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Research article

Self-perception of the acquisition of transferable competencies by the participants in a research congress for undergraduate students: A cross-sectional study

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ABSTRACT

Context: Several curricular initiatives have been developed to improve the acquisition of research competencies by Health Science students.
Objectives: To know how students self-perceived of whether their participation in the XIV National Research Congress for Undergraduate Students of Health Sciences had helped them in the acquisition of 36 research-related transferable competencies (TCs) common to Health Science degrees.
Methods: A survey design (Cronbach's alpha = 0.924), using a self-administered questionnaire, was conducted among undergraduate students who voluntarily participated in the Congress. Data analysis was performed using SPSS 25 and Statgraphics 19. Statistical significance was considered for $P < 0.05$.
Results: Eighty-one students from 12 Health Science degree programs responded. Key findings are presented in a structured manner, using a Likert-5 scale. Twenty-five of the competencies surveyed obtained an average ≥ 4 highlighting: "Critically evaluate and know how to use sources of clinical and biomedical information to obtain, organize, interpret, and communicate scientific and health information"; "To be able to formulate hypotheses, collect and critically evaluate information for problem solving, following the scientific method", "Critical analysis and research" and "Communicate effectively and clearly, orally and in writing with other professionals". Significance was found in 15 competencies. The development of the competencies "Teamwork",

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"Critical reasoning" and "Analysis and synthesis abilities" was considered to be of greater "personal utility" by the respondents.
Conclusion: Participation in this event contributed to the development of research-related TCs, critical analysis and information management and communication, especially in relation to learning the sources of clinical and biomedical information, to know, following the scientific method, how to formulate hypotheses that allow students to solve problems in their professional activity. The experience was significantly influenced by the respondents' year, the type of participation in the event and the gender of the students. Limitations and suggestions regarding future research are discussed to encourage further exploration of the topic.

1. Introduction

Research led by health professionals (HPs) is important because it fosters evidence-based clinical practice and improved health outcomes for patients [1]. However, since Wyngaarden [2] pointed out that the clinical researcher was an endangered species, this concern has been recognized worldwide [3] and numerous authors have emphasized the need to initiate research at the undergraduate level [4–6] as a natural catalyst in building a solid medical education for students [7–9], modifying or strengthening a positive attitude towards research [10].

In parallel, it has been pointed out that a very positive attitude towards research is based on intrinsic and attainment values and these help the HPs develop strong long-term connection with research [1]. Moreover, the effective application of evidence-based medicine makes research literacy necessary for Health Science graduates because it improves critical thinking by guiding critical judgment [11–13]. Nonetheless, in practice, research in students, as in HPs, is an activity conditioned, among other elements [1], by professors themselves, who may or may not create in them the idea that "publishing" is something utopian or necessary [14]. Professional identities of the faculty members have been noted to exert a powerful influence on the choices of students' professional roles [15,16], and they "must support learner emotions with the construction of positive relationships between them and the student with the construction of positive learner-teacher relationships" [17].

In response to involve future HP in scientific research, curricular initiatives have been developed to improve the acquisition of research skills in undergraduate medical and, by extension, Health Science students [18–30]. These skills, which consist of the ability to detect a problem, collect sufficient data relevant to the problem from reliable sources, evaluate and effectively apply those data to solve the problem, have been progressively framed in terms of global competencies [31] as it is considered that the future will be shaped by the adoption of competencies to specific contexts of information and knowledge [3,31].

One of the fundamental changes made by the European Higher Education Area was the introduction of the Tunning Project [32] recommendation on the acquisition of transferable competencies (TCs) in the training and education of future university graduates, some of which are related to research. In Spain these TCs, designed to meet the changing needs of Health Science education, are specified in the White Papers of the National Agency for Quality Assessment and Accreditation of Spain (ANECA, Spanish acronym) [33] as skills and knowledge that can be applied in various contexts and are crucial for students' success in the global job market and for their ability to face diverse professional environments. The distribution of TCs is not homogeneous in the different universities. Thus, all undergraduate students in the various degrees in Health Sciences face the challenge of actively initiating themselves in research, which is materialized in the Bachelor's Final thesis, or in the case of the Medicine degree the Master's Final thesis (hereinafter we will use the acronym TFG for its initials in Spanish: Trabajo Fin de Grado) (see Table 1).

At the initiative of a group of professors at the Complutense University of Madrid (UCM) [34], aware that with the time allocated in the curriculum to specific competencies it was not possible to adequately train undergraduate students in TCs and with the aim of integrating scientific methodology and the acquisition of TCs (Table 2), an annual congress event has been held since 2006: the National Congress on Research for Undergraduate Students in Health Sciences. This event was supported by the deans of the different centers and professors who teach degrees in Health Sciences at the UCM and other Spanish universities. Its general objective is that students, from any undergraduate year and tutored by their professors, become familiar with research, and complement the acquisition of knowledge and skills in their comprehensive training through research work [19]. Participation in this type of events in Spanish universities is not a mandatory condition for graduation; however, some of them, such as the UCM itself, reward participation through the recognition of credits or weighting in the final grade of the TFG.

On the other hand, educational programs are fundamentally about change, and themselves are rarely static. Thus, an evaluation

Table 1
Common objectives of the Bachelor's/Master's Final thesis in Health Science degrees at the Complutense University of Madrid.

1.	To know, critically evaluate and be able to use sources of clinical and biomedical information.
2.	To know and apply the principles of the scientific method.
3.	To acquire a critical, creative and research-oriented point of view.
4.	To know how to use information and communication technologies.
5.	To be able to formulate hypotheses, design and perform biomedical studies, collect and interpret information.
6.	To elaborate a manuscript following the structure of a scientific paper (IMRaD).
7.	To deliver and defend an oral presentation of the work done.
8.	Optional (criterion not required for all students): To prepare a research work susceptible to be published in scientific journals or to be presented at congresses.

plan must be designed to feed information back to guide their continuous development. In that way, the program evaluation becomes an integral part of the educational change process [35].

It has been pointed out that students' perceptions of the learning environment play a key role in fostering learning outcomes in them [36]. After several editions of the congress, it seems appropriate to assess students' viewpoints. The aim of this study was to give value to the event considering the opinion of its main actors, the students, to determine their self-perception of whether their participation in it had helped them in the acquisition of 36 TCs, established by ANECA, and common to Health Sciences degrees, and whether this experience is conditioned by the year in which the student is enrolled, the type of participation in the event and gender.

2. Materials and methods

The present study was approved by the Ethics Committee of the Hospital Clínico San Carlos, Madrid, Spain (11–261/E).

An observational, descriptive, cross-sectional study was conducted in a group of undergraduate students in Health Sciences. A survey was carried out among students who voluntarily participated in the XIV National Research Congress for Undergraduate Students of Health Sciences and XVIII Congress of Veterinary and Biomedical Sciences (hereafter the Congress). Scriven's Model of Curriculum/Program Evaluation was used as a theoretical framework [37].

For the purposes of this study, we distinguish between enrolled students - those who initially filled out the registration form - and participating students - those who obtained certification of attendance by fulfilling previously informed requirements.

Participants were recruited at the Congress, held on April 25–27, 2019. The present study was conducted by means of a survey carried out during the last quarter of 2019 with three reminders spaced 2 weeks apart. A questionnaire was sent to all Congress registrants. Questionnaires were distributed and collected online.

Student participation in both the Congress and the survey was voluntary, and anonymity was guaranteed.

A 50-item questionnaire was developed using Google Forms, a web-based survey application (Supplementary Data). The questions were developed based on the TCs established in the White Papers of ANECA [33] for the degrees of Biology (Health Biology branch), Dentistry, Human Nutrition and Dietetics, Medicine, Nursing, Occupational Therapy, Optics and Optometry, Pharmacy, Physiotherapy, Podiatry, Psychology, and Veterinary Medicine. The 36 TCs asked were measured on a Likert-type scale from 1 (not very important) to 5 (very important) (hereafter, Likert-5). In addition, for each block of competencies, respondents were asked to select the one that had been most useful to them personally.

The reliability of the survey was measured by Cronbach's alpha. The sample size was calculated for a 95% confidence level with 5% margin of error (using the sample size calculator https://www.questionpro.com/es/calculadora-de-muestra.html#calculadora_de_muestra).

Three different sets of characteristic parameters were considered for data analysis.

i. Respondent year. In Spain, undergraduate degrees have different number of credits. In general they have 240 credits (four academic years), except for Dentistry, Pharmacy and Veterinary Medicine which have 300 credits (five academic years) and Medicine with 360 credits (six academic years). For this reason, respondents were divided into two subgroups: students in the last year of the corresponding degree course ("last year" parameter) versus those in other lower years ("other years" parameter).
ii. Participation. For this purpose, respondents were grouped as follows: they did not present or presented a communication at the Congress, either oral or poster type (passive and active participation, respectively).
iii. Gender. The results were further classified according to the gender declared by the respondent (Female/Male/Other).

Quantitative variables were analyzed using mean and standard deviation. Since TCs are qualitative variables, they were analyzed using absolute frequencies and percentages. As the assessment of these qualitative variables was done subjectively in 5 ordered categories, the median was added. Although the mean and standard deviation were measures for quantitative variables, as they were valued on the same scale for all the variables, they were added for purely informative purposes, because they gave a better idea of which competencies were of greater "personal utility". For information purposes, the responses were regrouped into "not very useful" (categories 1, 2 and 3) and "very useful" (categories 4 and 5). Comparison of the recategorized competencies, according to the three parameters indicated above, was performed using Fisher's test or the test of proportions (depending on the sample size). Statistical significance was considered for $P < 0.05$. SPSS 25 and Statgraphics 19 statistical packages were used.

Table 2
Objectives of the national congress of research for undergraduate students in health sciences.

- To facilitate, through the presentation of papers, the training of students in communication skills.
- To familiarize students with the methodology and techniques of research in Health Sciences.
- To make students participate and play a leading role in the field of research in Health Sciences, highlighting the importance of this facet in their overall university education.
- To incorporate students into competitive research groups at the Complutense University of Madrid and facilitate teamwork.
- To align student activities with the European Higher Education Area.
- To implement activities in the field of Educational Innovation.

3. Results

Of the 1414 students initially enrolled, 793 students participated (56%): 721 (90.9%) from UCM and 72 (9.1%) from other universities (Table 3).

To ensure a homogeneous population in the study, we limited our analysis to data from UCM undergraduate students. Two hundred and twenty-six UCM undergraduate students responded to the survey (31.3%), but only 81 surveys were fully completed (margin of error to 10%), and these are the ones analyzed as results (Table 4).

A total of 86.4% students (n = 70) had an active participation, either by presenting oral communication (n = 40.57%) or poster communication (n = 30.43%). A total of 60.5% participants (n = 49) belonged to the last year of the respective degree program. The mean age of the survey participants was 22.7 ± 3.2 years (median 22 years); of these, 33.3% (n = 27) were male, 66.7% (n = 54) were female and 0% were other.

The description of the results that follows presents the key findings in a structured manner, using a Likert-5 scale and is arranged according to the questions in the questionnaire (Supplementary data, Questions 7–47), first by the respective blocks and then by the parameters studied (respondent year, participation, and gender) (Fig. 1). Cronbach's alpha calculated for the survey showed high internal consistency between items (0.924).

A. Instrumental Competencies (TCI)

Respondents indicated that the Congress helped them to achieve the 8 TCI evaluated with a mean value of 3.80 out of a maximum of 5 (very important). Four of the 8 TCI asked (50%) obtained a mean value (M.V.) ≥4 (Likert-5) (see Fig. 1). The competency "A3. Oral and written communication in the native language" obtained the highest mean value (4.40) followed by "A1. Analysis and synthesis abilities" (4.21), although the latter was the most frequent (34.6%) when we specifically asked respondents which of these TCI they found most "personally useful" (see Fig. 2).

For the different parameters we found significant differences in the following TCI (see Fig. 1).

3.1. *"Respondent year" parameter*

According to this parameter, significant differences were found in the following competencies:

"A2. Organizational and planning skills" (p = 0.019) where the percentage of "high utility" was significantly higher in students who were not in the last year (93.8%) with respect to those in the last year (73.5%).

"A3. Oral and written communication in the native language" (p = 0.004). The percentage of "high utility" was significantly higher in students who were not in the last year (100%) with respect to those in the last year (79.6%).

"A7. Problem solving" (p = 0.009) where the percentage of "high utility" was significantly higher in students who were not in the last year (84.4%) with respect to those in the last year (57.1%).

"A8. Decision making" (p = 0.072). The percentage of "high utility" was significantly higher in students who were not in the last year (84.4%) with respect to those in the last year (67.3%).

Table 3
Universities of the students participating in the Congress.

Country	University	Number of Participants (%)
Chile	De los Andes	1 (0.13)
Colombia	El Bosque	1 (0.13)
Spain:		
-Andalusia	Granada	5 (0.63)
	Sevilla	1(0.13)
-Basque Country	País Vasco	2 (0.25)
-Castile and León	Salamanca	6 (0.76)
-Extremadura	Extremadura	22 (2.77)
-Madrid	Alcalá de Henares	6 (0.76)
	Alfonso X El Sabio	3 (0.38)
	Autónoma de Madrid	4 (0.50)
	Complutense	721 (90.92)
	C. U. Villanueva	10 (1.26)
	Europea	3 (0.38)
	Francisco de Vitoria	1 (0.13)
	Nacional a Distancia	1 (0.13)
	Rey Juan Carlos	1 (0.13)
	San Pablo (CEU)	1 (0.13)
-Murcia	Murcia	1 (0.13)
-Valencian Community	Miguel Hernández	1 (0.13)
	Valencia	1 (0.13)
Uruguay	UDELAR	1 (0.13)
		793 (100)

Table 4
UCM undergraduate student participation by degree and respondents.

Degree	Number of Participants (%)	Number of Respondents (%)
Biochemistry	2 (0.3)	0 (0.0)
Biology (Health Biology branch)	46 (6.4)	11 (13.6)
Dentistry	51 (7.1)	3 (3.7)
Food Science and Technology	11 (1.5)	0 (0.0)
Human Nutrition and Dietetics	51 (7.1)	4 (4.9)
Medicine	66 (9.2)	4 (4.9)
Nursing	9 (1.2)	3 (3.7)
Occupational Therapy	81 (11.2)	1 (1.2)
Optics and Optometry	33 (4.6)	6 (7.4)
Pharmacy	222 (30.8)	23 (28.4)
Physiotherapy	3 (0.4)	1 (1.2)
Podiatry	7 (1.0)	2 (2.5)
Psychology (Clinical and Health Psychology profile)	41 (5.7)	13 (16.0)
Speech Therapy	6 (0.8)	0 (0.0)
Veterinary Medicine	92 (12.8)	10 (12.3)
	721 (100)	81 (100)

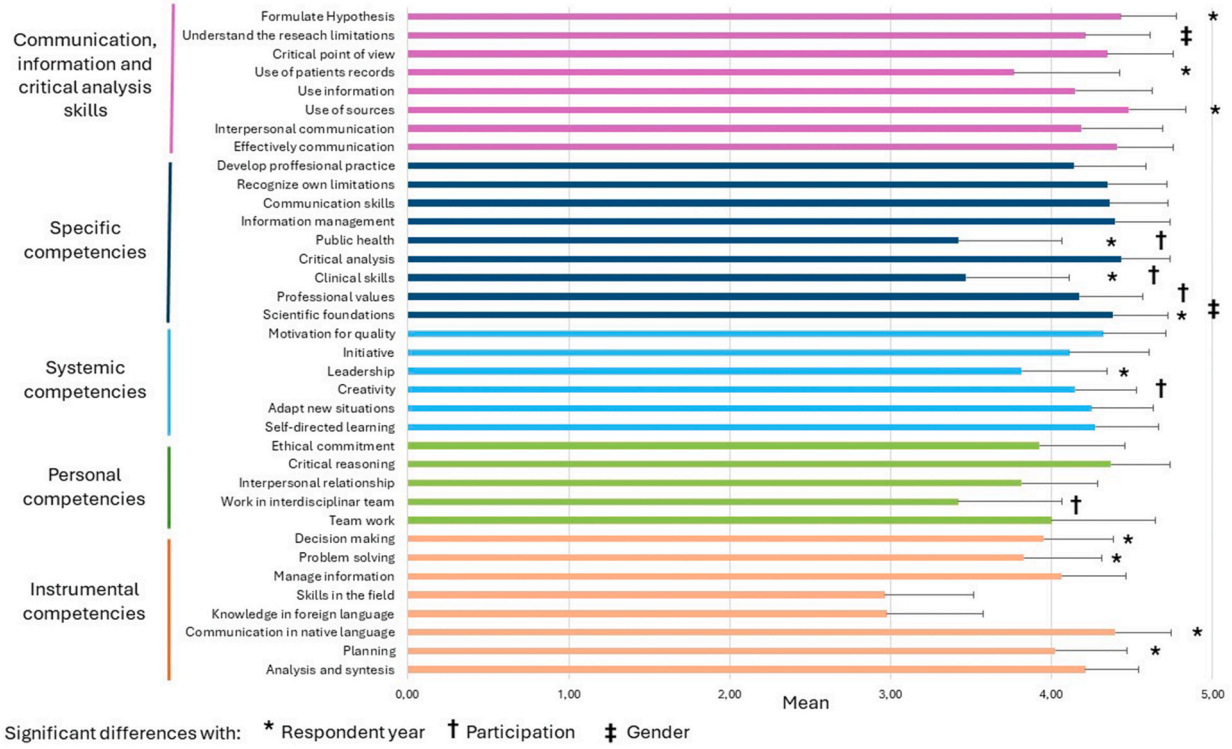

Fig. 1. Students' perception regarding transversal competencies studied (see Supplementary data). Data measured by a Likert-type Scale (with a maximum of '5 points'). Data shown in mean values (bars) ± standard deviations (error bars). Asterisks mark significance (p-values ≤0.05) according to the three different sets of characteristic parameters considered for the analysis: "Respondent year" (*); "Participation" (†) and "Gender" (‡).

3.2. "Participation" parameter

No significance was found in any of the TCI in this parameter.

3.3. "Gender" parameter

No significance was found in any of the TCI in this parameter.

B. Personal competencies (TCP)

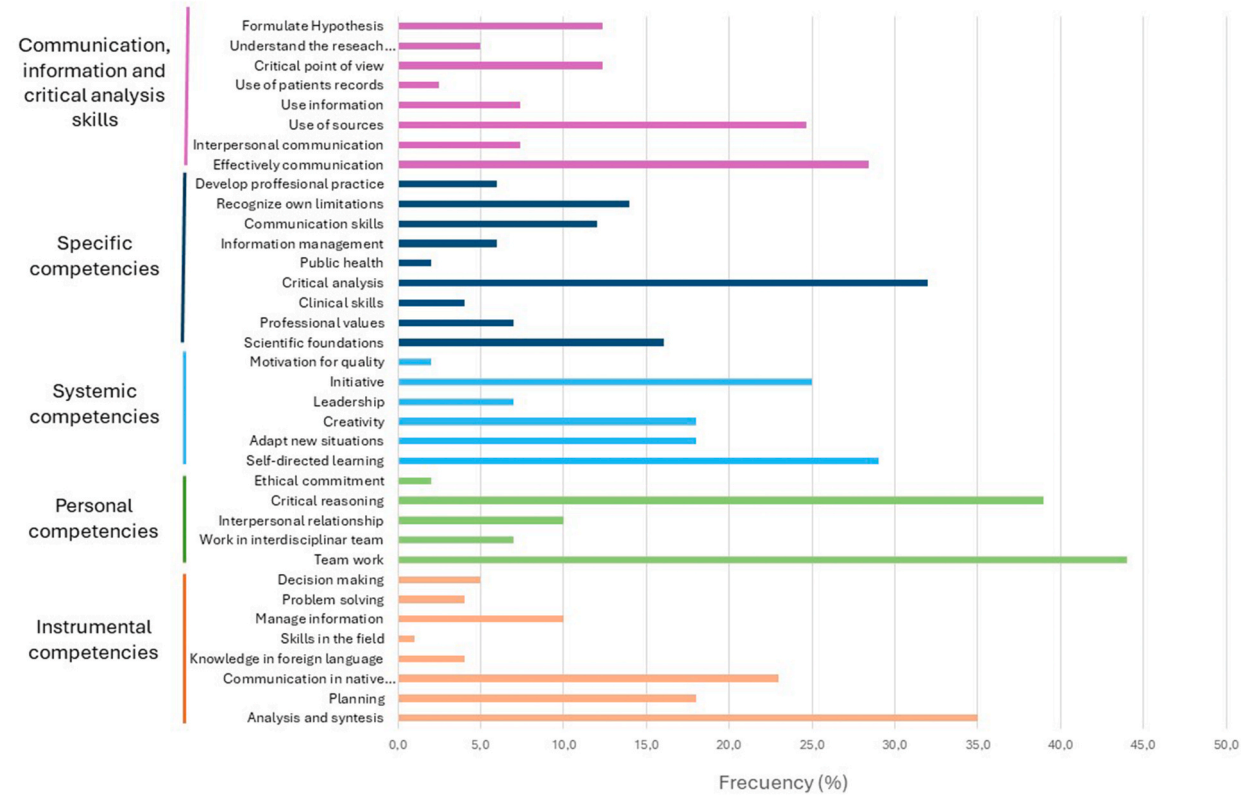

Fig. 2. Relationship between transferable competencies (see Supplementary data) and "Personal utility" according to students' perception. Data shown in frequency.

Respondents indicated that the Congress helped them to achieve the 5 evaluated TCP with an average value of 3.90 out of a maximum of 5 (very important). Two of the 5 TCP asked (40%) obtained a M.V. $\geq$ 4 (Likert-5) (Fig. 1). Of these, "B4. Critical reasoning" obtained the highest mean value (4.37) followed by "B1. Teamwork" (4.00), although the latter had the highest frequency (44%) when we specifically asked respondents which of these TCP they found to be most "personally useful" (Fig. 2).

In these TCP competencies, we found significant differences only in the parameter "Participation": "B2. Working in an interdisciplinary team" ($p = 0.029$) (Fig. 1) where the percentage of "high utility" was significantly higher in students who did not present communication (90.9%) than in those who presented it (57.1%).

C. Systemic Competencies (TCS)

Respondents indicated that the Congress helped them to achieve the 6 TCS evaluated with a mean value of 4.15 out of a maximum of 5 (very important). Five of the 6 TCS (83%) obtained a M.V. $\geq$ 4 (Likert-5) (Fig. 1). Of these, "C6. Motivation for quality" obtained the highest mean value (4.32) followed by "C1. Self-directed learning" (4.27), although the latter had the highest frequency (28.4%) when we asked respondents for the most "personally useful" TCS (Fig. 2).

For the different parameters we found significant differences in the following TCS (Fig. 1).

3.4. "Respondent year" parameter

According to this parameter, significant differences were found in the competency "C4. Leadership" ($p = 0.047$) where the percentage of "high utility" was significantly higher in students who were not in the last year (81.3%) with respect to those who were in the last year (61.2%).

3.5. "Participation" parameter

According to this parameter, significant differences were found in the competency "C3. Creativity" ($p = 0.036$) where the percentage of "high utility" was significantly higher in students who presented communication (85.7%) with respect to those who did not present it (63.6%).

3.6. Gender parameter

Significance was not found in any of the TCS.

D Specific Competencies (TCSp)

Respondents indicated that the Congress helped them to achieve the 9 TCSp evaluated with a mean value of 4.12 out of a maximum of 5 (very important). Seven of the 9 TCSp asked (78%) obtained a M.V. ≥4 (Likert-5) (Fig. 1). Of these, "D4. Critical analysis and research" obtained the highest mean value (4.43) followed by "D6. Information management" (4.40), although "D4. Critical analysis and research" was the most frequently reported as "personally useful" (32%) (Fig. 2).

In the different parameters we found significant differences in the following TCSp (Fig. 1).

3.7. "Respondent year" parameter

The following competences were significant:

"D1. Scientific foundations of the degree" ($p = 0.032$) where the percentage of "high utility" was significantly higher in students who were not in the last year (96.9%) compared to those who were in the last year (83.7%).

"D3. Clinical skills" ($p = 0.030$). The percentage of "high utility" was significantly higher in students who were not in the last year (68.8%) with respect to those who were in the last year (44.9%).

"D5. Public health and health systems" ($p = 0.003$) where the percentage of "high utility" was significantly higher in students who were not in the last year (71.9%) with respect to those who were in the last year (38.8%).

3.8. "Participation" parameter

The significant competencies were:

"D2. Professional values, attitudes, behavior, and ethics" ($p = 0.044$) where the percentage of "high utility" was significantly higher in students who did not present (100%) than in those who presented communication (78.6%).

"D3. Clinical skills" ($p = 0.047$). The percentage of "high utility" was significantly higher in students who did not present (81.8%) than in those who presented communication (50.0%).

"D5. Public health and health systems" ($p = 0.007$) where the percentage of "high utility" was significantly higher in students who did not present (90.9%) than in those who presented communication (45.7%).

3.9. "Gender" parameter

Significance was only found in competency "D1. Scientific foundations of the degree" ($p = 0.02$) where the percentage of "high utility" was significantly higher in males (100%) than in females (83.3%).

E. Communication, information, and critical analysis skills (TCCIA)

Respondents indicated that the Congress helped them to achieve the 8 TCCIA evaluated with an average value of 4.25 out of a maximum of 5 (very important). Seven of the 8 TCCIA asked (87%) in this section obtained a M.V. ≥ 4 (Likert-5) (Fig. 1). Of these, "E3. Critically evaluate and know how to use sources of clinical and biomedical information to obtain, organize, interpret, and communicate scientific and health information" obtained the highest mean value (4.48) followed by "E8. To be able to formulate hypotheses, collect and critically evaluate information for problem solving, following the scientific method" (4.43). However, "E1. Communicate effectively and clearly, orally and in writing with other professionals" was the most frequent (28%) when we specifically asked respondents for the most "personal utility" of this type of competency (Fig. 2).

In the different parameters we found significant differences in the following TCCIA (Fig. 1).

3.10. "Respondent year" parameter

The following competencies were significant:

"E3. Critically evaluate and know how to use sources of clinical and biomedical information to obtain, organize, interpret, and communicate scientific and health information" ($p = 0.043$) where the percentage of "high utility" was significantly higher in students who were not in the last year (100%) than in those who were in the last year (87.8%).

"E5. Maintain and use records with patient information for subsequent analysis, preserving the confidentiality of the data" ($p = 0.041$). The percentage of "high utility" was significantly higher in students who were not in the last year (81.3%) than those who were in the last year (63.3%).

"E8. To be able to formulate hypotheses, collect and critically evaluate information for problem solving, following the scientific method" ($p = 0.032$) where the percentage of "high utility" was significantly higher in students who were not in the last year (96.9%) than those who were in the last year (83.7%).

3.11. "Participation" parameter

No significance was found in any of the TCCIA.

3.12. "Gender" parameter

Significance was found only in the competency: "E7. Understand the importance and limitations of scientific thinking in the study, prevention and management of diseases" ($p = 0.043$) where the percentage of "high utility" was significantly higher in females (88.9%) than in males (74.1%).

3.13. Personal utility

Irrespective of the above assessment, the TCs considered most "personally useful" by respondents were "B1. Teamwork" (44%), "B4. Critical reasoning" (39%) and "A1. Analysis and synthesis abilities" (35%). Their analysis with respect to the three parameters did not present significant differences in any item (Fig. 2).

4. Discussion

The main objective of our study was to know how undergraduate students in Health Science degrees who participated in the Congress self-perceived the gain of TCs common to Health Science degrees. To our knowledge, this study is the first one carried out in Spain for that purpose. The main findings identified by respondents were that the event helped them notably in the acquisition of 25 of the 36 (70%) TCs surveyed in relation to research. However, our results also highlight the importance of student feedback and self-reflection in improving educational programs.

Various curricular initiatives have been developed to improve the acquisition of research skills by Health Science students [18,19, 21–30] but these are rarely discussed by the students themselves, although creating opportunities for authentic inquiry and meta-cognitive reflection are two of the most important pedagogical practices to help students think like scientists [38–40].

This study analyzed the self-perception of undergraduate students from 12 Health Science degrees on how a congress activity aimed at them and tutored by professors helped them to acquire TCs in relation to research. According to Scriven [41], in order to carry out an impartial evaluation based on the observed results, the evaluation must be completed by external experts who have no knowledge of the goal of a program. For this reason, we used the TCs established, prior to the event, by ANECA experts for undergraduate degrees in Health Sciences. This provided us with a common frame of reference for their evaluation in the different Health Science degrees. In addition, to gain a better understanding of the subject, the aim was to determine whether gender, type of participation in the event and the year in which the participating students were enrolled were conditioning factors in the opinion of the respondents.

The study was conducted with a clear, detailed, and reproducible methodology to obtain evidence-based knowledge [42]. For this purpose, we prepared a questionnaire consisting of 50 items (see Annex) and among them the 36 TCs established by ANECA. The survey had a high internal consistency and an acceptable margin of error for the sample size. Respondents belonged to 12 Health Science degrees.

The main findings identified by respondents were that the event helped them notably, M.V. $\geq$4 (Likert-5), in the acquisition of 25 of the 36 (70%) TCs surveyed in relation to research. This is in line with previous studies which indicate that "students in a professional bachelor program -such as those in the Health Science degree programs- grow more in TCs during the first year of higher education than students in an academic bachelor program" [43], although there were significant differences with respect to the three parameters analyzed.

4.1. "Respondent year" parameter

According to this research parameter, we found significance in 11 of the 36 TCs studied (A2, A3, A7, A8, C4, D1, D3, D5, E3, E5 and E8) (Fig. 1). Five of them with M.V. >4 and closely related to critical thinking (in decreasing M.V order: E3; E8; A3, D1 and A2). In those 11 TCs the percentage of "high utility" was higher in students who were not in the last year. This is in line with studies that point out that the lack of depth in research topics during secondary education generates a gap in the students of the first years of University, and there is a consensus "that all first-year students have the potential to improve their critical thinking skills during the course of their academic careers" [44]. On the other hand, our results complement the findings of authors who consider that research integration traditionally occurs towards the end of the medical curriculum, which is when, in general, professors consider students to be more "open" to research [36,45], although we have not found references in other Health Science degrees.

4.2. "Participation" parameter

Presenting a paper at an event such as the Congress offers participants the opportunity to gain visibility, build a scientific reputation, obtaining feedback, and engage in discussions with peers. It also allows for the exchange of ideas, stimulates discussions, and fosters interdisciplinary collaborations which are crucial for their academic and professional development [46], which is in line with our results. We found significance in five competencies (B2, C3, D2, D3, D5) (Fig. 1), two of them with M.V. >4. "D2. Professional values, attitudes, behavior, and ethics" and "C3. Creativity". In all of them the percentage of self-perception of "high utility" was higher

in students who did not present communication, except in "C3. Creativity", which was higher in those who participated in the congress presenting a communication.

Creativity is a product of critical thinking that provides fluency, flexibility, originality, and sensitivity to problems and the ability to rework answers [47]. In line with the above, the mean value of the creativity score was higher in the active participants, i.e., those who presented a communication, than in those who did not present communication. That difference was significant ($p = 0.036$).

4.3. "Gender" parameter

It has been reported that societal expectations and gender roles can influence the development of TCs in individuals. For example, women may be socialized to be more nurturing and empathetic, which can lead to the development of communication and interpersonal skills. On the other hand, men may be socialized to be more assertive and competitive, which can lead to the development of leadership and problem-solving skills [48]. In "Gender" parameter our results provide significance in two competences (Fig. 1): "D1. Scientific foundations of the degree" and "E7. Understand the importance and limitations of scientific thinking in the study, prevention and management of diseases" with higher scores in males in D1 and in females in E7. These results point to gender differences in the construction of scientific thinking of knowledge, which have been cited as a factor that can reduce learning opportunities in the professional practice of university students [49,50]. It would be of interest to corroborate these results with similar ones in Health Science undergraduate students to further analyze why women and men tend to present inequalities in these competencies. In students aged 15–16 years, candidates to become engineers, gender differences mediated by interest and recognition of others have been reported, with males presenting significantly higher scientific self-concept than females [51].

The implications of gender differences in TCs for gender equality in Health Sciences education are significant. Without addressing these differences, there is a risk of perpetuating gender bias in healthcare and limiting opportunities for women in leadership roles. Understanding the implications of all the above can be useful to obtain the best participation and involvement of Health Science students in research and to take advantage of the potential of each gender so that students make the most of this potential.

Overall, our results allow us to affirm that participation in the Congress is a true multidisciplinary meeting point that allows students, taking Health Sciences as a reference, to develop an open, active, critical and constructive attitude towards scientific activity [52], as well as creativity. In addition, respondents recognized that the Congress contributed to significantly acquire TCs that are related to the 3 types of learning: informative, formative and transformative [3] and implicitly as a tool that helped them to "think like" and "feel like" a scientist [53]. These skills, in addition to making undergraduate students in Health Sciences research literate, facilitate the defense of the Bachelor's Final thesis or Master's Final thesis, and improve skills and abilities that are highly valued in "post-scientific" societies, such as the ability to communicate and synthesize knowledge in an original way using higher order reasoning, evaluation, synthesis and critical skills [54].

In relation to the above, "B1. Teamwork" (44%), "B4. Critical reasoning" (39%) and "A1. Analysis and synthesis abilities" (35%), were the self-perceived TCs of greatest "personal utility" by respondents (Fig. 2). These competencies are essential to develop the necessary skills for research in Health Sciences [55], since nowadays this is only conceivable in a collaborative team. Teamwork skills are crucial for healthcare professionals to collaborate effectively across disciplines, leading to improved patient care, treatment outcomes, and overall healthcare delivery. Critical reasoning skills enable healthcare professionals to analyze complex clinical situations, make informed decisions, and provide evidence-based care, ultimately enhancing patient safety and quality of care. Analysis and synthesis skills are vital for interpreting and synthesizing medical information, conducting research, and implementing innovative practices, which can contribute to advancements in healthcare and patient treatment. Competencies "A1. Analysis and synthesis abilities" and "B4. Critical reasoning" are closely linked to the development of critical thinking, which to be optimal and maintain its critical and self-critical nature must be creative at the same time.

5. Limitations and strengths

This study is descriptive in nature and is not without limitations: First, each year the participants change and therefore the conditions and/or contexts of their learning may be different. Second, our results are based on a sample composed mostly of undergraduate students from a single university. The participation of other universities is also a limitation, but it must be taken into account that it is a congress for undergraduate students whose purchasing power is not very high, and they would have to assume travel and costs (although registration to the Congress is free). A future objective is to make a greater effort in the dissemination of the Congress, through social media, so that it reaches a greater number of universities. Third, our results are based on a sample with a low number of respondents to the survey relative to the number of conference participants (11%). However, the internal consistency of the survey was very high (Cronbach's alpha = 0.924). The small number of respondents from some degree programs meant that the results could not be fully compared. For future editions and in order to increase the number of all survey responses, we will redesign the survey in such a way that it is not allowed to move from one question to another without answering the previous one. Fourth, the small sample size meant that the variables had to be recategorized and more relationships could not be studied. It would be convenient to carry out longitudinal research, with different data collections, in which the effectiveness of the use of this active methodology could be assessed with greater size and specificity. Similarly, the self-perception of the students' skills before and after the Congress should be assessed in order to be able to make a future evaluation of a cohort study. Finally, the lack of similar studies in Spain or other countries, made it impossible to compare results, as well as to establish the evolution of this educational innovation through time.

A strength of this study is the high internal consistency of our survey (Cronbach's alpha = 0.924 indicated above). This indicates that the reliability of the survey is very high. Our results provide interesting results for the university environment by reflecting the

opinion and self-perception of the students. The study provides data that can contribute to establishing improvements in learning strategies, to explore enhancing and inhibiting factors and how learners interact with feedback [17].

6. Conclusion

This study identified positive outcomes. Notably, it facilitated the acquisition of 70% of the TCs established by ANECA in relation to research, including "Critical reasoning", "Professional values, attitudes, behavior, and ethics", "Scientific basis of the degree", "Teamwork", "To be able to formulate hypotheses, collect and critically evaluate information for problem solving, following the scientific method" or "Critically evaluate and know how to use clinical and biomedical information sources to obtain, organize, interpret and communicate scientific and health information". Our results confirm that the participation of Health Science undergraduate students, tutored by professors, in events such as the Congress referenced here is a good strategy to promote the acquisition of TCs among students and emphasizes the relevance of knowledge transfer and information skills in a student-centered learning context.

We encourage the academic community to use these findings as a stimulus to improve teaching practices, motivate students to participate in research-related activities, and seek support for such initiatives.

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Availability of data and materials

The data given in this work has not been publicly archived owing to privacy concerns. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics declarations

This study was reviewed and approved by the Ethics Committee of the Hospital Clínico San Carlos, Madrid, Spain (11–261/E). All participants provided informed consent to participate in the study.

CRediT authorship contribution statement

Luis-A. Arráez-Aybar: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Javier Arias-Diaz:** Writing – review & editing, Visualization, Validation, Software, Resources, Investigation, Formal analysis. **Sergio D. Paredes:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Investigation, Formal analysis, Data curation. **Pilar Zuluaga-Arias:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation. **Margarita Chevalier:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Investigation, Formal analysis, Data curation. **Elena Salobrar-Garcia:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Investigation, Formal analysis, Data curation. **Luis Collado:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Investigation, Formal analysis. **Olivia Hurtado:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Investigation, Formal analysis, Data curation. **Pilar Fernández-Mateos:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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