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Application of the Grounded Theory to the analysis of the school and curricular organization of the subject Technology in Secondary Education

Aplicación de la Teoría Fundamentada al análisis de la organización escolar y curricular de la asignatura Tecnología en Educación Secundaria

Aplicação da Teoria Fundamentada à análise da organização escolar e curricular da disciplina de Tecnologia no Ensino Secundário.

应用扎根理论分析中等教育科技课程的组织和设置

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Abstract

Technology is a cross-cutting subject of knowledge and skills in the Secondary Education curriculum. Its curricular content demands constant changes due to the requirements posed by society and educational laws in Spain. This article presents a qualitative empirical research, whose methodology is based on the Grounded Theory. Although the objective of the research is broader, for reasons of space, the part corresponding to the analysis of the organizational and curricular context from the teachers' perspective is presented here. The interviewers' data collection was through observation, field diary, and audio recording of the focus groups, with the participation of 68 teachers from 17 Secondary Schools in the province of Valencia, reaching theoretical saturation in the eighth school. The fieldwork was carried out between October 2019 and February 2020. The Atlas.ti software (v.8) was used for data processing, which allowed open, axial, co-occurrence and selective coding. The conclusions of the study are: (1) the difference in infrastructure, size and ratio have an impact on educational quality, (2) institutional coordination is necessary to adapt the student transition between the different educational levels, (3) school organization together with a fragmented curriculum in core, specific and free configuration subjects, hinder the acquisition of competencies, and (4) the choice of STEM subjects depends on the gender of the students and their family environment.

Keywords: Qualitative methodology; Grounded Theory; Focus group; Secondary Education; School organization; Technology.

Resumen

La asignatura Tecnología es una materia transversal de conocimientos y habilidades en el currículo de la Educación Secundaria. Su contenido curricular demanda constantes cambios debido a los requerimientos que plantea la sociedad y las leyes educativas en España. Este artículo presenta una investigación empírica de tipo cualitativo, cuya metodología se apoya en la Teoría Fundamentada. Aunque el objetivo de la investigación es más amplio, por razón de espacio, aquí se presenta la parte que corresponde al análisis del contexto organizativo y curricular desde la perspectiva de los docentes. La recopilación de datos de los entrevistadores fue mediante la observación, diario de campo, y grabación de audio de los grupos focales, con la participación de 68 docentes de 17 Institutos de Educación Secundaria de la provincia de València, alcanzando la saturación teórica en el octavo instituto. El trabajo de campo se realizó entre octubre de 2019 y febrero de 2020. Para el tratamiento de datos se empleó el software Atlas.ti (v.8) que permitió la codificación abierta, axial, coocurrencias y selectiva. Las conclusiones del estudio son: (1) la diferencia en infraestructura, tamaño y ratio repercuten en la calidad educativa, (2) la coordinación institucional es necesaria para adecuar la transición estudiantil entre los diferentes niveles educativos, (3) la organización escolar junto con un currículo fragmentado en asignaturas troncales, específicas y de libre configuración, dificultan la adquisición de competencias, y (4) la elección de asignaturas STEM depende del género de los estudiantes y de su entorno familiar.

Palabras clave: Metodología cualitativa; Teoría Fundamentada; Grupo focal; Educación Secundaria; Organización escolar; Tecnología.

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Resumo

A disciplina de Tecnologia é uma disciplina transversal de conhecimentos e competências no currículo do Ensino Secundário. O seu conteúdo curricular exige alterações constantes devido às exigências da sociedade e das leis educativas em Espanha. Este artigo apresenta uma investigação empírica qualitativa, cuja metodologia se baseia na Teoria Fundamentada. Embora o objetivo da investigação seja mais amplo, por razões de espaço, apresentamos aqui a parte que corresponde à análise do contexto organizacional e curricular do ponto de vista dos professores. Os entrevistadores recolheram dados através da observação, diário de campo e gravação de áudio dos grupos focais, com a participação de 68 professores de 17 escolas secundárias da província de Valência, atingindo a saturação teórica na oitava escola. O trabalho de campo foi realizado entre outubro de 2019 e fevereiro de 2020. O software Atlas.ti (v.8) foi utilizado para processamento de dados, permitindo a codificação aberta, axial, coocorrências e seletiva. As conclusões do estudo são: (1) a diferença em infraestruturas, dimensão e rácio repercute-se na qualidade da educação, (2) a coordenação institucional é necessária para adequar a transição dos estudantes entre diferentes os níveis de ensino, (3) a organização escolar juntamente com um currículo fragmentado em disciplinas nucleares, específicas e de livre escolha dificultam a aquisição de competências, e (4) a escolha das disciplinas STEM depende do sexo dos estudantes e do seu meio familiar.

Palavras-chave: Metodologia qualitativa; Teoria Fundamentada; Grupo focal; Ensino Secundário; Organização escolar; Tecnologia.

摘要

在中等教育的课程设置中，科技课程是汇集多种知识和技能的交叉课程。由于西班牙教育法及社会环境的要，课程内容需要不断地变化。因此该研究以扎根理论为方法依据，进行了定性观察研究。该研究的目标较广泛，但是出于篇幅限制，这里主要呈现了以教师视角出发对课程组织分析的部分。通过观察、田野调查、对焦点小组录音的方式收集数据。最后共有来自瓦伦西亚省 17 所中学的 68 名教师参与，在调查进行到第八所学校时，研究数据达到理论饱和。田野调查时间为 2019 年 10 月到 2020 年 2 月。在数据处理方面，研究使用可以进行开放、轴向、共现、选择编码的 Atlas.ti（v.8）软件。研究最终得到的结论为：（1）基础设施规模及比例的差异影响到教学质量；（2）教学机构良好的协调能力可以促进学生在不同学习级别间的顺利转换；（3）断片式的主干课程、特定课程和自选课程的设置和组织阻碍了学生的能力获取；（4）学生的性别和家庭环境决定了学生对 STEM（科学、技术、工程和数学）课程的选择。

关键词: 定性方法、扎根理论、焦点小组、中等教育、学校组织、科技

Various educational institutions raise the need for global and interdisciplinary learning, betting that these approaches are a facet of the culture that should structure the education and training of people. The UNESCO Convention on Technical and Vocational Education (1989) and international studies such as ROCARD (Spanish Ministry of Education, Science and Sport [SMESS], 2009), ROSE (Sjøberg & Schreiner, 2019), TIMSS (National Center for Education Statistics, 2022) and several reports promoted by UNESCO (2001, 2005) analyse the competences that students should acquire in science, technology, and mathematics. The TALIS report (Spanish Ministry of Education and Vocational Training [MSEVT], 2018) makes a comparison on teaching and learning in OECD countries, highlighting that Spain is one of the countries that has the greatest percentage difference between the collaborative work of Primary and Secondary education.

Baigorri et al. (1997), Aibar and Quintanilla (2002), and Robinson (2015), explain that most curricula are based on the notion of subjects whose fragmentation and hierarchy of knowledge, make certain disciplines sean "non-essential". According to Sanders (2009), this fact prevents having a global and shared vision of knowledge and skills, when you raise the "integrative STEM Education" (STEM stands for *Science, Technology, Engineering & Math*). Utiel (2010) stresses the importance of

"developing citizens' skills" for the understanding, manipulation and use of technical objects", and the survey "Social Perception of Science and Technology in Spain" (Arnau et al., 2019; Ortega, 2019), delves into the factors that keep young people away from STEM studies, highlighting that they are phobias linked to the Internet and ICT, age and gender, formal and informal learning styles, socioeconomic and cultural differences, and family members' studies.

The fragmentation of the curriculum by subjects is evident in the last three educational reforms LOGSE (Organic Law 1/1990, 1990), LOE (Organic Law 2/2006, 2006), LOMCE (Organic Law 8/2013, 2013). The recent educational law LOMLOE (Organic Law 3/2020, 2020), which is still to be implemented in the classroom, is committed to the integration of areas of knowledge, highlighting among other aspects: the development of competences, the elimination of the classification of core subjects, specific and free configuration, the reinforcement of coordination between the different stages, the organization of the courses, and the inclusion of interdisciplinary projects.

Since 1990, Technology has been part of the curriculum of Compulsory Secondary Education (CSE) and the Baccalaureate of Science and Technology (BST) and has an essential role in Vocational Training (VT). Its inclusion in the educational system is due to the fact that "the teaching of Technology contributes to the development of complex skills and makes more functional the knowledge acquired in other disciplines, increases the personal autonomy of young people and tends to correct the traditional segregation of professional options according to gender, facilitates the transition to active and adult life, and enriches the scientific and technical culture of citizens" González Pérez (2005). The current curriculum orients teaching and learning towards digital technologies (Ernst & Young, 2019) which, in practice, by minimizing the time of workshop experimentation, tends towards computer simulation, rather than towards the design, calculation and construction of projects.

Regarding the Baccalaureate, it fulfills the triple function: propaedeutic, guiding and semi-specialization. The Baccalaureate allows more specialized itineraries oriented towards Vocational Training (VT) or towards university studies of Sciences, Engineering and Architecture. The technological materials of the BST "constitute the answer to the study of the complex world of material products, of their industrial design and manufacture, of the operation and use of instruments, apparatuses and machines" (Baigorri et al., 1997). These studies offer students the multipurpose basis to develop their "competences in mathematics, science and technology" (Organisation for Economic Cooperation and Development, 2020).

Although in recent years the perception that Spanish society has of VT has improved, the potential of their studies has not yet taken off, especially in VT-Higher and VT-Dual. Spain is the seventh EU country with the lowest rate in VT. The percentage of students enrolled in VT (basic, middle, and higher) was 35.8%, while in the EU (27) it was 48.4%. Considering only the students enrolled in Higher Vocational Training, it was 11.6%. (SMEVT, 2020).

To warn the reader that this research was carried out between 2019 and 2021, referring in its legislative articles to the LOMCE (2013). Some of the improvement proposals that are reasoned here are included in the new LOMLOE law (2022), although its progressive implementation will be from the 2022-23 academic year.

In this context, this research focuses on the concept of "school as a learning community" of Hargreaves (2003), to understand the problem what underlies the paradigm shift from learning content to learning by competencies (knowledge, capabilities, and attitudes) in science and technology that Secondary education students must acquire. We focused our analysis from the perspective of "school and curricular organization" and the

practice of the teachers, who voluntarily participated to express their opinions and interest that education does not become a mere reproducer of routines. For these reasons, knowing and understanding what teachers say and do provides a rich experience that describes the facts in a comprehensive manner, justifying the application of a qualitative research methodology (Taylor & Bogdan, 1987).

The following sections describe the methodology of the research, which is *supported by the Grounded Theory* of Strauss and Corbin (2002), and one of the most used qualitative approaches for data collection such as the in-depth interview, with the participation of focus groups. The inquiry process has been inductive, and the researchers have interacted with the participants and with the data provided, to seek answers to questions about the teaching experience, so their approach is qualitative. The data processing has been carried out with the Atlas.ti software (v. 8) in its phases of open, axial, semantic and selective coding. The article ends with the discussion of the results and conclusions.

Method

This work is proposed to answer the following research questions:

1. How to improve the transition of students between different educational levels?
2. Which school and curriculum organization are right to develop talent?
3. How to ensure the acquisition of students' skills?
4. What initial and continuing training does teachers require?

To answer these questions, an interpretative study has been developed, based on observation, data collection and supported by the Grounded Theory of Strauss and Corbin (2002) whose objective is to develop concepts, discover relevant data, compare, and identify their properties, and explore their relationships in order to integrate them into an emerging theory that explains the context of the group of people under study. This methodological process is not intended to produce formal theories, but to theorize about very specific problems, which may acquire a higher category to the extent that new studies are added. The researcher simultaneously encodes the qualitative data and analyzes the context through "fieldwork". The qualitative data collection of the research was carried out in situ with teachers from 17 public secondary schools (SS) in the province of Valencia. The study was authorized by the Conselleria d'Educació, Cultura i Esport de la Generalitat Valenciana (Resolució 24 juliol 2019).

Of the three most used qualitative approaches for data collection, such as: focus groups, surveys, and content analysis, the focus groups have been chosen because they are a face-to-face and close activity, which contrasts the opinions of the participants with the researcher. The method used was to constitute focus groups with the teaching staff, assuming the position of Hamui and Valera (2013), who indicated that "the focus group is a tool of qualitative research, which has proven to be a source of information of enormous wealth for research in education, for its sensitivity to investigate knowledge, norms and values of certain groups". In order to center the topic with the focus groups, a script of questions was used, which the interviewer introduced orally, recorded the audio and marked the time of intervention of the participants, but without entering into discussion or debate. Simultaneously, a notebook was used to note down the most relevant observations and other elements that would allow the recorded discourse to be oriented.

The bias or influence of the researchers with the teachers participating in the study is minimal because none of the co-authors is linked to secondary education.

Context

In the Valencian Community, several studies have been carried out in recent years to study the educational situation in Secondary Education, and in particular of STEM, such as the pilot program Aprofundeix-CV (Conselleria d'Educació, Cultura i Esport. Generalitat Valenciana, 2017), and the CTEM Congresses of which three editions have already been held. In this framework, the research aims to know the opinion of a sample of teachers of the public network of the 330 secondary schools of the Valencian Community. For operational reasons, it was decided to limit the research to the province of Valencia, which has 158 secondary schools.

Characteristics of the participating teaching staff

This study is part of a larger study that also has a quantitative component, for which a sample of 17 secondary schools in the province of Valencia was selected. The researchers did not select the participating teachers, since it was decided to carry out an open and voluntary call to the teaching departments, based on criteria of homogeneity of the STEAM subjects, and heterogeneity of the participants of the educational levels (CSE, BST and VT). A total of 79 teachers initially registered for this call, of which 68 finally participated whose characteristics are shown in Tables 1 and 2.

Table 1. Sociodemographic data of the teaching staff

Age range:	<30 years	31-40 years	41-50 years	51-60 years	>60 years
	3%	5%	67%	25%	0%
Years in the center:	<=5 years	6-10 years	11-15 years	>=16 years	
	42%	5%	29%	24%	
Gender:	Female	Male			
	45%	55%			

Table 2. Degree of satisfaction of teachers with their teaching work (in %)

Degree of satisfaction of teachers with their students	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
CSE students:	6,29	3,03	15,22	75,46	0,00
VT-Basic Students:	3,03	7,51	71,21	18,25	0,00
BCT Students:	3,03	0,00	36,30	45,45	15,22
Among the SS faculty:	0,00	3,03	15,22	63,60	18,15

Source: own elaboration

Design and validity of the questionnaire

Although the research is broader and consists of the following sections: (I) School and curricular organization; (II) Synergies and project methodology; (III) Multidisciplinarity and STEM interdisciplinarity; and (IV) Taxonomy of projects, this article refers only to section (I) as indicated above for reasons of space.

To conduct the focus group interviews, a questionnaire of mixed questions was previously designed. Its validation (reliability) was carried out by applying the "expert judgment" method (Escobar-Pérez & Cuervo-Martínez, 2008). To this end, 13 university

professors from the Universitat Politècnica de València, Universitat de València, Universitat de Lleida, Universitat de Barcelona, Universitat de Alicante, Universitat Internacional de Valencia and Universidad de La Laguna collaborated in the validation of the questionnaire items on a scale of 1 to 10 according to the criteria of coherence, relevance, clarity, and sufficiency (binary criterion of elimination). The final questionnaire after validation is presented in Table 3.

Table 3. Questionnaire: dimensions, indicators, items and techniques used (online, audio)

(2) Dimensions	(18) Indicators	(18) Items	(8) online	(10) audio
Sociodemographic data	Age	<=30 / 31-40 / 41-50 / 51-60 / >=61	x	
	Gender	M/F/NC	x	
	Years in the center	<=5 / 6-10 / 11-15 / >=16	x	
	Degree of satisfaction (CSE students)	M.I. / I. / N. / S. / M. S.	x	
	Degree of satisfaction (B-VT Students)	M.I. / I. / N. / S. / M. S.	x	
	Degree of satisfaction (BST students)	M.I. / I. / N. / S. / M. S.	x	
	Degree in satisfaction (SS Staff)	M.I. / I. / N. / S. / M.S.	x	
	Teaching-Learning Methodologies	Coop. work / Byod / Case Studies/ Master class / F. Classroom / Gamif. / M. Empathy / M. Concept. / P. Aronson / V. Thinking	x	
School and curricular organization	Transition between educational levels	Is the transition between levels appropriate?		x
	Timetable organization (50-60 minutes)	How does it influence motivation?		x
	Curricular structure by subjects	Does it favor the acquisition of skills?		x
	Technology and specific subjects	Does it benefit or harm competences?		x
	Itineraries and continuity of studies	Does it guarantee the continuity of Technology?		x
	Choice of itinerary and gender	What does it depend on?		x
	Classroom - workshop and PBL	Is it suitable for the PBL methodology?		x
	Lifelong teacher training	What areas do you consider most necessary?		x
	Participation in educational research	To publish or to carry out research?		x
	Investment in education % GDP	The more investment, the more quality of education?		x

Focus groups

The technique of *focus groups* is a tool of qualitative research, which has proven to be a source of information of enormous wealth for research in education. This technique represents sensitivity to investigate knowledge, norms, and values of certain groups (Hamui & Valera, 2013). It is the interviewer who introduces the questions, and the interviewees respond anonymously and without entering the discussion or debate, and thus speed up the intervention time. During the sessions, the visitors (*on site*) take notes in their notebooks/tablet to facilitate their subsequent coding. Each participant had a card identifying "Prof. A, B, C, etc.", to ensure anonymity. The interviewer orally introduced each of the 10 questions of the questionnaire, while controlling the times of the interventions. The opinions were accepted, but without discussing them. The focus group sessions were recorded in audio files (MP3 format). The interviewer merely took note of the most relevant aspects of the participants' responses. Subsequently, the qualitative analysis software Atlas.ti (v.8) processed all the information in its "open coding", including labels of "code", "items" and "notes-memos".

Grounded Theory (GT) and Coding

The Grounded Theory of Strauss and Corbin (2002) is based on "concepts, categories and properties" discovered by examining the data, until reaching theoretical saturation, emphasizing the generation of theory. The "concepts" are central elements of the GT, and are basic units of analysis, created by the researcher from the identification of events or coincidences. "Categories" are constructed by grouping more abstract concepts, and are generated by the same analytical process, while "properties" indicate relationships between categories and concepts.

During this analytical process, three stages are identified: "open coding" (data analysis and assignment of codes), "axial coding" (obtaining categories and subcategories), and "selective coding" (central category allowing theoretical construction and conclusive approaches). It is from onto-epistemology, when we seek answers to the objectivity of the meanings of the codes, using evidence criteria such as opinions, comments, annotations, documents, etc., to integrate all the information in the Atlas.ti "project" (v.8), together with the "files" generated during open and axial coding.

Data logging

The coding and categorization of qualitative data in Grounded Theory requires describing its concepts, the research process, and the role of the researcher, emphasizing the coding and categorization of data, which are the core of the methodological procedure to make the data manageable and generate a theory (Vives Varela & Hamui Sutton, 2021).

The number of teachers per Department ranged from 2 to 7, and the average recording time (audio) per SS was 31m 02s. The total recording time for the 17 SSs was 08h 47m 41s. For the data recording, we counted on the voluntary participation of the teaching staff, between October 1, 2019, and February 5, 2020. During the focus group sessions, two tendencies were observed, the faculty who went "to see what was going on", and those who brought paper and pencil to "participate in depth". The coding used to identify the participants' audios is shown in Table 4.

Table 4. Codification

No Focus group	Initials name of the SS	Year of recording	Nº of intervention
From the digits 01 a 17	First two capital letters	From the digits 19, 20 from 21	One digit 1 from 2

Theoretical saturation

"Theoretical saturation" (TS) is defined by Glaser and Strauss (2017) as the "point in the construction of categories at which new properties, dimensions or relationships no longer emerge during analysis". For Vallés (1999), the TS is a methodological strategy of the "constant comparison method", so that it brings researchers closer to the possibility of verification, without departing from the central objective, which is the generation of theory. According to Ortega Bastidas (2020), it is problematic to continue interpreting the TS from the idea of repetition and redundancy, and therefore "there is no 'magic' number that ensures the TS", since it emerges from two criteria: "the density of information and the authenticity of information". The researcher must understand if the "criterion of information density" allows to obtain heterogeneity of meaning, so that its description can be detailed and not only in a simple annotation of frequencies or amount of data.

The fieldwork carried out with the 17 participating SSs was essential to obtain (*in situ)* the audio recording with the focus groups. During the interviews conducted with the focus groups, the discourse towards the seventh SS was already running out. However, the ST was verified by evaluating the eighth SS, so adding more institutions only increased the occurrence of the codes already created.

Results

This section details the process followed to obtain results, from "open coding" where codes are generated, from which concepts, categories and subcategories are identified, to "axial coding" where coding occurs around an axis of a category, linking it with other categories and emerging "semantic networks" to add to the analysis, depth, and structuring in the discourse. Finally, the process of refining the data with "selective coding" integrates the categories and subcategories in order to generate a level of abstraction that allows the elaboration of a theory in the discourse.

Open coding

During this phase, the in-depth interviews conducted with the focus groups, evidenced the empirical data found through the audio recordings. The categorization system of the responses of the teachers interviewed is shown in Table 5, finding: (6) concepts, (14) categories, (43) subcategories and their properties.

Table 5. System of categorization of the codes found during the interviews of the focus groups

(6) Concepts	(14) Categories	Properties	(43) Subcategories
Student Transition	Student Issues	*Adaptation problems that are carried over and maintained between educational levels.*	- Demotivation - Time adapted. - There's no communication. - Didactics - School model - Disengagement - Bad English level - Bad Math. level
	Adequacy between levels	*Difficult transition between Primary and Secondary Education, and between CSE and Baccalaureate.*	
	Transition from Primary to Secondary Ed.	*Difficult coordination between departments, school environment, and school schedule. The transition between Primary and Secondary Education has improved a lot/little. The transition from CSE to BST or VT is not sufficiently developed. Lack of vocational orientation. It depends on the voluntariness of the teaching staff.*	
Organization of Time	Educational model	*Relation of the class time (50´-55'), motivation of the students, and 5 or 6 subjects per day. Continuous or split school day.*	- More hours - 2h in block - Time slots from 50'-55' - Last hours - Schedules - Breaks - External activities. - Lack of coord. with universities - More practice - Too many subjects
	Adequate duration	*Difficulty of attention from 30' of theoretical class. On the contrary, practical classes lack time and 2 modules of 50'-55' are advised.*	
Curricular structure	Competences	*Progressive loss in the acquisition of competences (knowledge, skills, and attitudes) in S&T. Legislative changes and modification of status of the subjects breaks the social consensus.*	- Disagreements - Spaces - Separated knowledge. - Integration of curriculum - Teamwork - Weak vocational orientation - Compulsory Technology
	Student management	*Difficulty managing 11 subjects, free time and knowing how to solve class activities.*	
	Curriculum	*Each of the 11 subjects maintains an extensive/dense curriculum (previously by content and now by competences). Group knowledge blocks. Easy and other difficult subjects. Excess electiveness, loss of teaching quality and unfair key competencies/marketing. Reduction of subjects.*	
Technology Subject	Enrolment in Technology	*Subject categorized as "specific" and not as "compulsory" and its number of students depends on expectations, motivation, other electives, what their classmates choose, and perception towards the subject. With fewer and fewer hours, it makes it difficult to acquire key skills.*	- Positive perception - Technology offer - Expectations
	Student motivation	*Relationship between motivation to learn, academic performance and school day.* *Ratio and Classroom-Workshop space. Training itineraries are a trap.*	
Student Choice	Choice of electives	*Classifying the subjects as compulsory and elective, leads to students perceiving that the elective ones involve little work, quite the opposite of the compulsory ones. In the case of the BST, subjects are chosen if they are considered for university admission. The choice depends on the fashion of the moment. Training itinerary and methodologies.*	- Weak orientation - Gender difference - Fortresses Depart. - Outdated curríc. - Dark planif. - Social inclusion
	Expectations	*Loss of young talent due to school and curricular organization, lack of empathy and future professional career. It depends on the girl/boy role. There is no curricular continuity.*	
	Perception of the subject	*Positive perception if it is "easy" to pass and there are no exams. There is minimal influence from the family environment. Technology is a very attractive subject for students, but difficult for teachers to tackle: "it requires continuous updating". It is not easy to integrate hands-on workshop learning with computer learning.*	
Teacher training	Lifelong teacher training	*There is no immediate interest in researching or publishing classroom experiences, it requires a lot of effort. They participate in events (competitions and exhibitions), but there is little debate and written reflection. There is interest in the training offered by the institutions (online and / or face-to-face), but there are difficulties in accessing some training courses.*	- Master in Technology. - Robotics - Arduino - Multilingualism - Self-training - 3D printing - Software management - Picaxe - Lifelong training offer

Once the focus group interviews were completed, Atlas.ti software was used to include the audios and process their information. Table 6 shows the (66) codes found in descending correlation by "rationale" (r) and "densities" (d). The meaning of (r) represents a numerical variable generated by the Atlas.ti software, which relates the number of times the code appears in the files where are stored the teachers' discourse. While (d) represents a numerical value that is related to "axial coding", i.e. the relationship of a code with other codes. The highest values are considered as categories and their links as subcategories, identifying (14) categories and (43) subcategories.

Table 6. List of codes sorted by their rationale (r) and density (d). Numbers (bold and italics) are categories represented in semantic networks (Figures 2 to 7). Numbers (gray color) are higher weight values in (r) and (d).

No.	Code	r	d	No.	Code	r	d
1	Size of the SS defines your application	12	4	***34***	Dense curriculum	3	5
2	Offer of other electives	12	5	35	Weakness in student orientation	3	3
3	Classroom-Workshop adequacy and ratio	12	0	36	Companionship, social inclusion	2	3
4	Lifelong teacher training	12	10	37	Self	2	1
5	Publish and research	12	0	38	Separation of knowledge	2	2
6	Enrolment in the Technology subject	10	11	39	Arduino (Italy)	2	1
7	Student expectations	10	6	40	Multilingualism	2	1
8	More investment in education = Educational quality	10	0	41	Gender difference in choice	2	1
9	Institutional planning of the offer of subjects (will and obscurantism)	9	5	42	Evaluate objectives of the educational system (generalist-specialist)	3	2
10	Adequate class duration (50min)	9	8	43	Lack of computer equipment in the workshop	2	0
11	Proper transition between educational levels	9	7	44	Student demotivation	3	2
12	Student choice of the Technology subject	9	10	45	Intermediate school (French model)	1	1
13	Academic or applied way	8	0	46	Extracurricular activities	1	1
14	Motivation in students	8	10	47	No coordination SSs - Universities	1	1
15	Positive perception about the subject	8	6	48	Legislation affects elective subjects and selection	3	0
16	Difficult transition Primary Ed. to Secondary Ed.	7	4	49	Redundant subjects	2	1
17	Acquisition of competences with the curricular structure	7	10	50	Picaxe, as a reference in disuse and Arduino as majority acceptance	1	1
18	Time reallocation (more hours)	6	1	***51***	The educational model works	1	7
19	Teacher motivation	6	4	52	Shorten last hours of the day	1	1
20	Organizational problems of the spaces	5	2	53	Graphic design and 3D printing	1	1
21	Technology should be mandatory	5	5	54	Adaptation time	1	3
22	Innovation and ICT	5	0	55	Master in Technology	1	1
23	Lack of communication between levels	5	2	56	Management of computer programs or apps	1	1
24	Integrate curriculum and scopes	5	5	57	Teamwork	1	2
25	Inter-day breaks	4	2	58	More practice and less theory	2	2
26	Time distribution by type of subject	3	1	59	Outdated curriculum in the Technology subject	3	3
27	Formation and filial guidance brought from home	4	3	60	Adaptive didactics in Primary Ed.	2	1
28	Lifelong educational offer	5	1	61	Low English level	1	1
29	Student management	3	5	62	Decoupling between levels	2	1
30	Robotics	3	1	63	60-minute hours	1	1
31	2 hours in a row	3	1	64	Strengths Orientation Department	2	1
32	Disagreements with the curricular structure	5	3	65	System stiffness	1	4
33	Student issues	2	7	66	Low Math. level	1	1

Source: Own elaboration

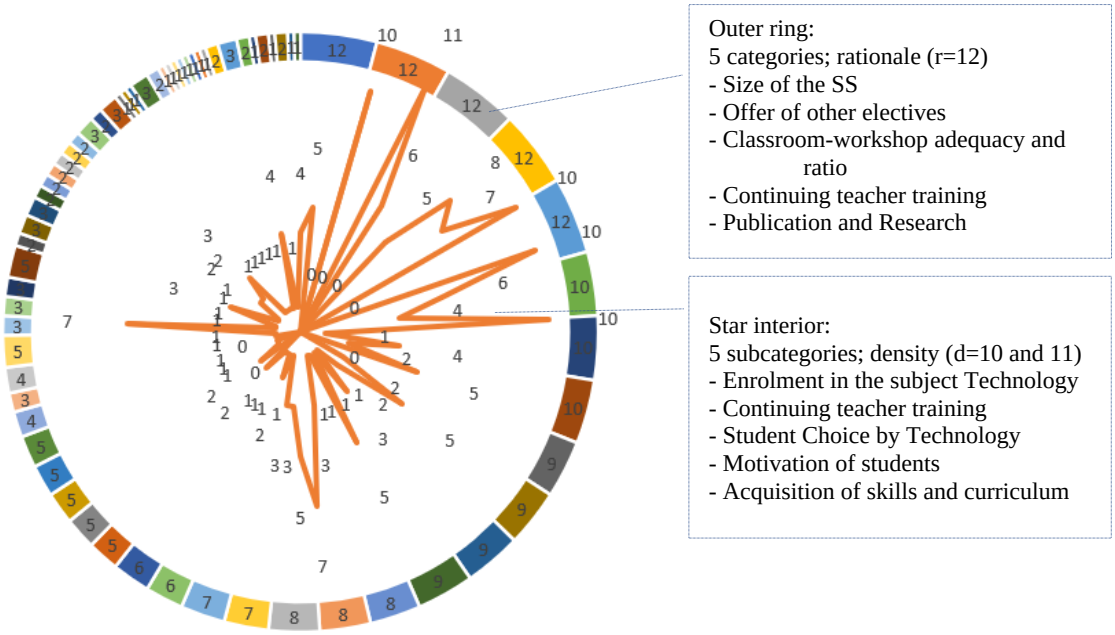
Figure 1 represents the relationship between the highest weight scores in (r) and (d), highlighting 5 categories with r=12 and 5 subcategories with d=10 and 11.

For reasons of space, only the first five codes are analyzed:

The first code "size of the SS" (r=12, d=4), refers to the number of units authorized by the regional government (Conselleria d'Educació) to teach CSE, Bac. and VT, and to the assignment of the number of teachers to each SS. The teachers considered the size of the SS and its location in the town to be influential.

The social-economic stratum of the student body is another factor that influences this code; while the diversity of the student body can be a value, it can become a difficulty in the management of the SS. Another determining factor is the offer of specific and elective subjects, among which is Technology. The larger the size of the SS, the more complex it is to organize schedules and spaces, but the greater the number of electives available to students. This means a smaller number of students per subject. Table 7 shows the number of authorized units of the 17 participating SSs, clearly identifying 7 large SSs (between 28 and 56 units).

Figure 1. Graphical representation of the scores obtained with rationale (r) and densities (d)



Source: Own elaboration

Table 7. Participating Secondary Schools and number of units authorized by educational level

		Number of authorized units			
Name SS	Town	CSE	Bac.	VT	Total
Clara Campoamor	Alaquàs	12	4	3	19
Sugar	Albalat de la Ribera	14	4	1	19
April 25th	Alfafar	13	4	5	22
The Segó Valley	Benifairó of the Valleys	10	3	1	14
Windmill of the Sun	Mislata	23	5	15	43
Gabriel Císcar	Olive	13	4	8	25
Henri Matisse	Paternal	13	4	11	28
White Taverns	White Taverns	22	5	4	31
The Marxadella	Torrent	24	6	26	56
Turís	Turís	15	4	2	21
Benlliure	Valency	16	13	6	35
Fountain of Sant Lluís	Valency	15	5	5	25
Isabel de Villena	Valency	14	6	2	22
Louis Vives	Valency	12	19	0	31
Mercy #26	Valency	19	7	0	26
Serpis	Valency	18	6	17	41
The Serrania	Villar del Arzobispo	10	4	2	16

Source: https://ceice.gva.es/va/web/centros-docentes/consulta-por-niveles

The second code "offer of electives" (r=12, d=5), refers to the fact that each year there are new opportunities to choose other electives, thus giving rise to "competition" or "rivalry" between subjects. Table 8 shows the offer of elective subjects.

Table 8. Offer of optional subjects in CSE and Baccalaureate of Sciences (according to LOMCE)

1st CSE (choose one)	2nd CSE (choose one)	3rd CSE (choose one)	4th CSE Applied / Academic Teachings (Choose one of each block)
Computer science	Computer science	Technology	**Block A:**
Reinforcement Workshops	Reinforcement Workshops	Computer science	Performing Arts and Dance
Deepening Workshops	Deepening Workshops	Reinforcement Workshops	Scientific Culture
Interdisciplinary Project	Interdisciplinary Project	Deepening Workshops	Classical Culture
Classical Culture	Classical Culture	Interdisciplinary Project	Visual and Audiovisual Plastic Ed.
Visual and Audiovisual	Initiation Act.	Classical Culture	Philosophy
Plastic Ed.	Entrepreneurial	Initiation Act. Entrepreneurial	Music
Initiation Act. Entrepreneurial	Second Foreign Language	Compete. Oral Communicative	Second Foreign Language
Second Foreign Language		1st Foreign Language	Information and Communication
		Second Foreign Language	Technologies
			Block B:
			Oral Communicative Competence 1st Foreign Language
			Reinforcement Workshops
			Deepening Workshops
			Interdisciplinary Project

1st Baccalaureate Science	2nd Baccalaureate Science
Choose one:	**Choose two:**
Technical Drawing I	Physics
Biology and Geology	Chemistry
	Technical Drawing II
Choose two:	Biology
Musical Analysis I	Geology
Applied Anatomy	
Scientific Culture	**Choose one:**
Artistic Drawing I	Musical Analysis II
Language and Musical Practice	CC. of the Earth and the Environment
Religion	Artistic Drawing II
Second Foreign Language	Fundamentals of Administration and Management
Industrial Technology I	History of Music and Dance
Information and Communication Technologies I	Image and Sound
Volume	Psychology
	Second Foreign Language
	Graphic and Plastic Expression Techniques
	Industrial Technology II
	Information and Communication Technologies II
	Voluntary:
	Sports Physio-Sports Education and Health

Source: Curriculum - Generalitat Valenciana (gva.es)

It was observed that there is no such offer of electives, but rather it is a decision of the institutional management who plan such an offer. When students have to choose which subjects, they should take next year, "marketing" appears with teachers "selling their subject" and students "buying at a good price". The teachers of Technology (we imagine that other subjects will do the same), do their best to "attract" the students and have a minimum of enrollment, but that, from one year to the next, "everything can jump through the air, and you run out of students".

The third code "Adequacy Classroom-Workshop and ratio" (r=12, d=0), refers to the classroom, workshop, or laboratory space. The teachers indicated that the spaces are adequate to develop the curriculum, although the

obsolescence of the equipment and the lack of updating of the workshops and laboratories emerged. Likewise, there are SSs that, due to their management or size, have larger spaces, which facilitates the teaching task. Underlying the teachers' discourse is the "ratio", associated with the grouping of subjects by "areas". There is a discrepancy among the teachers interviewed, on the one hand, those who consider it essential to "reduce the ratio" and "eliminate the grouping of subjects", considering that each subject has its own internal logic and that it must be a specialist who has to teach its contents. On the other hand, there is a group of teachers who are in favor of "grouping subjects by areas" and "interdepartmental collaboration", pointing out that students improve their S&T skills, reduce school failure, and work on interdisciplinary projects. There is unanimous opinion that in the classroom-workshop, it is key to reduce the ratio between 15-20 students. They emphasized that the maintenance of the infrastructure depends on the teaching staff, who, in general, have to double their timetable to support it.

The fourth code "lifelong teacher education" (r=12, d=10), together with the fifth code "publish and research" (r=12, d=0), drew attention to the teachers' responses regarding classroom experiences. This question sought to know if there is motivation to do research, publish experiences, or if they have attended events and congresses as speakers. It was unanimously evidenced that teachers have no immediate interest in research or in publishing their experiences. They stated that they had attended events "some time ago", but never as speakers. This should set off an institutional alarm throughout the educational system since it shows that teachers do not value the value of disseminating their experiences and findings in their own teaching activities. This lack of value may be evidence of the degree of motivation that teachers have for their work. Bearing in mind that the teachers' training comes from the field of S&T, and that scientific and technological advances are evident, the lack of dedication to reflect, publish and exchange their experiences is not understandable. They expressed that "everything is on the Internet" and that "in one click" they have access to what they need at any given moment. However, they recognized that the real exchange of experiences takes place in person, through the Centers for Training, Innovation and Educational Resources (CTIERs) and school competitions.

Axial coding

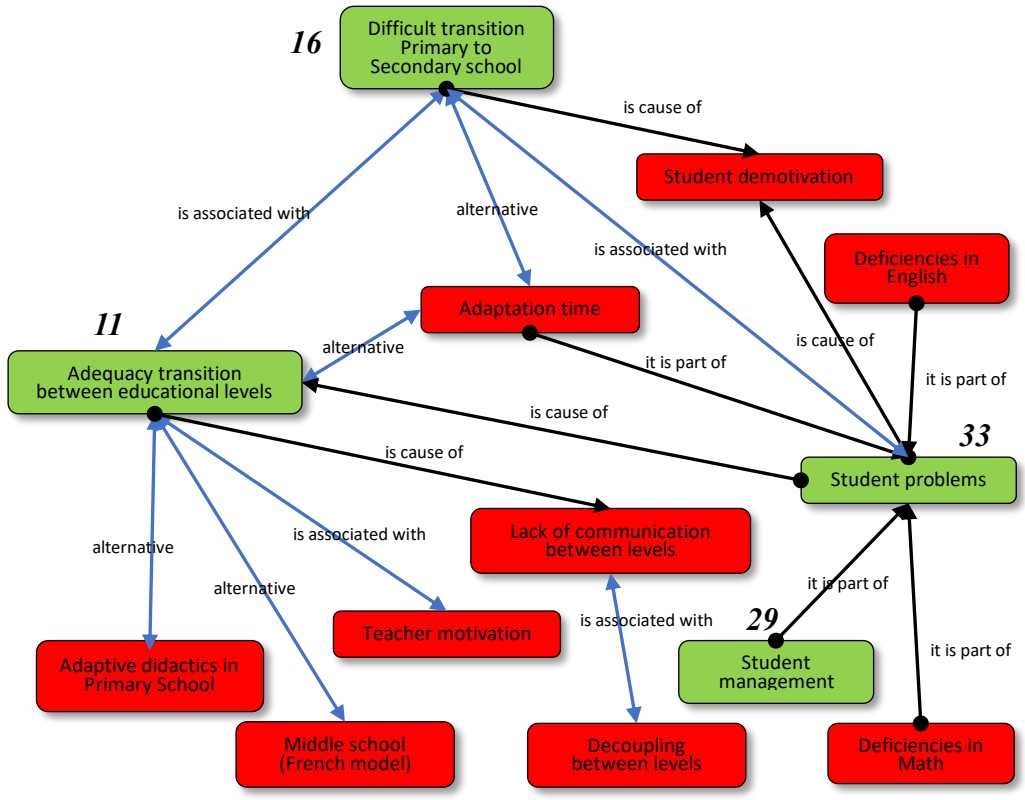
"Axial coding" involves categorizing the codes, so that those that are found around a common axis become categories, and their relationships become subcategories. From the interrelationship between categories and subcategories emerged the "semantic networks", which are ultimately graphic constructions that add depth and structure to the qualitative analysis of the data. From the questions of the questionnaire applied to the focus groups, 6 semantic networks emerged and obtained greater variability in their responses, due to the complexity in the branching of their inter-code relationships (code-code). For the "axial coding" the variable density (d) was taken into account. This numerical value differentiated the categories from the subcategories. The 6 semantic networks were identified as:

I. Student transition between educational levels.
II. Timetable and appropriate scheduling of classes.
III. Curricular structure.
IV. Subject Technology as "specific".
V. Student choice of the Technology subject.
VI. Interest in teacher training.

Semantic network (I): Transition of the student between educational levels

Figure 2 represents the relationships between codes, with 4 main categories: "student problems", "adequacy of transition between educational levels", "student management" and "difficult transition from Primary to Secondary Ed.". The category "adequacy of transition between levels" that students make between the different educational stages, showed that there are student problems that are carried over from one level to another. The teachers recognized the difficulty that students have in the transition from primary to secondary school. In this network, deficiencies emerged in the mastery of Mathematics and English, in addition to knowing how to manage 11 subjects, free time and home activities. It is a pending task to educate leisure time. Teachers urge the educational authorities to review successful experiences in the transition between levels, such as the case of alternating training in the VT and University stages of the French educational system. The lack of communication between levels, the involvement of teachers to improve the transition and the continuity of the subject Technology underlie the teachers' concerns. It happens that, in 1st and 2nd CSE, Technology is compulsory, but as it is optional in 3rd and 4th year (academic courses) they can stop taking it until Baccalaureate. This fact causes a problem for the teacher because of having "students who have taken the subject" throughout the CSE stage, and others who have not, with a difference of two years.

Figure 2. SN (I): "Transition of the student between educational levels" from the point of view of the teachers. The codes labeled in green are the 4 found categories and red the 9 subcategories



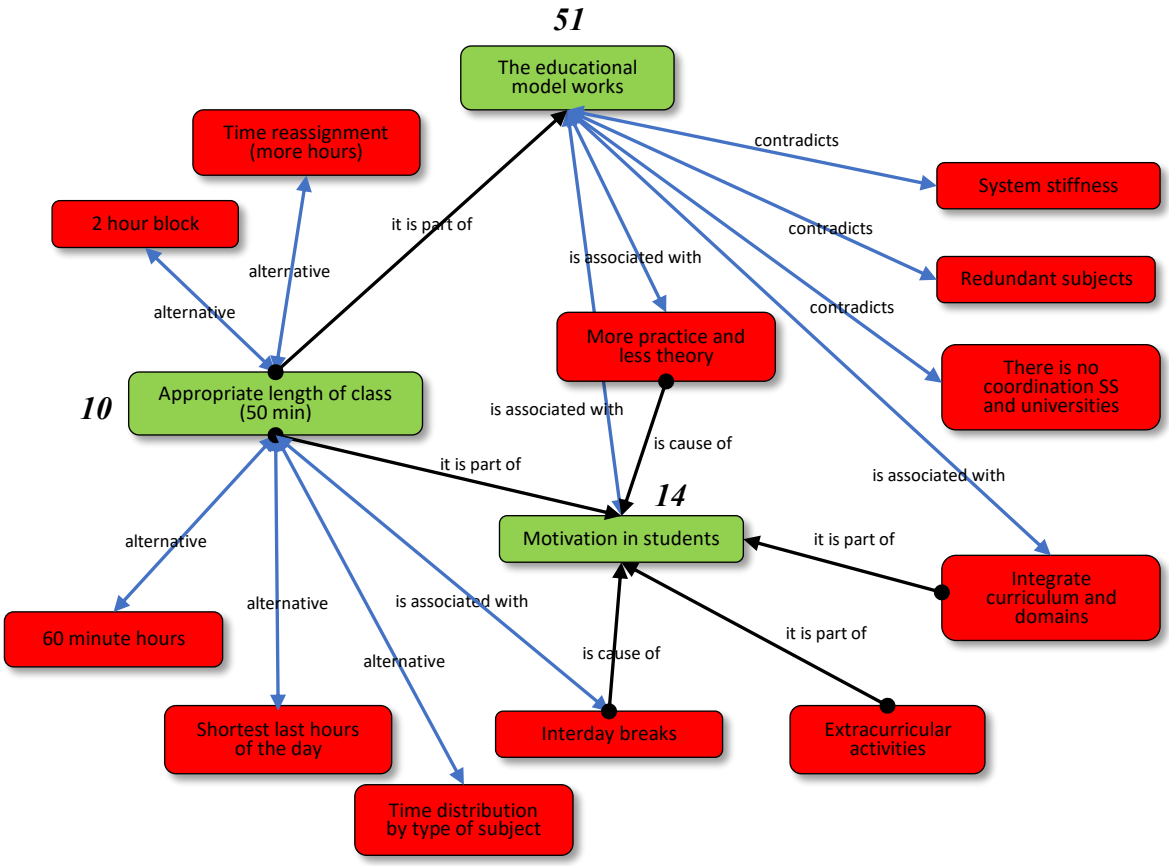
Source: Elaboration with Atlas.ti

Semantic network (II): Schedule and appropriate class timing

Figure 3 represents the relationships between codes, with 3 main categories: "educational model works", "adequate class management" and "student motivation". This semantic network relates the temporality of the class time and the motivation of the students, given that they have between 5 and 6 subjects daily. Teachers agree that the 50–55-minute class is suitable for academic purposes, although there are also those who consider that it should be 45 or 60 minutes. They agree that it decreases the academic performance and motivation of students throughout the school day.

The interviewees indicated that the blocks of two continuous hours concentrate the attention of the students, since the teachers design long-term activities and the "stress" of carrying out activities "against the clock" is avoided. They believe that classes should be more practical and less theoretical. They suggest that the conceptual or abstract subjects are in the first time slot of the morning and the subjects of a procedural nature are in the last hours. The majority considered that 50 minutes is an adequate time for a class, and that rest periods should be respected according to educational levels. The teachers were of the opinion that practical activities (projects) should be carried out in contrast to the dense curricular load, integrating extracurricular activities.

Figure 3. SN (II): Teachers' view of the "appropriate class schedule and timing". The codes labeled in green color are the 3 categories found. In red are the 12 subcategories



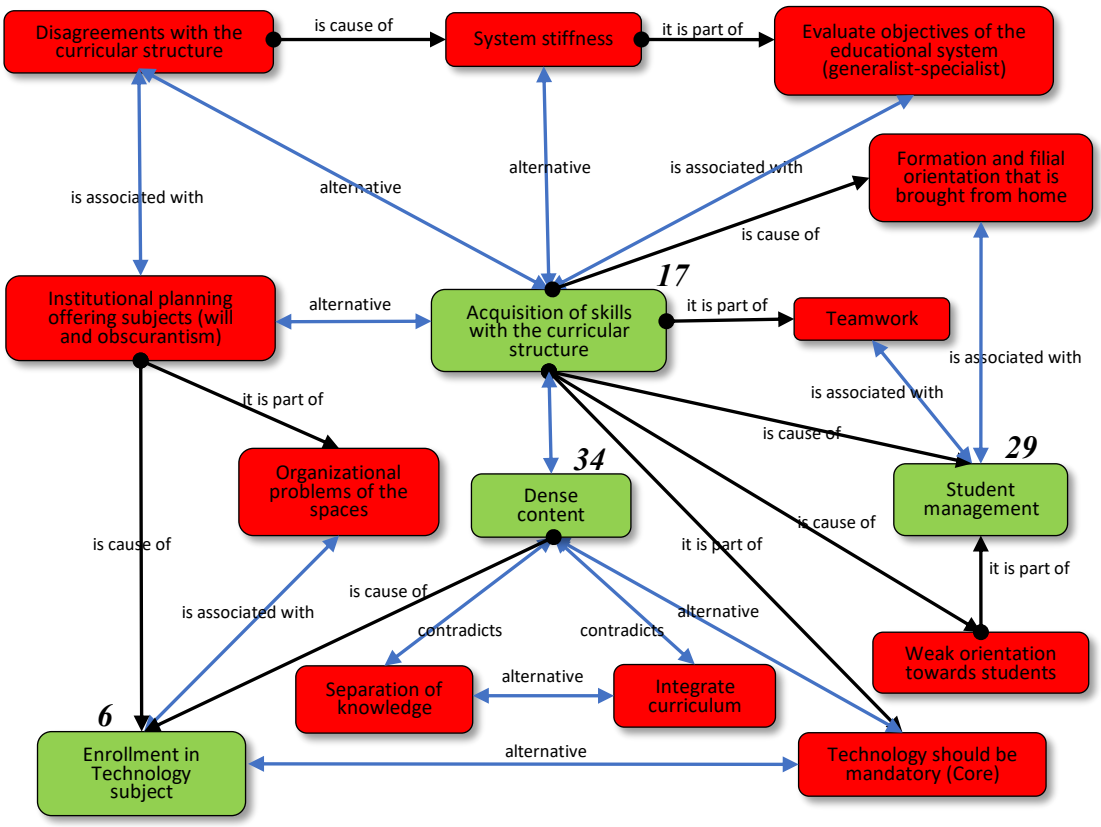
Source: Elaboration with Atlas.ti

Semantic network (III): Curricular structure

Figure 4 represents the relationships between codes, with 4 main categories: "acquisition of competencies and curricular structure", "student management", "dense curriculum" and "enrollment in the Technology subject". The category "acquisition of competences and curricular structure" is the one with the highest density, since it is a source of "discord" because it classifies the subjects into core, specific and elective, and is perceived by most of the research subjects as "very dense" and "rigid", an antagonistic element to the acquisition of key competences. The teachers pose the dilemma: "few contents and well assimilated" which leads to work by "areas" reducing subjects, or else continue with "the current curriculum" represented by 11 subjects.

The teachers expressed the need to evaluate the objectives of the educational system. They consider that the participation of the educational institutions, teachers, students, and families would correct the weaknesses detected. It is common to hear the comment that "it is the educational institution that decides whether or not to offer certain subjects and in which courses". The teachers were perplexed by the way in which the meaning of "electivity" has been distorted. Despite these difficulties, the teachers showed their willingness to face the educational challenges.

Figure 4. SN (III): Teachers' vision in relation to the "curricular structure". The codes labeled in green color are the 4 categories found. In red color the 11 subcategories



Source: Elaboration with Atlas.ti

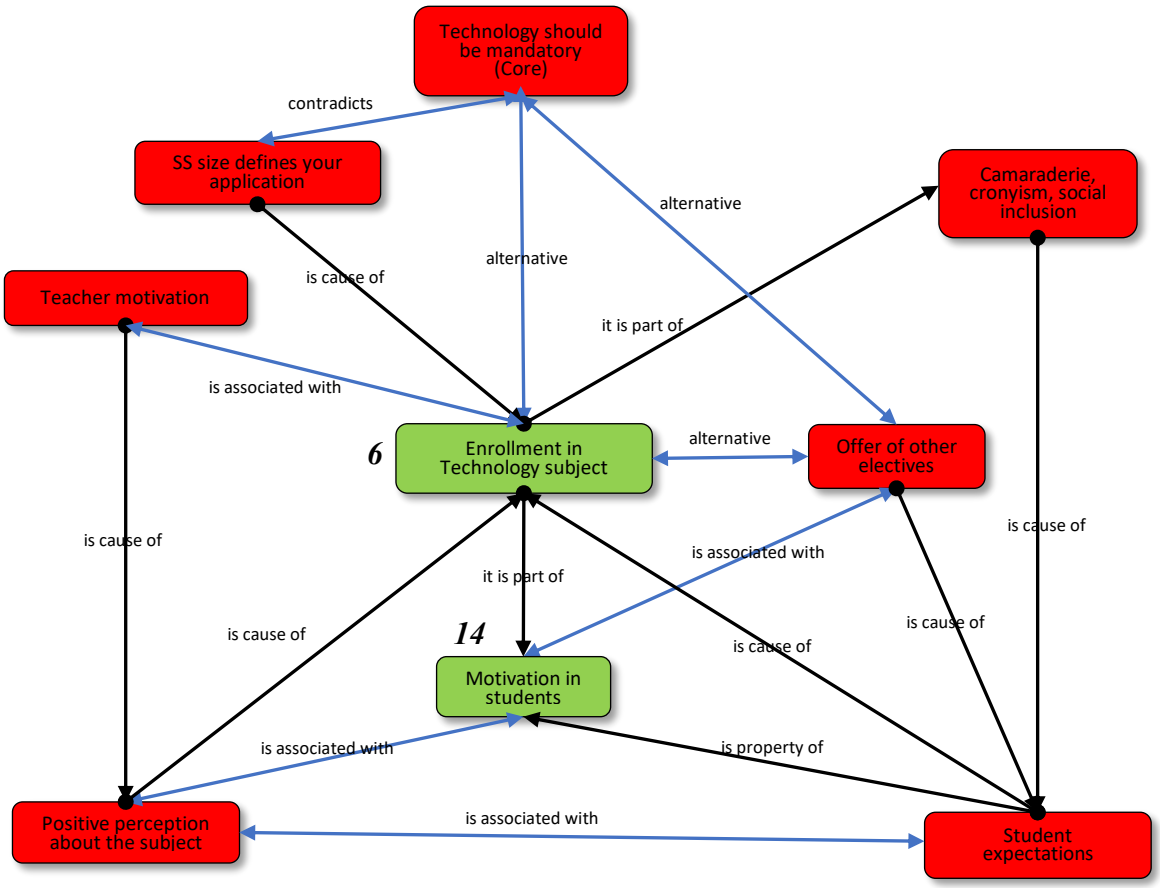
Semantic network (IV): Technology Subject as "specific"

Figure 5 represents the relationships between codes, with 2 main categories: "enrollment in the Technology subject" and "student motivation". The teachers considered that the current curriculum has been detrimental to the Technology subject, categorized as "specific" and not as a "compulsory" subject, which directly affects enrollment in the course. For students to choose a subject, several factors contribute: expectations, motivation, other electives, companionship, social inclusion or the perception of the subject.

In addition, there are institutional aspects, such as the size of the SS, the school organization, or the seniority of the teaching staff at the Center, which leads teachers to consider that, for an adequate curricular development, it should be compulsory in CSE and BST. Teachers are skeptical about the reduction of the timetable with each new educational law.

Teachers do not perceive that the classification of the subject as "specific" is a problem, but neither do they consider that it generates improvements in the competencies to be acquired by students. The Technology subject has changed in recent years, and this compromises its validity. Its curriculum does not correspond to the material and didactic resources that exist in the SSs, generating uncertainty at the time of programming projects.

Figure 5. SN (IV): Teachers' view of "technology as a specific subject". The codes labeled in green color are the 2 categories found. In red color the 7 subcategories



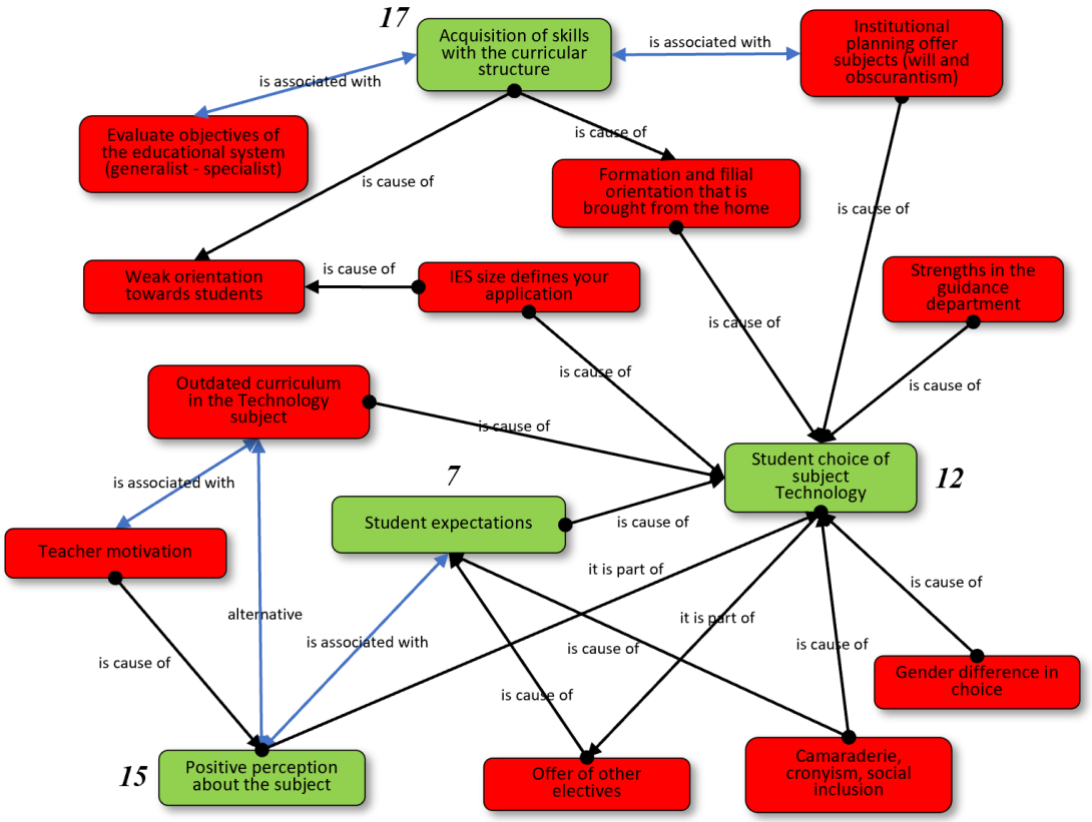
Source: Elaboration with Atlas.ti

Semantic network (V): Student choice of the Technology subject

Figure 6 represents the relationships between codes, with 4 main categories: "acquisition of competencies and curricular structure", "student choice of the Technology subject", "student expectations" and "positive perception of the subject". Teachers believe that students have a positive perception of the subject and prefer it to others, especially in the first years of CSE. However, if students perceive that the subject is "easy" to pass, and if it is convenient for them, they will enroll more frequently. This means that there is no control to supervise what is done in class, beyond the Department itself. This fact prevents the coordination of synergies between departments unless they are produced by the teachers' own will. The teachers recognize that they are interested in the training offered by the institutions, whether online and/or face-to-face, but there are difficulties (more demand than supply) to access some training courses.

The educational guidance given to students was recognized as a weakness, as well as the perception they have from their family environment. On the other hand, one of the strengths is the motivation and commitment of teachers to the Technology subject, despite the strong competition between the different elective subjects. They consider that Technology is a very attractive subject for students, but difficult for teachers to approach because "it requires continuous updating", and it is not easy to know how to integrate practical workshop learning with virtual learning (computer simulation).

Figure 6. *SN (V): Teachers' vision in relation to the "Student choice of the subject Technology". The codes labeled in green color are the 4 categories found. In red color the 11 subcategories*

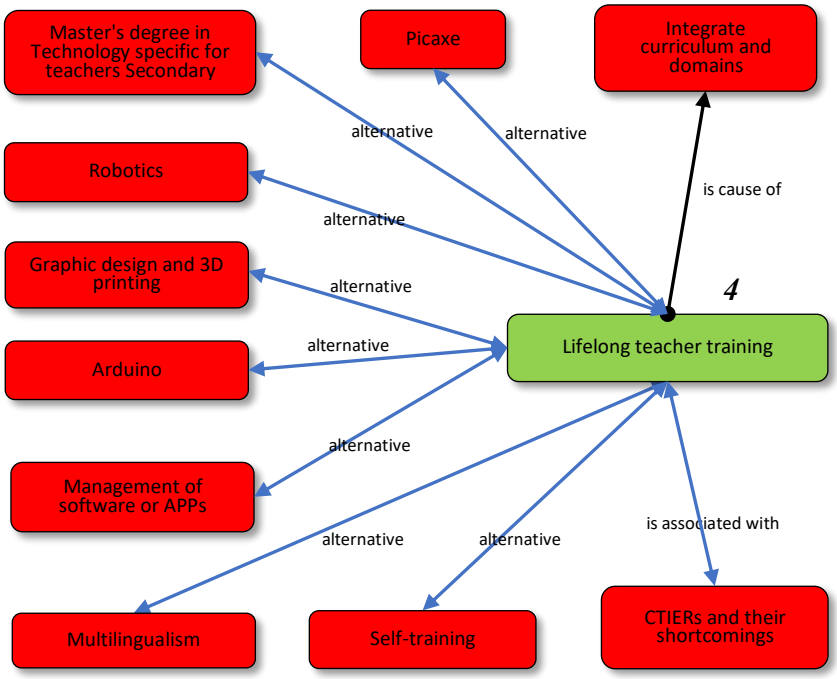


Source: Elaboration with Atlas.ti

Semantic network (VI): Interest in teacher training

Figure 7 shows the only main category found: "lifelong teacher training". The teachers are interested in training in robotics, Arduino cards (Picaxe is in disuse), programming and applications, graphic design and 3D printing. They highlighted their motivation to learn about other collaborative learning methodologies and multilingualism. Although there is a network of CTIERs that design and establish the training offer, the teachers consider that they should be organized more efficiently. In contrast, some of the participating teachers advocate "self-training", considering that it is an individual action, and that each teacher can choose the training area that most interests him/her. They reflected that, in Technology, teachers should be "continuously recycled", and that training is the basis for updating knowledge, but in its proper measure, since burnout syndrome is appearing. The educational administration and the network of CTIERs need to be more agile, plan for the long term and facilitate the exchange of teaching experiences.

Figure 7. SN (VI): Teachers' vision of "interest in teacher training". The code labeled in green is the only category found. In red the 10 subcategories

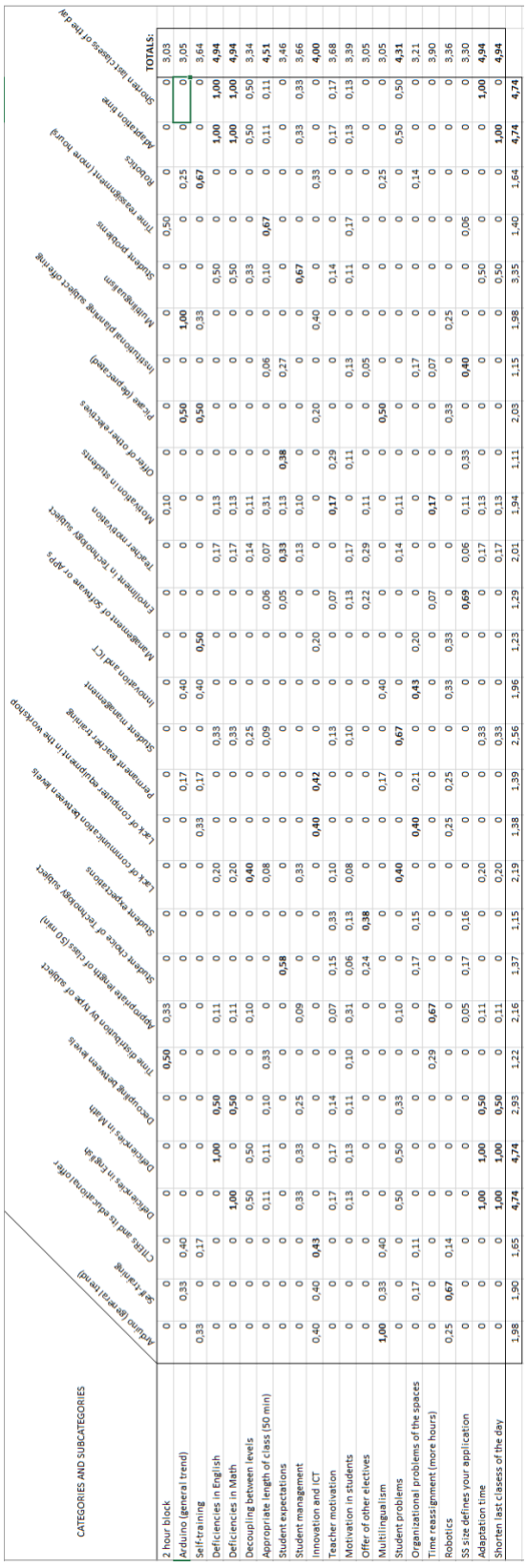


Source: Elaboration with Atlas.ti

Co-ocurrences

The analysis of "co-occurrences" made it possible to discover and group strongly related concepts within the set of data and documents recorded, and can be used to define categories. This technique considers two or more concepts to be co-occurring when they appear frequently together in a set of documents and if they rarely appear separately. Co-occurrences provide objective criteria for understanding the relationship between categories. The "cooccurrence analysis" option of the Atlas.ti software provided a symmetric matrix of 76 rows by 76 columns, with 5,776 scores from 0 to 5. After filtering the data and removing the lowest scores (0 to 1), a 21x28 matrix with 588 scores remained. Table 9 shows the scores between pairs of codes.

Table 9. Matrix of codes with scores (between 3.03 and 4.94). Cooccurrence values with frequencies of pairs of codes and strongest pairwise relationships (in bold).

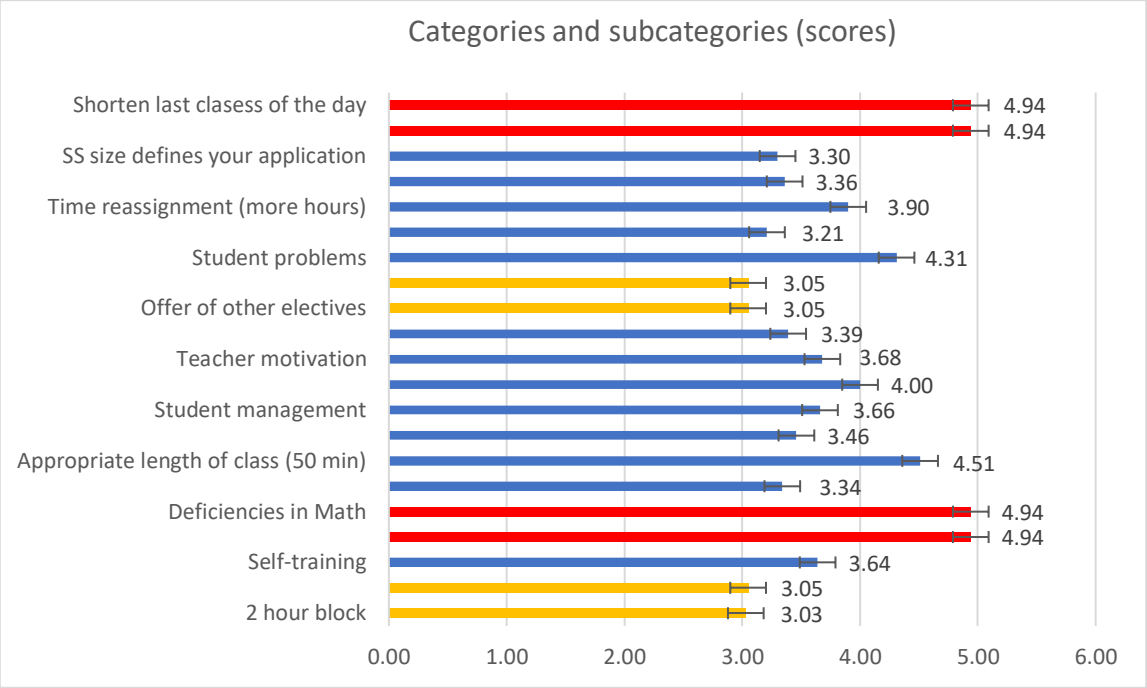


CATEGORIES AND SUBCATEGORIES	Arduino (general trend)	self-training	CTIEMs and its adaptation to other	Deficiencies in English	Deficiencies in Math	Decoupling between levels	Time distribution by type of subject	Appropriate length of class (50 min)	Student choice of technology subject	Student expectations	Lack of communication between peers	Purchase of computer equipment in the workshop	Student management	Innovation and ICT	Teacher motivation	Motivation in students	Offer of other electives	Multilingualism	Student problems	Organizational problems of the spaces	Time reassignment (more hours)	Robotics	SS size defines your application	Adaptation time	Shorten last classes of the day	TOTALS:
2 hour block	0	0	0	0	0	0	**0,50**	0,33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,03
Arduino (general trend)	0	0,33	0,40	0	0	0	0	0	0	0	0	0	0	0,40	0	0	0	0	0	0	0	0	0	0	0	3,05
Self-training	0,33	0	0,17	0	0	0	0	0	0	0	0,33	0,17	0	0,40	**0,50**	0	0	0	0	0	0	0	0	0	0	3,64
Deficiencies in English	0	0	0	**1,00**	**0,50**	0	0,11	0	0	0	0,20	0	0	0	0	0,17	0,13	0	0	0	0	0	0	0	**1,00**	**4,94**
Deficiencies in Math	0	0	0	**1,00**	**0,50**	0	0,11	0	0	0	0,20	0	0	0,33	0	0,17	0,13	0	0	0	0	0	0	0	**1,00**	**4,94**
Decoupling between levels	0	0	0	0,50	0,50	0	0,10	0	0	0	**0,40**	0	0	0,25	0	0,14	0,11	0	0	0	0	0	0	0	0,50	3,34
Appropriate length of class (50 min)	0	0	0	0,11	0,10	0,33	0	0	0	0	0,08	0	0	0,09	0	0,06	0,07	0,31	0	0,06	0	0	0	0	0,11	**4,51**
Student expectations	0	0	0	0	0	0	0	**0,58**	0	0	0	0	0	0	0	0,05	**0,33**	0,13	**0,38**	0	0,27	0	0	0	0	3,46
Student management	0	0	0	0,33	0,33	0,25	0	0,09	0	0	0,33	0	0	0	0	0,13	0,10	0	0	0	**0,67**	0	0	0,33	0,33	3,66
Innovation and ICT	0,40	0,40	**0,43**	0	0	0	0	0	0	0	0	**0,40**	**0,42**	0	0	0	0	0	0	0,20	0	0	0,40	0	0	**4,00**
Teacher motivation	0	0	0	0,17	0,17	0,14	0	0,07	0,15	0,33	0,10	0	0	0,13	0	0,07	**0,17**	0	0,29	0	0	0	0,14	0	0,17	3,68
Motivation in students	0	0	0	0,13	0,13	0,11	0,10	0,31	0,06	0,13	0,08	0	0	0,10	0	0,13	0,17	0	0,11	0	0,13	0	0,11	0,17	0	3,39
Offer of other electives	0	0	0	0	0	0	0	0	**0,24**	**0,38**	0	0	0	0	0	0,22	0,29	0,11	0	0,05	0	0	0	0	0	3,05
Multilingualism	**1,00**	0,33	0,40	0	0	0	0	0	0	0	0	0,17	0	0,40	0	0	0	0	**0,50**	0	0	0	0	0,25	0	3,05
Student problems	0	0	0	0,50	0,50	0,33	0	0,10	0	0	**0,40**	0	0	0	**0,67**	0	0	0,14	0	0,17	0	0	0	0	0,50	**4,31**
Organizational problems of the spaces	0	0,17	0,11	0	0	0	0	0	0,17	0,15	0	**0,40**	0,21	0	**0,43**	0,20	0	0	0	0	0	0	0,14	0	0,50	3,21
Time reassignment (more hours)	0	0	0	0	0	0	0,29	**0,67**	0	0	0	0	0	0	0	0,07	0	**0,17**	0	0,07	0	0	0	0	0	3,90
Robotics	0,25	**0,67**	0,14	0	0	0	0	0	0	0	0	0,25	0,25	0	0,33	0,33	0	0	0,33	0	0,33	0,25	0	0	0	3,36
SS size defines your application	0	0	0	0	0	0	0	0,05	0,17	0,16	0	0	0	0	0	**0,69**	0,06	0,11	0,33	0	**0,40**	0	0	0,06	0	3,30
Adaptation time	0	0	0	0	0	0	0	0,11	0	0	0,20	0	0	0,33	0	0	0,17	0,13	0	0	0	0	0,50	0	0	**4,94**
Shorten last classes of the day	0	0	0	**1,00**	**1,00**	**0,50**	0	0,11	0	0	0,20	0	0	0,33	0	0	0,17	0,13	0	0	0	0	0,50	0	**1,00**	**4,94**
	1,98	1,90	1,65	**4,74**	**4,74**	2,93	1,22	2,16	1,37	1,15	2,19	1,38	1,39	2,56	1,96	1,23	1,29	2,01	1,94	1,11	2,03	1,15	1,98	3,35	1,40	1,64	**4,74**	**4,74**	

Source: Own elaboration

Figure 8 represents in alphabetical order the codes with the highest scores (4.94): "Deficiencies in English, deficiencies in mathematics, adaptation time, shortening last classes of the day". The codes with the highest scores (4.00 to 4.51) are: "Adequate class duration (50'-55'), student problems, innovation, and ICT". The codes with the lowest scores (3.03 to 3.05) are concentrated in: "2h in a row, Arduino, offer of electives, multilingualism".

Figure 8. Code frequency graph



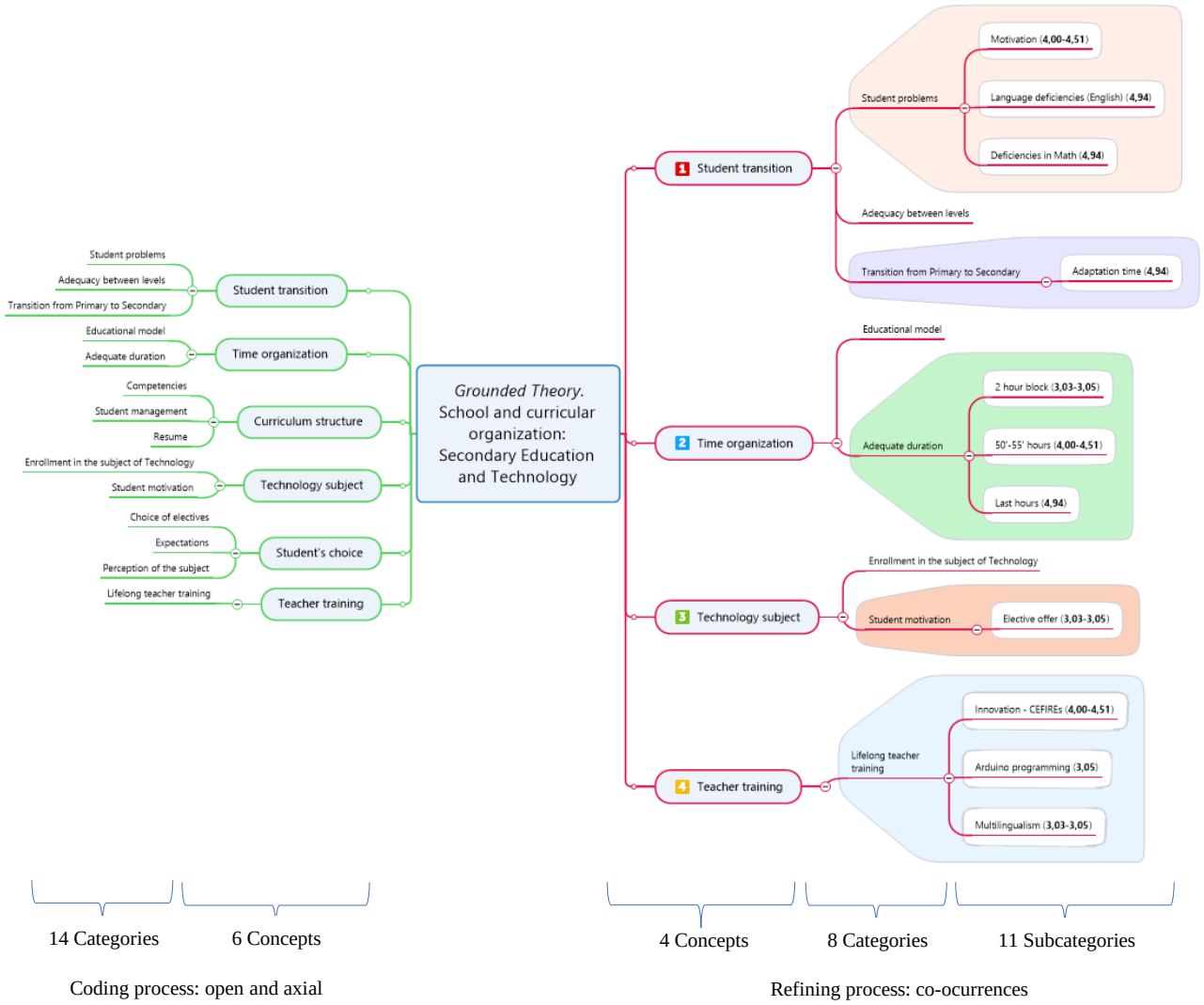
Source: Own elaboration

Selective coding

"Selective coding" is not an independent stage of open coding and axial coding, but an extension of the latter, but with a higher level of abstraction. After the process of refining the data and integrating the categories and subcategories, it is possible to generate a theory that contextualizes the object of study and to draw conclusions. Therefore, selective coding "consists of all the products of the analysis, condensed into a few words that seem to explain what the research is about" (Strauss & Corbin, 2002).

Figure 9 represents the results of the analyses conducted. On the left is shown, after "open and axial coding" the categorization of 6 concepts and 14 categories (for lack of space, the 43 subcategories are not indicated). On the right, after the process of refining the "co-occurrences", the simplified model is shown in 4 concepts, 8 categories and 11 subcategories, indicating the priorities of the 68 teachers interviewed. Therefore, the focus groups and the analyses carried out in open and axial coding, and co-occurrences, reveal that the school and curricular organization must adapt the categories: 1. Transition between educational levels; 2. Time organization; 3. Technology subject; and 4. Teacher training.

Figure 9. Selective coding: categorization of "school and curricular organization"



Source: Own elaboration with MindManager

Discussion

The discussion of the results is structured according to the research questions proposed in this paper for better follow-up.

1. How to improve the transition of students between different educational levels?

Although the transition between Primary and Secondary Education has greatly improved, the adaptation of students to the Secondary stage must take into account the new individualistic culture, focused on disciplines and oriented to results (Azorín, 2019). In the same way, the transition from 4th CSE to the post-compulsory studies of Baccalaureate and Vocational Training is not sufficiently developed. Coordination between teaching departments would improve the transition between different levels of education.

The SN (I) suggests combining strategies for the integration of students and dedicating time for their adaptation, as Lorente (2006) points out. Teachers report a lack of vocational guidance for students. This task of orientation is often made to fall on the tutorials and the voluntariness of the teaching staff. As indicated by Luengo and Gutiérrez (2003), the vocational orientation of students contributes to eliminating gender stereotypes, which can condition their decisions, being active agents: families, the media and education. Connected

with this, the SN(III) reflects the transfer of responsibility to the students, since from 1st CSO year they have to choose their training itinerary, giving rise to assume maturity at an early age, which in practice is not the case. However, towards 4th CSO year, students are empowered with their decisions. For all these reasons, the orientation work should be a more recognized activity and better managed by the centers since it is a critical factor to feed the vocations in the STEAM area.

During adolescence, knowing how to manage free time and leisure is very important especially for academic performance (Hermoso Vega, 2009), in the same way that participation in extracurricular activities has a benefit in the short and medium term. The continuous overstimulation that students receive through their interaction with social networks often hinders a correct management of study time and impacts on their academic performance (García-Martín & Cantón-Mayo, 2019). Schools should take action to make students aware of this problem.

The teachers interviewed emphasize the lack of continuity of the Technology subject among the different courses and educational levels. The teachers' perception of the changes in the curriculum and timetable of the subject reinforces this feeling. It is enough to analyze the different educational laws (LOGSE, LOE, LOMCE and LOMLOE) to verify the loss of identity in CSE and BST.

2. Which school and curriculum organization is right to develop talent?

In relation to this issue, the teachers suggest adapting the length or reduction of the teaching time, depending on whether it is at the beginning or at the end of the day. Students have between 5 and 6 subjects per day, at a rate of change of activity-subject every 50'-55', which influences fatigue towards the end of the day. According to Alonso (2021), these considerations are made outside the debate on the school day (continuous or split), and although teachers are in favor of the continuous school day, this does not guarantee that students improve their academic results or that school failure decreases (Morales Yago et al., 2017).

In some cases, there is difficulty of coordination between the didactic departments of the same IES, and in particular between the STEM/STEAM Departments that could dynamize joint actions. This is a major handicap, since teaching departments play a fundamental role in the context of school organization, as they are structures for personal and professional communication, although at the same time, they are balkanized into subcultures and are "kingdoms of taifas" (Lorente, 2007).

Teachers show their concern about legislative changes and as a consequence in their threats, such as: "what about my subject", timetables, classroom-subject availability, lowering the ratio or "suppressing the areas". These concerns probably generate a demotivation that is reflected in the non-participation in joint activities. The TALIS report (MSEVT, 2018) shows that in primary education 47% of teachers schedule joint activities, while in secondary education it is 21%. In primary education they participate in different classes and age groups 32% and in secondary it is 11%. In primary education, 15% observe other teachers' classes, and in secondary it is 5%. Some of the consequences of the atomized work of teachers are reflected in the number of repeating students, who in the public schools of the Valencian Community have around 32.8% of the students in 3rd CSE year. Therefore, there is still a long way to go to improve this issue in the secondary education field.

Regarding the curricular organization, educational laws have evolved from a rigid position (LOMCE, 2013), classifying subjects by their degree of importance (more mathematics and less art), to the current LOMLOE (2020) with a more open approach. Even so, we find absurdities in the continuity of the subjects, such as: Technology is a compulsory subject in 1st and 2nd CSE years, and optional in the 3rd and 4th ones. As there is no curricular continuity, if a percentage of

students intend to study the BST, it is obvious that they have lost two years of training. All this justifies the structure of the SN (III) that analyzes the vision that teachers have on the curricular structure.

Regarding the elective subjects, their choice is contradictory to the training itinerary according to the talent of the students. In CSE, the choice of these subjects depends on the fashion of the moment and how teachers "sell their subject". In Baccalaureate, subjects are chosen if "there are no exams" and if they are taken into account in the university admission process. The SNs (IV and V) expose the difficulty of a "removable" curriculum, and how the Technology subject (like other subjects) suffers from its continuity according to each legislative change.

3. How to guarantee the acquisition of students' skills?

In relation to this issue, the debate on what contents and what competences students should acquire is widely discussed by Coll Salvador and Solé i Gallart (1987), who, bet on the importance of contents in teaching, while Angulo and Redon (2011), propose the teaching of competences and contents, but "each is its own place". From the point of view of the importance of S&T studies, students are offered the multipurpose basis for developing their "competences in mathematics, science and technology", and if the school acts as a "learning community", it will guarantee that students acquire competences in knowledge, skills, and attitudes (Hargreaves, 2003).

The LOMLOE (2020) points out the paradigm shift of teaching by competencies (knowledge, skills and attitudes), instead of teaching by content. SN (III) relates the categories "acquisition of competencies and curricular structure" and "dense curriculum". However, some of the teachers interviewed consider that for this change to take place, it is essential to "reduce the ratio" and "eliminate the grouping of subjects". They consider that "each subject has its own internal logic, and it has to be a specialist who has to teach its contents". On the other hand, there is a group of teachers who are in favor of "grouping subjects by areas" and "interdepartmental collaboration". They consider that students improve their S&T skills, reduce school failure, and work by projects. The SNs (IV and V) show how teachers are not so concerned about the curricular classification of the subject as about improving the conditions of its stability, since they see its validity as "endangered", despite the fact that the Technology subject has a "positive perception" (EU Council Recommendation, 2018).

The acquisition of competences in S&T is primarily due to the students' choice of these subjects. The participants' responses are very much in line with the results of the study "Social Perception of Science and Technology in Spain" (Arnau et al., 2019; Ortega, 2019), which delves into the factors that keep young people away from S&T studies, highlighting that they are phobias linked to the Internet and ICT, age and gender, formal and informal learning styles, socioeconomic and cultural differences, and the studies of family members (Martín & Moreno, 2009; Utiel, 2010).

4. What initial and lifelong training does teachers require?

Mourshed et al. (2010) analyze the policies that have implemented the most advanced education systems in the world, and ask *why since the 2003 evaluation, some systems improve, and others do not?* The answer is clear: "the quality of an education system has as its ceiling the quality of its teachers". The next question posed by these authors is: *How does a low-performing education system become a good or excellent one?* The answers are: "a good system needs stability, not political swings", "reducing inequality between classrooms and schools", "turning schools into learning organisations" and "improving teacher training". In this sense, teachers believe that it is increasingly difficult to implement legislative changes in the classroom, because they break with the social consensus, stating that "we are not listened to by the Educational Administration".

Teacher training is a recurrent and widely discussed issue among the teachers interviewed, which, as Table 5 shows, teacher training is a "concept" that becomes a "category", whose properties are: "there is no immediate interest in researching or publishing classroom experiences, it requires a lot of effort", teachers are interested in "participating in events (competitions and exhibitions)", but there is "little debate and written reflection", although "there is interest in the training offered" from the CTIERs s in the STEM field, whether online and/or face-to-face, but there are "difficulties in accessing" some training courses.

During the "open coding", teachers expressed the importance of the category "teacher training", occupying the fourth place in Table 6. There are difficulties in accessing some training courses, and they do not consider on a day-to-day basis, research on teaching/learning processes or for publishing classroom experiences, since all this requires a lot of effort and "there is no time". However, according to Imbernón (2001, 2017) teachers work (or spend more hours in the center) compared to the average in EU countries, "although it should be studied not so much the amount of hours but what they are dedicated to". In this sense, the recognition of training activities and the sharing of teaching experiences should be reinforced.

But *what is the training model?* According to García (2012) until 2009, the Certificate of Pedagogical Aptitude (CPA) fulfilled a mission: to integrate theory and practice, learn to teach coherently, have individual and group training, and oriented to the acquisition of professional skills. The implementation of the Master's Degree in Teacher Training, aims to cover the initial teacher training, but with the arrival of competitive examinations for access to the civil service, it rather seems that the Master's Degree has become the preparation for competitive examinations according to the participants. Regarding continuing education, the TALIS study (MSEVT, 2018) says: "the percentage of teachers who are concerned about training is very high, but they are dissatisfied", and this is confirmed by the teachers interviewed

The SN (VI) reveals the need for teachers to "continuously recycle", for "training in digital technologies" and for "implementing collaborative methodologies" in the classroom. They assume that training is the basis for updating knowledge "but in its proper measure", since burnout syndrome has appeared a long time ago, especially in secondary education teachers (Llull et al., 2015). The teaching staff believes that the training offer of the CTIERs network is more agile, that there is long-term planning and that they facilitate the exchange of experiences among teachers.

The LOMLOE (Title III: Teaching Staff, Chapters I and III, Art. 100 and 102), states that *initial training* must guarantee adequate training to face the challenges of the educational system, and that pedagogical and didactic training will be necessary, while *lifelong learning* should contemplate the adaptation of knowledge and methods to the evolution of sciences and specific didactics and promote research and innovation programs by promoting collaborative work.

The network of CTIERs plays a strategic importance for teacher training and the dissemination of experiences. It is advisable to continue promoting meetings of experiences, exhibitions, and school competitions, despite the effort it requires and is often not valued. The teachers propose that "it is not about accumulating points" for the professional career, it is about encouraging institutional mechanisms to investigate and publish professional experiences. Some teachers advocate "self-training", considering that it is an individual action, and that each teacher can choose the field of training that most interests him.

Conclusions

The research carried out attempts to contribute to the improvement of educational quality, because it tries to understand through the opinion of 68 teachers interviewed, and

from the point of view of qualitative methodology, the problems of an area of knowledge, such as Technology, subject to the ups and downs of the successive educational laws that have come into force in Spain in the last 30 years.

In relation to the improvement of the "*student transition*" between different educational levels, teachers address the basic issues, such as: problems in adapting from primary to secondary education, and especially from 4th year CSE to Vocational Training or Baccalaureate. In this sense, there are deficiencies that are carried over from primary school, such as: low academic performance, grade repetition, deficiencies in mathematics and foreign language (English), management of free time and home activities. The task of guiding the training of students according to their abilities and developing strategies for leisure time, falls on the voluntary work of teachers and their ability to empathize with the students. The improvement of educational transition is linked to the communication between teachers of the different educational stages, and to the coordination between teaching departments. It is proposed to organize multidisciplinary coordination teams between the different educational levels as an improvement measure.

With respect to the transition from the S&T modality of the Baccalaureate to university studies (sciences, engineering, and architecture), a progressive decrease of students with interest and competences in S&T is detected. As a consequence, the loss of young talent, especially girls, means that the majority of technology students are boys. Stimulus measures such as the *STEM Talent Girls website* (ASTI Foundation, 2022) can serve to motivate girls' vocations in this field.

Regarding "*school and curricular organization*", teachers consider a good school organization to be one that proposes a school day that avoids overlapping in the use of classrooms and generates a good school environment. Management teams and teachers should be committed to interdepartmental collaboration. We insist on the loss of young talent, sometimes due to issues of school and curricular organization, sometimes due to a lack of empathy or job expectations.

Teachers express the necessary evaluation of the objectives of the education system. They consider that the participation between the educational institution, teachers, students, and families, would correct the weaknesses detected. On the other hand, a dense, rigid, and fragmented curriculum by subjects does not favor the acquisition of competences that students must assume for a complex society, and, in addition, is in contrast to the lack of reading comprehension.

The organization and choice of elective subjects has lost its meaning, and students and professors enter into a "marketing war" between them. The deployment in the offer of electives complicates the organization of schedules and spaces, and students are presented with the dilemma of having to choose a subject from a wide range of electives. In short, they are chosen according to the level of demand/non-demand, while the teaching staff competes to fill in hours in their working day. In the case of the BST, subjects are chosen if they can be considered in the university admission process, and their choice depends on the fashion of the moment. Guidance to students should avoid this situation and should therefore be reinforced.

Although the school day (continuous or split) is under debate, the 50'-55' timetable module is considered adequate, although experimental subjects such as Technology, are advised modules of 2h in a row. However, if the legislative tendency is to reduce the curricular load to 2 hours per week, the idea of working by projects fades away, although there is a positive perception of the students. In this sense, the educational administration (Inspection, Territorial Directorates, etc.), should make a normative effort to give more support to the complex task of teachers, and avoid, among other issues, their bureaucratization.

Regarding the *"acquisition of competences of students",* the change of educational laws from a model (LOMCE, 2013) based on training itineraries and the classification of subjects according to their importance of knowledge, to the current model law (LOMLOE, 2020) based on the integration of areas of knowledge, the development of competences, and the elimination of the classification of subjects, it can be an important advance, although we will have to wait for its implementation in the classroom to check its validity.

The progressive loss in the acquisition of competencies (knowledge, skills, and attitudes) in S&T makes teachers keep an eye on how the curriculum will be developed and the "status" of the subjects. Teachers consider that changes in the law have always been detrimental to the subject of Technology, and by extension to S&T subjects. On the contrary, one of the strengths is the motivation and commitment of the teachers, despite the strong competition among the different S&T subjects. They consider that Technology is a very attractive subject for students, but difficult for teachers to approach because "it requires continuous updating", and it is not easy to know how to integrate practical workshop learning with virtual learning (computer simulation).

After analyzing the participants' interventions in relation to the *"initial and lifelong training"* required by teachers, it is clear that they are interested in improving their training. The difficulty that teachers have to participate in educational innovation programs, school competitions, attendance at congresses, master's and doctoral studies is recurrent, as it is a task of enormous personal effort. Teachers recognize the need for publications and documentation that facilitate the inclusion of innovative experiences in the classroom. For this, it is necessary to create the proper conditions for the training and dissemination of teaching experiences. Teacher training (*online* or face-to-face) must be agile, continuous, and rooted in needs. The training offer of the CTIERs network is adequate, but insufficient, and it is demanded that the training be within school hours.

The training carried out by future teachers, through the Master in Secondary Education, is evident that it helps to improve their initial training, and that they will complete their training throughout their professional life. There is a wide range of lifelong training, although more and more training is *online*.

The new LOMLOE law aims to improve educational deficits, and to focus efforts on the methodological change from teaching-learning by content to teaching-learning by competencies, coordinating the different stages, promoting Vocational Training or the inclusion of interdisciplinary STEM projects. In view of the results of the present study, it may serve to facilitate a framework that promotes improvements in teaching and learning in the S&T field.

Limitations of the research

The "subjectivity" and "bias" of the research occurs for various reasons, the most frequent of which are due to the observer-interviewer. Cornejo and Salas (2011) refer to "what is observed and what is observed with". Minimizing subjectivity and bias has been addressed through the exchange of knowledge of researchers and the constant search for the veracity of data, the methodological, bibliographical, and narrative review of the results found.

In relation to the validity (Martínez Miguélez, 2006) of the results obtained, a great effort has been devoted to "knowing how to listen to and interpret" the opinions of the participating teachers, for which the triangulation technique has been applied (Aguilar & Barroso, 2015).

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Future work

After the rich interaction with the teachers who collaborated in this study, questions arise that deserve particular attention in future studies. It may be of great interest to delve deeper into the mechanisms that condition students' choice of their educational pathway, since it is necessary to promote vocations in the field of S&T.

Another question of interest has to do with the process of implementing teaching and learning by competencies. What training should be provided to teachers who are used to working by content in order to make this transition?

The growing importance of virtual training environments raises concerns among S&T teachers regarding the loss of learning and manual skills in workshop and laboratory activities. It would be of great interest to deepen the analysis of the impact of the use of virtual environments on the skills described.

Finally, a more global and interdisciplinary knowledge requires the redesign of the spaces in our schools to facilitate this new approach. What characteristics should these physical spaces have to facilitate this transformation?

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