full realisation" (Alonzo et al. 2016, 110).

Following the ideas of Delors (1996), peer tutoring can be constituted as a privileged space for the formation of the 'Being', a synthesis of the relationships between knowledge, practice, and coexistence with other people, which marks a different way of tertiary education. Part of this transformative impulse was, in one way or another, also included in the European Higher Education Area (García et al. 2004), incorporating within the development of professional competencies, generic competencies associated with the development of persons and their social development, beyond formal education.

As Villa and Poblete (2008) point out, and which is reinforced by UNESCO education is a privileged space for young people to engage with social causes and responsibilities, as it can "offer them sufficient opportunities to relate to the world in an engaged way" (UNESCO 2022, 61). In this case, peer tutors play a very important role that needs to be discussed: "role clarity is challenging for those in 'in-between' positions: the unique positionality of being situated between faculty and students is both the opportunity and challenge of peer tutoring" (Abbot, Graf, and Chatfield 2018, 253).

IV. Peer tutoring and competences

Tutoring is a valuable mechanism that has been used in the educational field and has positioned itself as one of the most important support strategies in the socio-educational paths of students. This strategy has had a new impulse and particular interest in the context of post-pandemic education, considering that the global educational system had to adjust itself to new

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doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

conditions of training and supporting of its students (Gallagher-Mackay, Mundy, Feitosa, and Asim 2022; Sabzalieva et al. 2022; MINEDUC 2023; UNESCO 2022).

Peer tutoring can be defined as "the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions, where both tutees and tutors' benefit from the transaction" (Topping 2015, 1); and its effectiveness in higher education has been widely demonstrated (Arco-Tirado, Fernández-Martín, and Hervás-Torres 2020; Boud, Cohen and Sampson 2013; Colver and Fry 2015; Topping 2015).

Peer tutoring specifically contributes with a closer, less hierarchical type of socio-formative intervention, which contributes to the transition from secondary education to university (Véliz and Navarrete 2023) but also contributes to the construction of the 'job' of becoming a university student (Coulon 1995), accompanying students who transition from secondary education to higher education.

By accompanying the transition to university life, peer tutoring not only contributes in terms of its impact on academic results (grades, retention rates and timely graduation), but also in the comprehensive training of the people who are part of this strategy: students and tutors.

Within the research on peer tutoring strategies in higher education, a large part of it precisely explores its impact on the students who are tutored, but we found that only a small part of this research has focused on the benefits and specific impact on the tutors themselves. Among the findings of these enquiries, tutors are considered to have a high level of satisfaction when carrying out their role with new students. Tutors develop -at the very least- skills for their personal and professional life (Beltman and Schaeben 2012), improve their own communication and academic language skills (Thurston, Cockerill, and Chiang 2021); they deploy new connection and mediation skills between students and teachers (Abbot, Graf and Chatfield 2018) and they improve their engagement and understanding of the student body (Brown 2020).

Here lies an important part of the discussion. The scientific evidence reviewed for this research agrees that peer tutoring is an important part of the training process. This is also consistent with the results observed in the improvement of the learning of tutored students, and the place that these programmes have today in higher education. However, even with some attempts at institutionalisation, peer tutoring programmes are in the interstices of university education and there is a dispute between being either dependent programmes (of higher education institutions) or independent programmes (as a type of volunteering or university service-learning).

This leads to a permanent process of delimiting their action, which can be rather difficult to analyse without falling into conceptual extremisms: Dependent/Independent; Formal/Informal; or Professional/Novice. Therefore, in this research, we have chosen to analyse the contributions and benefits to tutors of peer tutoring programmes from a comprehensive training perspective, as they contribute to the student body by providing information about the university educational process, but also tutors support students' personal well-being, institutional relationships and sense of belonging, as they interact more closely with them (Thomas et al. 2017).

V. Articulation between comprehensive training, generic competences, and peer mentoring

Taking as a reference the four pillars of education by Delors (1996) that we noted above. One of these pillars, the dimension of Being, was of special interest for our research, since this dimension can articulate the other 3 (learning to know, learning to do, and learning to live together), since by itself, the dimension of Being is a synthesis of comprehensive training, leaving the merely educational field: social transformation. The idea of transformation of society in education (Jurkova and Guo 2022; Martínez-Iñiguez, Tobón, and Soto-Curiel 2021; Ruano- Borbalan 2022; Torres and Cobo 2022) gives intrinsic importance to the training trajectories of the students, which is the idea that is at the heart of the dimension of the Being: "This development of the human being, which goes from birth to the end of life, is a dialectical process that begins with self-knowledge and then opens up to relationships with others" (Delors 1996, 107-108).

Therefore, in this paper we argue that peer tutoring favours the comprehensive training of students, a phenomenon that has been discussed in the last decade in the context of Higher Education (Abbot, Graf, and Chatfield 2018; Clarence 2016; Narro and Arredondo 2013; Bejar 2018; Delgado-García, Conde and Boza 2020; León-Carrascosa and Fernández-Díaz 2021; Thomas et al. 2017), and as Amor (2020, 93) points out "the need for guidance and tutorial action as a key element for the comprehensive training of university students is more than justified".

For the purposes of this research and establishing a link between comprehensive training and the experience of student-tutors, we have considered the proposal by Villa and Poblete (2008) to analyse the generic competences that are deployed in this area.

The authors consider that competence-based learning means developing or deploying competences needed to interact on today's world in general. In

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 163-189 •
doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

this context, and without discrediting universities in their obligation to train in all the professional dimensions they deem appropriate and necessary, the authors point out a holistic proposal for the development of generic competences which, by definition, are also articulated with: human rights; they are cross-cutting, integrate human capacities and strengthen autonomy and interrelation between people.

To operationalise this proposal for the development of generic competencies, Villa and Poblete (2008) proposes a taxonomy of competencies that is based on 3 main types: instrumental, interpersonal, and systemic.

> Instrumental competences: considered as means or tools for obtaining a given end. Interpersonal competences: different capacities that enable people to interact well with others. Systemic competences: concerned with comprehension of an entire set or system. They require a combination of imagination, sensibility and ability to see how the parts of a whole are interrelated (Villa and Poblete 2008, 60).

These three types of competencies give rise to more specific generic competencies and can be developed/deployed in higher education, since -by being cross-cutting- they support the training trajectories that students are carrying out in their own disciplines, with their corresponding specific professional competencies. These instrumental, interpersonal, and systemic competencies were taken as a reference for the analysis of the research data.

Based on the elements set out in this research, we have drawn on the experience of the peer tutoring programmes at Universidad Alberto Hurtado in Chile, which openly ascribes to a comprehensive training from a competency-oriented perspective. This emphasis is operationalised in a pedagogical model that promotes training geared towards i) academic and professional excellence, ii) social justice and service, iii) comprehensive training, iv) reflective and critical training, and v) ethical training (UAH 2019).

UAH recognises all areas of personal development and aims to ensure that its students are "able to use, in a relevant and creative way, the specific competences that their disciplines provide them with, in order to build a fairer and more equitable society" (UAH 2019, 12).

In this paper we seek to communicate the results of the research project *Learning and challenges of first-year tutoring programmes in the Faculty of Social Sciences and Education of Universidad Alberto Hurtado: a look at the experience of student-tutors from higher education courses*. The purpose of this research was to learn about the participation experience of students who work as peer tutors and how this participation favours their comprehensive training during their careers. We will emphasise the possible articulations

between the dimensions of comprehensive training and the generic competences for higher education.

VI. Research design

This research responded to the question: How do student-tutors live their experience related to their professional and comprehensive training from the accompaniment of first-year students? Specifically, this paper characterises the role, motivations and learning of student tutors that contribute to their comprehensive training, based on the description and discussion of a set of generic competences observed in their experience.

A case study methodological design was chosen with a qualitative approach due to its comprehensive interpretative nature (Flick 2009) that responds to the in-depth analysis of the experience of student-tutors at the Universidad Alberto Hurtado. According to the purposes of the research, the scope of the study was exploratory and descriptive (Yin 2003; Stake 2007, Stake 2013).

Specifically, the case study was instrumental (Yin 2003; Stake 2007), as Archenti (2018) indicates, the case plays the role of mediation for the understanding of a phenomenon that transcends the institution studied, the experience of student-tutors at a Chilean university, allows us to problematise the relationship between comprehensive training and generic competences in Higher Education in non-classroom spaces.

The semi-structured interview was used as a technique to produce information, which is characterised by generating a reflective dialogue on the subject of study (Denzin 2001). Specifically on the experience of senior student-tutors participating in peer tutoring programmes.

Regarding the interview instrument, and to ensure its relevance and quality, the research team developed the following actions:

- Construction of a preliminary version of an interview instrument according to the research objectives.
- Conducting interviews with four institutional experts. The objective was to identify how the university has favoured the implementation of peer tutoring programmes and what their perceptions are of the comprehensive training and competences of the students participating in these programmes that they observe.
- Based on these interviews and the theoretical review carried out, the interview instrument was adjusted, and themes were prioritised, based on

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 163-189 •
doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

Villa and Poblete's (2008) model of generic competences in Higher Education according to their relevance to the context of study.

- Subsequently, an interview protocol was drawn up that included the identification of generic competences; instrumental, interpersonal and systemic, and their respective dimensions.
- In addition, a set of questions related to the motivations for participation and learning of students participating in peer tutoring programmes was developed.

The semi-structured interviews were developed in groups according to the specific discipline that implements the peer tutoring programme. They were conducted through the Zoom® virtual meeting platform. They were recorded and then transcribed for analysis.

In terms of ethical safeguards, participation was voluntary, confidential and anonymous. To this end, they were asked to give their authorisation and sign an informed consent form. When the research project was awarded, it was submitted for evaluation to the Ethics Committee of the Universidad Alberto Hurtado.

For the delimitation of the sample, as noted, at Universidad Alberto Hurtado more than 20 undergraduate programmes have implemented peer tutoring programmes. Ten of these programmes are developed in the faculties of Social Sciences and Education (the object of this study) and operate with a group of peer tutors from each programme, where -adjusted for enrolment size- each tutor accompanies 10 students (on average) per year. Specifically, the participants were students from these faculties who serve as tutors in their respective academic programmes.

A snowball or chain and convenience sampling strategy was used to contact students (Creswell 2013). Accordingly, tutors from the following undergraduate programmes participated voluntarily:

- Faculty of Education: Mathematics Pedagogy, Elementary Education, Special Education.
- Faculty of Social Sciences: Social Work, Geography, Sociology, Journalism and Anthropology.

Thus, the sample size was 18 tutors. The sample does not seek to be representative of the total universe of students at the university, but in coherence with a qualitative approach, we sought to deepen the participation experience of the student-tutors based on the criterion of data saturation.

For the analysis of the data produced, we worked with the categorical analysis proposal (Flick 2009). In coherence with the scope of the study, the transcripts of the interviews were first read in detail and coded according to the following categories: comprehensive training, role of the tutor, interpersonal competences, instrumental competences and systemic competences.

Based on the coding carried out, a matrix was drawn up that made it possible to synthesise and reduce the material to establish relationships between categories, which made it possible to prioritise the learning and competences that the tutors themselves recognise as fundamental for developing their role.

VII. Results

Peer tutoring programmes, where skills and competences are developed that benefit both students and tutors, and which -additionally- contribute to the job of becoming university students (Coulon 1995), constitute a comprehensive training space that is worth discussing from the perspective of tutors and whose main purpose is to accompany the university transit of first-year students in undergraduate programmes.

A common characteristic of the peer tutoring programmes developed at Alberto Hurtado University is that they are initiatives designed and implemented by the students of higher grades (tutors) for their peers entering their first year where they develop an annual accompaniment (voluntary participation) and are linked to the academic programmes through a representative of the respective academic team.

The accompaniment developed by the tutors is characterised by a series of socio-educational strategies aimed at the personal and social development of first-year students (Véliz and Navarrete 2023). Based on the interviews conducted, it was possible to identify that, although each peer tutoring programme has its own specific emphasis for each discipline of knowledge, the accompaniment developed is characterised by the following:

- Use collaborative learning strategies among peers.
- Provide guidance in the knowledge of the institutional culture and of the specific programme.
- Generate social networks (at institutional level and among peers).
- Strengthen students' sense of belonging to each specific degree programme.

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doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

- Contribute to the development of adaptation skills, time management, study strategies, oral and written communication.

The analysis allowed us to identify and group together a set of actions from these tutorial strategies that combine individual and group actions according to the requirements of each first-year student:

Individual actions. Tutorials for academic reinforcement and management of specific academic support, accompaniment for personal situations that affect the adaptation and permanence of students, guidance for students in their first year of university on institutional functioning, scholarships and socio-economic benefits.

Group actions. Welcome activities, assessment preparation workshops, study habits workshop, intergenerational meeting events, activities to approach professional practice, organisation of self-care and mental health actions.

Based on the above, regarding the generic competences that are perceived by the tutors, it was possible to identify that, as a relevant skill, interpersonal competences are the main self-perceived benefit for peer tutors. On the other hand, instrumental and systemic competences are perceived by the tutors as skills that helped them to improve their own understanding of learning, their planning skills, leadership and orientation towards professional quality. In the following, we will review these competences in detail.

Interpersonal competencies: key to peer mentoring

Within interpersonal competencies, tutors' self-motivation emerges as a strong characteristic of their identity and role within peer tutoring programmes. When asked about their motivations for becoming tutors, many of them point to their own experience as first-year students in higher education, and the difficulties they themselves had, as one tutor points out:

> It was quite interesting to have been able to become a support for first-year students, helping them in their integration into university life, because we all know how difficult it is to face a new context after having spent years at school (Tutor for the Mathematics Pedagogy study programme).

The tutors' own experience when they entered the first year of university was later transformed into the main interest in participating in these programmes: the possibility of filling the support gaps that they had identified

when entering university, and the process of change that the transition from secondary education to higher education means. In this regard, another tutor points out:

> I have always had the interest -so to speak- of being able to accompany my classmates a little, because, for example, when I got into university I think that I lacked that help a lot, because the change from school to studying at university is quite large, and for people who did not have such a well-established study method, it was a bit difficult to adapt (Tutor for the Anthropology study programme).

By sharing their own experience as first-year university students, tutors perceive that their contribution to the adaptation to higher education is a key factor. Following what Coulon (1995) stated about the challenge of transition from secondary education to higher education, tutors transmit relevant information and experiences to their first-year classmates about the "job" of becoming university students. In this sense, tutors become a key (and necessary) actor to accompany, in a much closer way, this process of uncertainty and adaptation to the university environment. In this regard, two tutors related their own analyses of this process of transition to higher education, and the importance of accompanying their tutees in this process:

> It is a diverse context that is entering the university. These are people who have had fewer support systems in their schooling process, people who really feel at disadvantage in front of their peers due to the same sociocultural, socioeconomic capital. People who, actually, have often a low level of prior knowledge, so it is much more difficult for them to do something that, perhaps, is much easier for other people (Tutor for the Special Education study programme).
>
> It is important to let first-year classmates feel that they are more familiar with the university, or to feel in a safer space. Sometimes it happens that they are in their comfort zone at school, and after entering university, one tends to feel like more of an adult, with more responsibilities, such as attending classes, which is one's responsibility (Tutor for the Geography study programme).

Finally, tutors perceive that when they exercise their role in peer tutoring programmes with their first-year classmates, they validate their own professional identity, and in this accompaniment process, they also provide feedback and better delineate their personal and their professional "beings". One of the tutors, who was a graduate of the course itself, mentioned:

> Students often ask me about how the study courses affected me, how I dealt with them. Then they ask me what I am doing now, because -in one way or another- they see through me what their work field is going to be like or

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doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

> also how they are going to face their study, the tests, classes, or exams (Tutor for the Sociology study programme).

In this way, the tutors also recognize that this is a feedback process between students (tutors and tutees), and that that helps the support of the tutoring. At this point, one tutor noted:

> Being a tutor means you are not going to be neither the teacher nor the psychologist of your peer, but in the end, we are the ones who are going to accompany them, sharing the same experience that we had, so, in the end, I feel that it is an element of experience, of sharing, and of feedback with our pairs. To this day, I see it that way and that is what I like about the programme, which is this interaction that can occur between students and ultimately creates all these bonds until the end of the study programme, which is equally important for the development of a person in their university career (Tutor for the Journalism study programme).

In summary, tutors, in the exercise of their role, by contributing their own experience of when they entered Higher Education, strengthen their interaction skills with others while reinforcing their professional convictions. In doing so, they not only help their first-year peers to have a much closer accompaniment in their transition to Higher Education, but also, through their own action, they also contribute to a different form of knowledge construction, a type of disinterested, genuine and motivational accompaniment.

Instrumental competences: learning orientation and identity-disciplinary strengthening

The point of origin of peer tutoring programmes has a clear emphasis on academic results, which is why one of the main distinctive features that tutors recognize as a skill that they have developed with their first-year classmates, it is precisely the 'orientation to learning'. In this competence, learning is used as a strategy depending on the purpose pursued, "based on the recognition of the learning system itself and the awareness of learning itself" (Villa and Poblete 2013, 157). Regarding this recognition of the learning orientation, two tutors mention:

> It has been very useful for me to be able to analyse strategies, to be able to organize times with them, to be able to learn, above all, from them, because perhaps one is a tutor, but one is constantly learning, so many times the tutees themselves teach us to be able to improve (Tutor for the Mathematics Pedagogy study programme).
>
> Many times, you can learn more outside the classroom than inside of it since feedback between peers is much more rewarding and useful. So, I

> said, 'I think this is the instance in which I can help someone' and that moved me a lot (Tutor for the Journalism study programme).

In this same sense, regardless of the specific contents that both the different peer tutoring programmes and the tutors themselves could prioritise, being oriented towards learning, as any social intervention process, requires planning. This exercise puts into action a significant number of more specific skills, which are strongly linked to the most specific competencies of each discipline. Villa and Poblete (2013) point out that the development of planning competence necessarily also entails the deployment of other associated competences: "Analytical and critical thinking, decision making, problem solving, time management, project management, rationality, etc." (Villa and Poblete 2013, 163). The links between these competencies were clearly identified in the interviews with the tutors in our research. One of the tutors specifically referred to the flexibility of this planning depending on the context, and notes:

> Something that we also saw during the course of our studies is being tactful with the students and in this case with our tutees. We cannot turn a blind eye to the situations that happen just to comply with a plan that perhaps has no importance for the students at that moment, because they have something much more relevant in their lives that is happening, and if they cannot deal with that, they would not be able to do anything else (Tutor for the Mathematics Pedagogy study programme)

Another tutor referred more specifically to how their own planning competence as tutors is transferred to their tutees:

> I was not a teacher with them, and I was not a student either, so they felt more confident (...) it was also possible to generate a more permanent connection where the students still request support and that is still good. In the end that is what it is about for me: the accompaniment. I started by talking about the cognitive skills and the soft skills that one must have to start studying, entering the world of the university, I showed them study strategies, I was presenting the subjects, the schedules, I gave a calendar to each student so that they could start planning themselves (Tutor for the Special Education study programme).

Finally, the instrumental competences that tutors develop in their role with first-year students, as they are linked to learning processes and, in addition, as they are deploying professional development skills in each of their disciplines of origin, the 'learning to know' (Delors 1996) becomes a much more localised type of competence, because not only is there the fact of learning the 'job' of being university students in general, but also the 'job'

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of becoming professionals in training in their own discipline in particular. As it is a task carried out among students from the same undergraduate programme, this generates a much more synergistic and positive identity-disciplinary learning, particularly for the tutors, who have the ideal possibility of putting their own professional learning into practice with their first-year peers.

Systemic competencies: leadership and quality of peer tutoring

An important characteristic of the peer tutoring programmes that were the subject of this research is that they are projects that are designed, planned, and executed mainly by the tutors themselves (who, in turn, are students) of the different undergraduate programmes. With a greater or lesser level of autonomy, it is the tutors themselves who develop the purposes and methodologies of these support strategies. Certainly, Alberto Hurtado University has made progress in providing them with a minimum training system regarding the tutorial function, but, in general, the space for autonomy of the tutors in these programmes may be one of their most distinctive characteristics. For example, an elementary education tutor tells us that:

> The programme works based on volunteering and on the work of the people involved in the project, and in that case that work is completely managed by students. From time to time there are meetings with the Director [of the degree programme] for specific issues or for topics more than anything to support us with promoting the programme, etc., but everything is always created, managed, and guided by students and we always try to function in a much more constructivist logic (Tutor for the Elementary Education study programme).

This leadership exercised by the students who are tutors, gives -in addition to a particular identity to each programme- a sense of horizontal learning community that provides the tutors with a high sense of responsibility and concern for the quality of their work carried out with their tutees. This identity is recognized by a tutor as a learning community. In this regard, she points out:

> They are the most powerful learning communities because they teach you leadership development, interpersonal relationships, introducing yourself to other people and that is not something that everyone has (Tutor for the Special Education study programme).

For another tutor from the journalism programme, this identity is precisely the horizontality between students (peer tutoring), and she points

out that even this could fill a gap in terms of the students' personal well-being. She points out:

> We are students who help other students, I think that accounts for collaboration. For me it means supporting each other, helping the other person in things that perhaps, in an academic regard, the university does not provide so much personalized support, but rather the university provides generalized knowledge, but does not worry about the personal and individual well-being of each student (Tutor for the Journalism study programme).

In this sense, tutors develop a broader view of university education and are recognised as a significant actor who is located precisely in the gap between the students' own trajectories (in their process of entering Higher Education) and the learning expectations of the graduate profiles of their academic programmes. In many cases, this gap is seen as an integral contribution to the socio-emotional well-being of students entering university, which means that tutors - having developed instrumental and interpersonal competences - are able to visualise more comprehensive strategies for improvement through peer support.

VIII. Discussion

In peer tutoring, as proposed by Topping (2015), both tutees and tutors benefit themselves from this relationship. Although the research carried out on the topic has addressed the impact on tutored students more extensively, research on the specific impact on the tutors themselves has been much less explored, and this is precisely what has been made visible in the findings of this research.

By combining the categorical analysis of tutors' own perceptions of the benefits and impact of peer tutoring programmes; the analysis from the 4 axes of comprehensive training by Delors (1996) and the taxonomy of generic competencies of higher education proposed by Villa and Poblete (2013), it is possible to establish some articulations among these elements to better understand the contribution to tutors in these programmes.

As evidenced in the results, peer tutors develop generic competences which, on the one hand, point to the 3 types identified by Villa and Poblete (2008): interpersonal, instrumental and systemic, but on the other hand, also contribute to broadening these categories towards a notion of integral training which aims to develop all the dimensions of the human being, and which has as its ethical-political horizon not only training but also the transformation of society.

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 163-189 •
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In the **interpersonal competences**, mainly related to the skills to relate to and collaborate with other people for the achievement of common purposes, the peer tutors recognise that, in the development of their role in the tutorials, they also strengthen their own self-motivation, as, having been students on the undergraduate programmes (just like their peers), they permanently value and re-signify their own role as students, but with a different degree of responsibility when they identify themselves as tutors, as they pay special attention to the way in which this knowledge is transferred to their peers. This generates a type of feedback that is not reduced to the development of specific competences but transcends a certain way of constituting themselves as students of a specific degree course (strengthening of identity).

In the development of **instrumental competences**, which is oriented towards the means for achieving certain professional competence goals, tutors not only provide guidance in the specific profession of the disciplines in which the undergraduate programmes they contribute to are inscribed, but also all of them collaborate in the construction of the profession of being university students. In this sense, although the tutors develop a clear learning orientation, they also transfer their own experiences and the decisions they themselves made as students, so that the development of generic competences such as time management, planning strategies and decision-making is guided by the tutors from a professional, but also experiential, knowledge, which contributes to a more comprehensive view of learning.

Finally, regarding the development of **systemic competences**, tutors contribute directly to the development of an overall vision of university education, enabling students (and themselves) to assess how contributions from different perspectives, academic trajectories and support contribute in an integral way to professional, but also personal, education. In this way, tutors strengthen their own autonomy (as they now have a collegiate voice that gives them their own experience), improve their methodologies and techniques for accompanying students (which adapts to the characteristics of the student body) and exercise a leadership role that is recognised and valued by their peers.

The tutors, by strengthening their own competences; re-signifying their own identity and role (from the profession of becoming students in their own discipline); having the possibility of transferring their knowledge and experiences, developing a sense of responsibility (as a learning community); strengthening their autonomy and leadership; recognise and reinforce the indivisible dimension of the integral human being in 'learning to be', since, in the exercise of their role, they not only deploy their own personal professional

values in their training trajectories (as professionals), but also, in 'learning to be', they develop as key facilitators of integral training (as people).

By further exploring the motivations of the tutors - as also suggested by Beltman and Schaeben (2012), it was possible to advance to a broader motivational framework that allowed us to identify competences deployed by peer tutors at different levels (interpersonal, instrumental, and systemic), each of which may become areas of interest for future research, but may also be areas for training and continuous improvement of the peer tutoring programmes themselves in the future. As Amor (2020) points out, university students need to be mentored in the professional, academic and personal dimensions, and, in the author's opinion, they contribute to quality and innovation in universities.

Peer tutoring programmes recognise the social gaps and transit barriers in the education system (Mella and Moya 2024; Narro and Arredondo 2013), and allow tutors - in the development of their own and students' competences - to contribute as protagonists in the transformation of the social, to enhance their social commitment to the service of others (Villa and Poblete 2008), and allow them to collaborate far beyond training (or the formality of training to be more precise); making integral education itself a process of permanent recognition of human heterogeneity and the development of the human being in its multiple dimensions.

Limitations and future lines of research

An important limitation of the research is that the results of this case study on the motivations and learning of tutors in peer tutoring programmes at a Chilean university do not aim to generalise the role played by tutors in all other higher education institutions, but rather allowed us to make the study more complex with regard to university transition processes by looking more deeply into the importance of the articulation of generic competences developed from this role in comprehensive training.

A second limitation of the study is that, although it focuses on the role of tutors, a possible triangulation could also have been explored regarding the same role, but from other actors such as the tutored students themselves or the management/academic teams. This limitation thus opens the first line of inquiry for future research into the perceptions of students and academics regarding the role of tutors in the development of generic competences and comprehensive training.

Other possible lines of research that can be explored could be linked to the methodologies used to accompany peer tutoring programmes, both

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doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

individual and group. The way in which the tutors themselves implement, adapt, evaluate and improve these strategies can contribute to nurturing the methodological field of these initiatives, which could also visualise institutional alternatives for supporting and financing these programmes.

Finally, we believe that it is necessary to create more collegial training and development strategies for tutors (Clarence 2016), which can mediate between the autonomy of the tutors themselves and the more general orientations of the higher education institutions where peer tutoring programmes operate. In this sense, it would be interesting to be able to encourage action research by the tutor teams themselves, to build more specific knowledge of tutoring action from the perspective of those who guide these processes.

IX. Conclusion

By observing the contribution of peer-student tutoring to the tutors themselves, this research already contributes to valuing the formative trajectories of the students, and, as we have seen, the space for interaction that occurs in peer tutoring contributes to the idea of comprehensive training of 'learning to be' as an articulating axis of comprehensive training. This highlights not only the need to articulate accompaniment strategies from a much more comprehensive perspective, but also that peer tutoring spaces deserve to be developed because they have a social and political purpose by themselves, and because in one way or another, they contribute to improving equity in higher education, addressing the inequality gaps present in the Chilean education system.

By shifting the focus of observation from the impact on the competences of those being tutored to the impact on the competences developed by the tutors themselves, the research contributed to reflecting on top-down strategies in higher education (which could reproduce the inequalities of the education system), transforming the focus from useful learning to a more horizontal construction (bottom-up) where the concern for comprehensive training can be deployed in competency-based learning codes. This has not been sufficiently visible but could contribute to a much more participatory institutional vision of the university, with different levels of support for students who are not only being trained for the world of work, but also (especially from the hallmark of the Alberto Hurtado University) are being trained as socially responsible people.

In this sense, the decentralised work on educational achievements carried out by tutors contributes to the construction of disinterested knowledge that

also contributes to the motivation of the students being tutored. The tutors - who have the possibility of putting their own professional learning into practice in the peer tutoring spaces - recognise this privilege from a sense of identity and responsibility, which orients the tutors to carry out quality-oriented work that compels them to have a greater understanding of their peers from a perspective of student welfare that exceeds the purposes of the peer tutoring programmes.

In this scenario, the tutors of peer tutoring programmes are not only aware of this important contribution to comprehensive training and equity in education, but also, from the discomfort of being in the interstices of university training (neither dependent nor independent of Higher Education institutions) they have legitimised themselves as a key participant in the accompaniment of their peers, contributing - in the development of their role - other ways of inhabiting the university, more comprehensive and collaborative.

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 163-189 •
doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

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© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 163-189 •
doi: https://doi.org/10.18543/tjhe.2983 • http://www.tuningjournal.org/

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What ideas about climate change do future science teachers possess and how do they integrate them when arguing about greenhouse effect? A case study

Marina Martínez-Carmona, Beatriz Bravo-Torija, and Luisa López-Banet*

doi: https://doi.org/10.18543/tjhe.3020

Received: 23 April 2024
Accepted: 21 January 2025
E-published: June 2025

Abstract: Climate change is one of the socio-environmental problems with the greatest complexity and media impact in the world. However, difficulties have been observed in its understanding. In this study, we worked on this social problem in the classroom through argumentation, from the evaluation of different statements made about the causes and consequences of climate change, considering the evidence provided. The study was carried out with a group of 18 future physics and chemistry teachers to encourage argumentation. They had to write an essay expressing their opinion about a statement extracted from a news item, considering whether the big corporations that manage hydrocarbon reserves are really responsible for denialism, containing arguments that supported and refuted the theory. The data collected and analysed were their essays and their answers to the question: How do you think gases can affect the increase in temperature? The analysis is framed in qualitative content

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Acknowledgements: None.

Funding: This work has been partially financed by the projects PGC2018-097988-A-I00, funded by FEDER/Ministry of Science and Innovation (MCI) of Spain-State Research Agency (AEI) and Project PID2023-150682NA-I00, Spanish Ministry of Science, Innovation, and Universities, MCIU/AEI/10.13039/501100011033/ FEDER, UE.

Conflict of interests: None.

analysis. The results show that justifications based on evidence from reliable sources were scarce, being mostly opinions. Future teachers have difficulty in both assessing the reliability of data and integrating evidence in their justifications. They positively valued the activity and expressed their intention to put it into practice in their professional future. We consider it essential that initial teacher training includes how to teach the same activities that it would be desirable for teachers to put into practice.

Keywords: climate change; greenhouse effect; argumentation; higher education; initial teacher training.

I. Introduction

Spanish law (Ministerio de Educación y Formación Profesional 2022) currently indicates that "Competence in science involves understanding and explaining the natural and social environment, using a set of knowledge and methodologies, including observation and experimentation, in order to raise questions and draw conclusions based on evidence". In other words, it advocates the development of scientific skills such as recognition of researchable problems, design of experiments, analysis and interpretation of data, or the obtention of conclusions based on evidence, all framed in real problems such as climate change, as selected in this article. Therefore, there is a shift in science education from an education that focuses on theoretical content to an education that provides students with opportunities to develop scientific skills and enables concerns and involvement in environmental problems, making them aware that their behaviour could contribute to solving them (Jaén and Barbudo 2010). This change of educational approach would make it possible to develop a better relationship among causes, consequences, and actions to be taken in order to the face the climate crisis (Bello Benavides et al. 2021).

I.1. The chosen context: climate change

Currently, climate change is a socio-environmental problem with great complexity and media impact (García-Rodeja and De Oliveira 2012; Shapiro Ledley et al. 2017), and it has a relevant role in the Spanish secondary education curriculum. However, its study is associated with a series of recurring difficulties. Prieto and España (2010) detected that students, media, and the general public use terms such as "climate change", "global warming" and "greenhouse effect" interchangeably. This leads to the error of understanding the greenhouse effect as a negative phenomenon instead of a necessary process to allow life on Earth (Prieto and España 2010). It has been also observed that

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 191-212 •
doi: https://doi.org/10.18543/tjhe.3020 • http://www.tuningjournal.org/

students tend to associate climate change with other phenomena, such as the hole in the ozone layer or acid rain (Bello Benavides et al. 2021; Fernández Ferrer et al. 2011; Hoyuelos-Álvaro and Ibáñez-Quintana 2023). Regarding greenhouse gases, and in particular CO_2, some students possess preconceptions about its possible toxicity to living beings without considering its role in processes relevant as photosynthesis (Boronat-gil et al. 2018).

These difficulties in understanding climate change are due, among other factors, to the fact that most people have the media as their only or main source of information (Meira Cartea et al. 2009; Morote and Moreno 2022; Prieto and España 2010). This means that their conceptions about its causes and consequences derive from what comes through the media (Bingle and Gaskell 1994). This can lead to confusion, because the topic is often treated in a disjointed way according to the news of the moment. Besides, the reliability of some of the sources of information is questionable. As Oreskes (2004) pointed out, although there is unanimity in scientific journals on the anthropogenic nature of global warming, more than 50 per cent of press publications express doubts about the existence of climate change and its possible causes.

Regarding possible solutions to reduce CO_2 emissions, most students from all countries propose a radical reduction of CO_2 emissions but without showing awareness of the possible economic consequences (Andersson and Wallin 2000). According to Andersson and Wallin (2000), this highlights the current limitation of relating social and economic aspects to scientific aspects. Therefore, working in the classroom on problems related to science in social contexts, such as climate change, allows students to be aware that to address these issues it is not enough to know science. They must consider economic, ecological, political, ethical aspects, because they also come into play in the decision-making processes (Prieto and España 2010).

I.2. Addressing climate change in the classroom

In recent years, studies have been carried out to analyse how students and their teachers perceive climate change (Boon 2010; Punter et al. 2011) and how it should be addressed in the classroom (Ariza et al. 2021). According to Allen and Crowley (2017) or Stevenson et al. (2017), the approach to climate change should have a socio-cultural and global participatory dimension. For this type of problem, Alméstar et al. (2022) proposed a multidimensional, quintuple helix approach in which different institutions work together with the objective of driving competencies and actions from the educational community to the neighbourhoods. Society should link thinking with problem-solving, and innovation skills with knowledge of scientific methods.

After conducting a literature review, Ranney and Velautham (2021) proposed a series of ten brief and compelling types of information for use in class to promote the development of students' scientific skills while achieving a successful revision of climate change beliefs. Examples are representative statistics on greenhouse gas/temperature/glacier changes or texts that enhance understanding of the physicochemical mechanism of global warming. Ranney and Velautham also integrated this information in activities that encourage reasoned discussions among students.

Working on climate change in the classroom could be done through argumentation, since evaluating the different claims about the causes and consequences of climate change in light of the evidence provided can help students to improve their understanding of the phenomenon itself (Ariza et al. 2021; Dawon and Carson 2020). To do so, the development of argumentation skills is crucial. Argumentation promotes that students can develop a greater understanding of scientific phenomena by having to evaluate the validity of the evidence that supports, or not, a given conclusion based on their conceptual knowledge or by selecting those data they consider adequate to support a conclusion (Bravo-Torija and Jiménez-Aleixandre 2018; Dogruer and Akyuz 2020). Therefore, students should evaluate the information provided, identifying the important data, interpreting them, and considering their reliability. Then they should establish a justified conclusion, evaluating the different options provided.

I.3. Training of teachers in strategies to address climate change

The introduction of argumentation into the classroom, especially to work on complex problems such as climate change, is therefore a necessity in which teachers play a relevant role. However, promoting this type of activity is not an easy task for teachers (Vílchez-González and Bravo-Torija 2015). Pérez-Mora and Gértrudix Barrio (2020) showed that early childhood and primary education teachers could have sufficient conceptual knowledge of environmental problems but they were deficient when it came to working on these issues in the classroom. These difficulties have also been reported in pre-service secondary science teachers, for whom Erduran et al. (2006) recommended formative feedback in argumentation activities. One reason for this problem could be related to their previous education. Ariza et al. (2021) found that pre-service secondary science teachers tended to replicate the educational models they experienced as students, mainly a traditional approach based on the transmission of theoretical concepts. Therefore, during teacher training, is necessary to confront them with situations far from these traditional models

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doi: https://doi.org/10.18543/tjhe.3020 • http://www.tuningjournal.org/

based on "what do we want to know?" with a focus on learning a closed body of knowledge (Grandy and Duschl 2007); situations should instead focus on "what do we want to know how to do and what do we need to do for that?", wherein the learners should understand how scientific knowledge is constructed and validated by the scientific community and the processes involved in it. This paradigm shift would have major repercussions, since the consideration of what science is and how it is learned and taught is a key element in how future teachers approach science education (Reiser 2013; Revel Chion et al. 2021).

In relation to climate change, a study conducted by Fernández Ferrer et al. (2011) concluded that it is necessary to train teachers in critical thinking, with better training on environmental issues, especially at a time when they receive most of their information on climate change from social networks, which constitutes a risk regarding the interpretation, search, and contrast of information (Morote and Moreno 2022). Therefore, in teacher training there is a need to carry out training activities that encourage the young teachers to contrast information derived from media and academic work.

This background highlights two relevant facts. The first is the importance of developing scientific literacy, with a perspective of awareness in order to reach action (using what is known to make decisions and take actions), and it is essential to promote an adequate capacity for argumentation that allows us to relate what we know to making meaningful decisions. To do so, future teachers should have opportunities during their training to carry out activities that can serve as a reference framework to address these issues with their future students. In this work, we use an argumentation activity contextualized in the greenhouse effect with a double purpose: 1) to analyse the capacity of physics and chemistry teachers in training to integrate ideas of climate change with provided data in order to write an essay to answer how greenhouse gases can affect the increase in global temperature; and 2) to serve as a model for teaching science from the perspective of "what do we want to know how to do and what do we need to do for that?"

We posed the following research problems:

What ideas about climate change are teachers in training able to combine and integrate when answering the question about how greenhouse gases can affect the increase in global temperature?

What aspects do teachers in training use when evaluating the statement considering whether the big corporations that manage hydrocarbon reserves are really responsible for denialism?

How many of these aspects are scientifically substantiated?

II. Materials and methods

II.1. Methodology

The present research work is a case study in which the argumentative process on a socio-scientific topic is used as a teaching strategy for future teachers (Kim, Anthony, and Blades 2014). In this research, we conducted a qualitative study on how students apply the ideas they have about climate change, identified through content analysis (Bardin 1996), and how they justify them based on the sources of information used.

II.2. Participants

This study was carried out at the University of Murcia with a group of 18 students (11 women and 7 men) following a Master's degree in teacher training, required to become a science teacher in secondary education. These students had previously studied chemistry (6), physics (6), biochemistry (4), chemical engineering (1) and food technology (1).

II.3. Proposed activity

The proposed activity consists of providing a current news item (https://elpais.com/elpais/2019/09/18/eps/ 1568820907_023534.html) that deals with the opinions of people from different fields on climate change.

The purpose of this activity is to encourage argumentation and evaluate how students justify different positions. It is proposed that future teachers read the press article and look for complementary information to respond in an informed manner to a series of questions such as "How do you think gases can affect the increase in temperature?", the answers to which are analysed in this paper.

This will be followed by a group discussion to encourage collective debate. Finally, individually, they should write an essay (also discussed in this paper) expressing their opinion on a statement extracted from a news item considering whether the big corporations that manage hydrocarbon reserves are really responsible for denialism, containing arguments that support and refute the theory. To do this, it is necessary to start from the scientific ideas that have been discussed in the didactic unit, along with value aspects (ethical, moral, health, environmental).

II.4. Data collection and analysis

The data collected and analysed were the students' written responses to the two tasks proposed in the activity.

Tuning Journal for Higher Education
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doi: https://doi.org/10.18543/tjhe.3020 • http://www.tuningjournal.org/

Considering the research question, what ideas about climate change are future teachers able to combine and integrate when answering the question about how gases can affect the increase in the temperature of planet Earth? In order to identify which content knowledge is required by future teachers to answer the question and how they should relate to them; firstly, we selected different sources of information considering the topic and how it is addressed in secondary education. The sources were: a) secondary school textbooks, specifically those that refer to the greenhouse effect and climate change; b) scientific reports and articles that address the greenhouse effect, its increase and its consequences for the planet (Zein and Chehayeb 2015; PCC 2014); and c) studies related to the ideas that students present about what the greenhouse effect is and how its increase influences climate change. Then, to characterize the core scientific ideas in these documents, we followed the methodology of analysis based on reading (textual or visual) which is characterized by systematic, objective, replicable and valid reading aiming to discover and extract the basic contents of a given phenomenon (Noguero 2009). From crossing these sources, the ideas that it is considered that teachers in training should be able to identify and integrate to respond to the task are as follows:

A) Energy exchange (or energy transfer on Earth). The Earth receives a large amount of energy from the sun in the form of radiation that includes all electromagnetic frequencies. Some of this radiation passes through the atmosphere, is reflected and returns to space; other radiation reaches the ground and increases its temperature to the point of equilibrium and is re-emitted to space in the form of infrared (IR) radiation (700–1000 nm).

B) Identification of greenhouse gases and their characteristics. There are many gases in the atmosphere, but only some of them can absorb IR energy. The ability of a gas to absorb IR energy depends on its structure and the types of bond that form it. Specifically, the major gases N_2 and O_2 cannot absorb this range of wavelengths, while carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), water vapor (H_2O) and ozone (O_3) can, since they have vibrational modes that allow them to absorb IR photons. For this reason, they are known as greenhouse gases.

C) Use of the kinetic model. The energy absorbed by the greenhouse molecules provides motion and therefore kinetic energy to them. Since the temperature of a gas is a measure of the velocity of its component molecules, the absorption of IR photons increases the velocity of its molecules, which increases the temperature of greenhouse gases.

D) Role of the greenhouse effect on Earth and the consequences of its increase for the planet's temperature. Without this natural greenhouse effect, the Earth's equilibrium temperature would be about -18°C; however, the average temperature of the Earth's surface is roughly 14°C, a difference of around 33°C, which gives us an idea of the magnitude of the effect. This natural effect is therefore beneficial. However, in recent years, excessive greenhouse gas emissions (mainly from the burning of fossil fuels) have begun to modify the Earth's climate at a problematic rate. In the last 50 years alone, we have doubled greenhouse gas emissions.

Table 1

Definition and examples of the categories of analysis constructed for this study

Category	Future teachers are able to	Example
C1	Relate the absorption of IR from the Earth to the molecular structure of greenhouse gases and their effect on temperature, with the consequences of the increase of the greenhouse effect on the planet.	No examples.
C2	Relate the absorption of IR from the Earth to greenhouse gases and the increase in the Earth's temperature, without considering the consequences for the planet.	A5: The greenhouse gases mentioned above (CO_2, N_2O and CH_4) absorb the Earth's infrared radiation, causing the Earth's surface temperature to rise.
C3	Relate the excess amount of greenhouse gases to the absorption of radiation and the increase in the Earth's temperature. Negative conception of the greenhouse effect.	A18: The increase in greenhouse gases means that the generation of long-wave radiation by the Earth does not go out. Therefore, there is an increase in temperature.
C4	Relate the absorption of solar radiation by gases to the increase in the Earth's temperature.	A14: Some particles absorb solar IR radiation, which has a warming effect.
C5	Use non-task related answers.	A12: Increase of holes in the ozone layer. More ultraviolet enters. Increase in greenhouse gases.

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Taking into account the ideas described, five categories were established (Table 1). These categories were arranged in a continuum from those that combine and integrate the two criteria mentioned above (C1) to those that provide other ideas not directly related to the task (C5). The answers can range from those that refer to the relationship between the absorption of IR from the Earth with the molecular structure of greenhouse gases and their effect on temperature, with the consequences of the increase of the greenhouse effect on the planet, to those not directly related to the task, such as the supposed role of the ozone layer in the increase of greenhouse gases.

Once the core ideas and categories were established, the researchers analyzed how students used these ideas to answer the question by fragmenting students' responses into different units of analysis. Based on Henri (1992), units of analysis in written responses are defined as concrete fragments in which students refer to specific scientific ideas. In this study, the unit of analysis is any specific segment in which students reference ideas related to the increase of the greenhouse effect on the planet, including its causes and consequences.

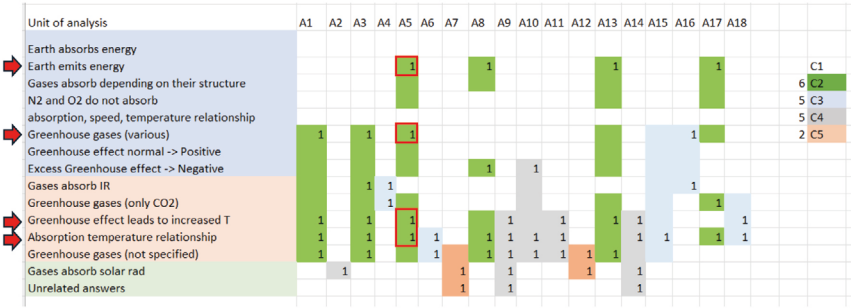

Fig. 1

Emptying of student responses based on their units of analysis. The red boxes indicate those units of analysis included in the answer of student A5 (example)

Finally, each student response was classified into a specific category based on the units of analysis used and how these units were combined. For example, consider the response of student A5: "The CO_2, NO_2, and CH_4 gases emitted absorb the Earth's infrared radiation, causing the Earth's surface temperature to rise." This response (Fig. 1) demonstrates a partial understanding of the greenhouse effect. It incorporates two key ideas

typically found in complete conceptions: the emission of energy by the Earth and the variety of gases involved in the greenhouse effect, extending beyond just CO_2. However, the response does not fully encompass all the elements characteristic of a complete understanding. For instance, while the student connects the greenhouse effect to a rise in temperature, they fail to specify that this temperature increase is beneficial under normal circumstances, with only excessive increases being harmful.

Regarding the second and third research questions, addressing the aspects on which the future teachers base their evaluation of the statement considering whether the large corporations that manage hydrocarbon reserves are truly responsible for denialism and how many of these aspects are scientifically substantiated, the answers were analysed based on two criteria: 1) the aspects on which they focused their response (health, economic, ethical and environmental), proposed by Ruiz Gonzalez et al. (2021), adding two new categories—political and educational aspects—after considering the answers given by the future teachers; and 2) whether their answers were supported by reliable sources (Christenson and Chang Rundgren 2015; Ruiz Gonzalez et al. 2021) or only by a learned pattern or an opinion (Rodríguez et al. 2021).

Finally, an anonymous, voluntary questionnaire on students' opinion of the activity was conducted online using the wooclap platform. The questionnaire consisted of 3 sections: First, on a Likert scale of 5 (1 not agreeing at all and 5 strongly agreeing) they had to express their degree of agreement or disagreement with two statements: 1) The activity is well designed and 2) I believe that this type of argumentation activities is necessary in secondary education. Secondly, they had to indicate from 1 to 5 (1 being nothing and 5 could explain it to a friend), the knowledge they thought they had about argumentation activities before and after doing the activity. They were also given the option to include any free comments (suggestions for improvement, elements to highlight, etc.) about the activity.

III. Results and discussion

III.1. Ideas on climate change from future teachers of physics and chemistry

As can be seen in Table 2, none of the students provided an answer that could be included in category C1. This fact is remarkable, since given their previous training (most of them graduated in chemistry or biochemistry) it was expected that they would be able to establish a relationship between the

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doi: https://doi.org/10.18543/tjhe.3020 • http://www.tuningjournal.org/

molecular structure of gases, specifically those that are part of the greenhouse effect, and their ability to absorb infrared radiation. They should also be able to connect these ideas with kinetic theory, recognizing that an increase in the vibration of the molecules due to the absorption of radiation would imply an increase in the temperature of these gases. Besides, an increase in the amount of these gases in the atmosphere has consequences for the temperature of the planet.

Table 2

Results of the first research objective

Category	No. of students
C2	6
C3	5
C4	5
C5	2

Six answers were classified as C2 because they do identify the absorption of infrared radiation from the Earth with the greenhouse gases that cause the increase in temperature, although they do not refer to the structure—for example, A17: "Increasing the concentration of CO_2 increases the energy remaining in the Earth from the sun, in the form of heat, since CO_2 allows solar radiation to pass through, but retains IR radiation". However, these answers do not refer to whether the greenhouse effect is positive or not, but simply describe the increase in temperature produced by these gases or establish a direct relationship between the increase in gases and the increase in temperature. The lack of connection between the causes and consequences of this increase in the greenhouse effect has been previously described (Bingle and Gaskell 1994; Jeffries, Stanisstreet, and Boyes 2001; Liu 2021).

Thirdly, five future teachers provided a response that falls into category C3, since they recognize the existence of the greenhouse effect but attribute exclusively negative connotations to it. They consider that it is the increase in greenhouse gases, and not their presence in natural concentrations, which causes the absorption of IR radiation and, therefore, the increase in the Earth's temperature. This can be seen in in the response of A15: "The increase of gases in the atmosphere absorbs the Earth's infrared radiation, producing an increase in the temperature of the Earth's surface". As Prieto and España (2010) pointed out, this confusion, which is quite common, may

be linked to the fact that terms such as "climate change", "global warming" and "greenhouse effect" are often used interchangeably, generating the false belief that the greenhouse effect is negative per se. These results demonstrate the need to work on this content in the classroom in a deeper way to avoid confusion between relevant concepts in today's society.

Five answers were classified within category C4. This category includes those that reflect an erroneous understanding of the greenhouse effect, in which the radiation absorbed by greenhouse gases is that emitted by the sun and not that radiated by the Earth because of its warming. For instance, the answer of student 9 claims that "Greenhouse gas particles absorb solar and infrared radiation in the atmosphere and therefore have a warming effect". This alternative idea is also frequently found among secondary school students (Andersson and Wallin 2000).

Finally, we found that only two of the answers provided, A12 and A7, did not address the question posed (C5). In the case of A7, the response is as follows: "Suspended particles, depending on its composition, can have a warming effect on the climate, for example, carbon black, resulting from incomplete combustion of fuels, absorbs solar and IR radiation in the atmosphere. Atmospheric changes in ozone concentration, as UV radiation generates O-radicals, which cause a temperature increase". A12 is presented as an example in Table 1. In these answers, we find the use of ideas that are not directly related to the question posed, since although it is true that the emission of certain greenhouse gases such as chlorofluorocarbons (CFCs) destroys the ozone layer, its consequence is not an increase in the Earth's temperature, but a greater penetration of ultraviolet rays that cause damage to the skin's DNA. This idea on the part of both high school students and future primary school teachers has been previously described by other authors such as Bello Benavides et al. (2021) and Fernández Ferrer et al. (2011). However, it is noteworthy that it is also present among graduates in scientific careers in which this phenomenon is treated in greater depth. It would be expected that with the knowledge acquired during their scientific training they would be able to distinguish between what global warming is and what it produces and what the depletion of the ozone layer is and its consequences. However, we see that, although in low proportion, we continue to find these ideas among future teachers. We also highlight a difficulty in associating the term 'particle', instead of 'molecule', to gases, which, although not directly related to the question, was observed in several answers (A7, A9 and A14). This term is imprecise, as a particle, defined by Oxford Advanced Learner's Dictionary as "a very small piece of something", is usually used for smaller elements such as electrons, protons, or quarks.

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III.2. Aspects on which future teachers base their arguments and reliability of the sources consulted

Table 3 analyses the aspects (economic, ethical, social, political, etc.) that students refer to when evaluating the statement considering that the large corporations that manage hydrocarbon reserves are truly responsible for denialism. It includes three sections: the number of students selecting each aspect, the number of answers that are justified by evidence, and the number of answers that are mere opinions. The aspect that appears most frequently in the responses of the future teachers is economic (17). Most of them refer to the economic advantages enjoyed by large corporations thanks to the sale of hydrocarbons—for example, A11: "Certain organizations may promote these arguments out of economic and oil power interests." Of all these answers, only twice is the information provided substantiated, as in A7: "It may be that the denialists are responsible for the large companies that speculate on the price-oil ratio and do not care about the human cost, as reported by the CREAF blog [Centre for Ecological Research and Forestry Applications]".

All other justifications (15) are considered naïve by not including the source on which they rely, as in A2: "I think … that the origin of denialism is in large oil corporations seeking economic benefit."

Table 3. Aspects referred to by students to justify their answers (including the number of students selecting each aspect and differentiating between those that are arguments justified on evidence and mere opinions).

Table 3

Aspects referred to by students to justify their answers (including the number of students selecting each aspect and differentiating between those that are arguments justified on evidence and mere opinions)

Aspects	Nº students who include evidence	Substantiated evidence	Opinions
Economic	17	2	15
Environmental	11	0	11
Social	11	0	11
Ethical	6	1	5
Health	3	0	3
Political	1	1	0
Educational	1	0	1

Secondly, among the most frequent aspects, we find environmental and social aspects referred to by 11 of the 18 future teachers. When referring to environmental aspects, they cite the consequences of the increase in greenhouse gases, as in A7: "But I would point out the atmospheric deterioration due to polluting gases. It is a resource that is not always going to be present." Those of a social type are mostly related to the lack of scientific education of citizens, as in A15: "The lack of adequate information can also be responsible for denialism."

None of the responses included in these categories were classified as well founded. Most of the responses do not refer to any type of data on which to base them, and others that, a priori, seemed to be based on historical data, do not indicate their origin or location, as in the case of A6: "They claim that this increase is natural because it has been happening all our lives. And it is true that climate change (temperature increase in particular) has always been there. But using (historical) temperature data one can check the change in the trend of this increase with the beginning of industrial activity."

On the other hand, six future teachers included ethical motives in their arguments, suggesting that the owners of large corporations, despite knowing the harmful effects of hydrocarbon consumption, prioritize their economic wellbeing over social welfare. One of the answers included in this section (already reproduced in the economic motives as A7) is well-founded given that it refers to the CREAF blog as a source of information consulted. Another example is found in A14: "With these data, the only reasonable option is for capital to take precedence over morality and for large corporations to promote ignorance and anti-intellectualism for economic purposes." The difference between this statement and the one used by A7 is that in this case it is not substantiated.

Finally, and to a lesser extent, there are health, political and educational aspects. The only political answer is well founded and is previously cited in the sections on economics and ethics. The answers classified under health and educational aspects are not well founded, such as A7: "There are also a large number of diseases associated with CO_2 emissions"; or A14: "The solution lies in providing citizens with scientific tools and knowledge."

III.3. Student's opinion about the activity

12 of the 18 students in the course responded to the anonymous, voluntary question-naire. As can be seen in Fig. 2, in which they scored 4.3 out of 5, the students considered that the proposed activity was well designed. Their

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opinion on the appropriateness of incorporating this type of argumentation activities in secondary education was even higher, 4.6.

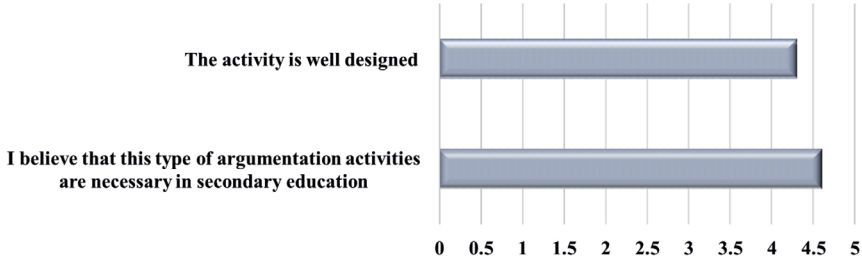

Fig. 2

Degree of agreement or disagreement of the students with respect to the activity carried out (1 not agreeing at all and 5 strongly agreeing)

Furthermore, although they considered their initial knowledge of argumentation to be adequate (3.4), there seems to be a consensus that the development of the activity was useful for them to improve considerably (4.4) in argumentation and how to take it to the classroom (Fig. 3).

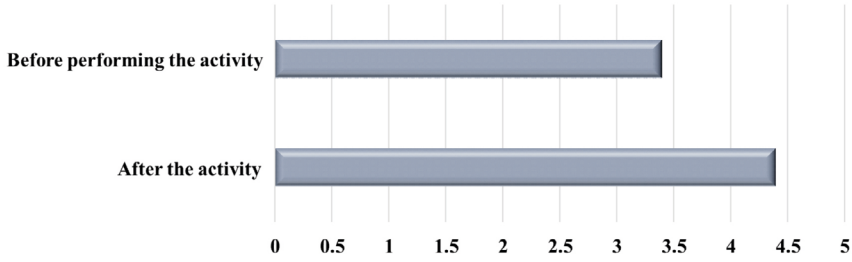

Fig. 3

Students' perception of their knowledge in argumentation activities. Before and after performing the proposed activity (1 being nothing and 5 could explain it to a friend)

In the last section, in which they could include any comments, the 12 students empha-sized the importance of this type of activities and how useful are for the training of future citizens. As an example, the following are some of the students' comments: ¨The activity was quite attractive and serves both to learn and to put knowledge into practice¨, ¨I think it is very important to

deal with the issue of climate change in a scientific way and to inte-grate it into the daily knowledge of students¨ and ¨The approach and execution is very simple, which gives great value to the practice¨.

IV. Conclusions and educational implications

The results of this study reveal that the knowledge about climate change shown by future physics and chemistry teachers is incomplete or partially erroneous. This is evidenced by the fact that when asked about climate change, none of the future teachers gave a complete answer in terms of the relationship between the molecular structure of greenhouse gases and their absorption of IR from the Earth, and their effect on temperature, with the consequences of the increased greenhouse effect on the planet. The union of these concepts is essential to acquire a complete understanding of the phenomenon of climate change and thus be able to address it later in an appropriate way with their students.

Regarding their ability to select evidence to support their claims, the results show that of the 50 justifications provided by the 18 future teachers, only three were based on evidence from reliable sources. This shows the difficulty that future teachers have in assessing the reliability of the data provided, choosing the most appropriate, and integrating the data into their justifications. These argumentative skills have also been pointed out by Gotwals et al. (2012) and Sandoval and Millwood (2005) as the most complex to acquire. This demonstrates the importance of working on this type of activity in teacher training to make trainee teachers aware of the difficulties when addressing these skills in their future classrooms.

On the other hand, the number of secondary school classrooms in our country in which students learn science thanks to the incorporation of this type of activity is currently anecdotal. This is due, among other factors, to the lack of teacher training. We agree with Ariza et al. (2021) that the teaching-learning models we experience as students strongly influence the teaching model we implement during our professional stage. This fact is related to our second objective, that future teachers are aware of the importance of developing argumentation in students. What is more, even those who have sufficient knowledge about climate change lack the necessary resources to address learning it in the classroom (Pérez-Mora and Gértrudix Barrio 2020).

In this work, the participants gave a positive evaluation of the activity and expressed their intention to put it into practice in their professional future. Based on this result, we consider it essential that initial teacher

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training includes the same activities that it would be desirable for teachers to put into practice with their students.

The results of this study have several practical applications for science teachers, particularly in how they design and implement classroom strategies to teach the greenhouse effect, their causes and consequences. For instance, based on the results teachers should prioritize addressing common misconceptions, such as the idea that the greenhouse effect is inherently negative or that it involves solar radiation absorption instead of Earth-emitted radiation. Moreover, especially in the last years of secondary school, teachers should place a stronger emphasis on the molecular basis of greenhouse gases and their interaction with infrared radiation. This includes explaining the structure of these gases and their role in absorbing and re-emitting infrared radiation, which contributes to global warming. To address these conceptions, the use of models, simulations, or experiments that demonstrate these molecular interactions should be integrated in the classroom.

Regarding the ability to construct well-founded arguments and critically evaluate information sources, teachers should emphasize the importance of basing claims on reliable evidence and citing credible sources, which can be integrated into lessons by teaching students how to assess the validity of information and identify authoritative references. To do so, lessons should explicitly address the role of misinformation and denialism, equipping students with the skills to critically engage with such challenges in the broader context of climate change and environmental science. For example, educators can use real-world scenarios, such as the economic and environmental implications of hydrocarbon usage, to encourage students to research, analyze, and justify their positions with evidence rather than opinion.

Finally, educators should work on developing students' understanding of the interdisciplinary nature of these topics by addressing ethical, social, and political dimensions alongside scientific concepts, promoting a holistic approach of the problem.

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Tuning Journal for Higher Education
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doi: https://doi.org/10.18543/tjhe.3020 • http://www.tuningjournal.org/

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Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 191-212 •
doi: https://doi.org/10.18543/tjhe.3020 • http://www.tuningjournal.org/

Editors' Acknowledgments

Editors' Acknowledgments

Mary Gobbi

doi: https://doi.org/10.18543/tjhe.3308

E-published: June 2025

Once again, the editors offer very sincere and genuine thanks to all who have helped produce this edition of the Journal. Thanks are due to Ladislas Bizimana our patient Managing Editor, who has supervised the overall production of the Journal, by supporting authors and editors in the process. His cheerful encouragement and attention to detail is unsurpassed. Finally, I would like to thank the many professors, scholars, and colleagues listed below who devoted their time and expertise to assist the reviewing process of this Issue. We are very aware of the time pressures upon colleagues who act as reviewers, and we are truly appreciative of the efforts made when there are heavy workloads or difficult circumstances.

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doi: https://doi.org/10.18543/tjhe.3308 • http://www.tuningjournal.org/

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VERSION 1ST JUNE 2025

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Ethical Guidelines for Publication

TJHE Ethical Guidelines for Publication

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3.7. Authorship

a) Authorship should be limited to those who have made significant contributions to the concept, design, execution or interpretation of the work reported in a manuscript; others who have contributed should be acknowledged;

b) Author order should be agreed on by all authors as should any changes in authors and order that occur while the manuscript is under review or revision. Changes in authorship must be submitted to the Editor in writing and must be signed by all authors involved.

c) Authors and co-authors should review and ensure the accuracy and validity of results prior to submission; co-authors should have opportunity to review manuscript before submission.

3.8. Authors should reveal to the Editor any potential conflict of interest (e.g., a consulting or financial interest in a company) that might be affected by publication of the results contained in a manuscript. The authors should ensure that no contractual relations or proprietary considerations exist that would affect the publication of information in a submitted manuscript.

3.9. Authors are encouraged to disclose major funding sources (e.g., government agencies, private foundations, private industry, and universities) for reported research.

4. Reviewers

4.1. A reviewer should disclose real or perceived conflict of interests to the Editor before agreeing to write a review. Examples include, but are not restricted to, past (within the last 5 years) or current collaboration, close friend, employer or employee, family relationship, institutional relationship, past or present graduate advisor or advisee, someone with whom the reviewer has had a past or on-going scientific controversy, or situations where the reviewer could stand to gain or lose economically or in any other way by publication or rejection of the manuscript. The Editor will decide if the conflict is severe enough to prevent the reviewer from writing a fair, objective review.

4.2. A reviewer should decline to review a manuscript if she/he feels technically unqualified, if a timely review cannot be done, or if the manuscript is from a competitor with whom the reviewer has had an acrimonious professional relationship or a conflict of interest as defined above (section 4.1).

4.3. Reviewers should be encouraged, but not required, to sign reviews. The Editor will preserve anonymity of reviewers should a reviewer elect to remain anonymous.

4.4. Reviewers must treat the manuscript as confidential.

4.5. Reviewers must ask the Editor for permission to discuss the paper with others for specific advice, giving names and reasons for such consultation.

4.6. Reviewers must not pass the manuscript to another to carry out the review without permission from the Editor.

4.7. Reviewers must not use information, data, theories, or interpretations of the manuscript in their own work unless that manuscript is in press, published or the author has given permission to do so.

4.8. Reviewers should clearly support and justify the basis for their review analysis.

4.9. Reviewers should alert the Editor to similar manuscripts published or under consideration for publication elsewhere in the event they are aware of such. However, it is the responsibility of the Editor, not the reviewer, to decide on the proper course of action once so informed.

5. Citation Manipulation

5.1. Citation manipulation is considered unethical. Manipulation may include adding citations not contributing to a manuscript's content or solely aiming at increasing an author's or a journal's citations.

6. Sanctions

6.1. Suspected breaches of this policy may be handled by the Editor or may be forwarded to the Editorial Board for review and recommendation.

6.2. If an *Editor* is determined to have violated the **TJHE Ethical Guidelines for Publication**, the matter will be referred to the Editorial Board.

6.3. If an author is determined to have violated the **TJHE Ethical Guidelines for Publication**, TJHE reserves the right to impose sanctions, which may include restriction from further consideration of accepting the author's work, retraction of a published paper, or withdrawal of a submitted paper.

Date: 16 March 2015

Approved by the TJHE Editorial Board and signed on behalf of the Tuning Academy by:

Pablo Beneitone
Director, Tuning Academy (Deusto)

Robert Wagenaar
Director, Tuning Academy (Groningen)

Acknowledgements

Many sources were consulted in preparation of these ethical guidelines. However, the Editorial Board of the TJHE would like to acknowledge in particular principles outlined in documents by C.O.P.E. (The Committee on Publication Ethics, http://publicationethics.org/resources/guidelines) and the Geological Society of America (www.geosociety.org/pubs/ethics.htm).

Tuning Journal for Higher Education
© University of Deusto • p-ISSN: 2340-8170 • e-ISSN: 2386-3137 • Volume 12, Issue No. 1, June 2025, 227-230 •
http://www.tuningjournal.org/

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Tuning Academy

Tuning Journal Volume 12, Issue No. 1, June 2025
DOI: https://doi.org/10.18543/tjhe1212025

Generational differences in University Students: Challenges or opportunities?

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