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Exploring the construction of social capital within the student entrepreneurship sub-ecosystem

Pauline Brunner^{a*} and Karim Messeghem^b

^aBureau d'Économie Théorique et Appliquée (BETA), Université de Strasbourg, Université de Lorraine, CNRS, Strasbourg, France ; ^bMRM Labex Entreprendre, Université de Montpellier, Montpellier, France

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Abstract: The aim of this article is to show how student entrepreneurs construct their social capital within the sub-ecosystem of student entrepreneurship. We conducted a single case study on the professional network of a cohort of students participating in an entrepreneurship programme in the city of Strasbourg in France. Analysis of their professional networks for their entrepreneurial project reveals the relational dynamics between student entrepreneurs, very strong at the beginning of the scheme but fading over time. Our results also cover the dynamics of professional relationships with other actors in the student entrepreneurship sub-ecosystem, which tend to disperse over time. However, it appears that the role of some students is changing, moving from that of student learner to that of entrepreneur who plays an intermediary role within this sub-ecosystem.

Keywords: entrepreneurship sub-ecosystem, student entrepreneurship, social capital, social network analysis, professional network

Introduction

Many countries have developed programmes to encourage entrepreneurship among students. These take the form of awareness-raising initiatives or training to develop their human capital as well as support measures in the form of business acceleration or incubation schemes to develop their social capital. Like any other type of entrepreneur, student entrepreneurs suffer from a liability of newness (Stinchcombe, 1965) compounded by their deficit in terms of social capital, i.e. both the effective and potential value inherent in the social relations of individuals or social entities (Nahapiet and Ghoshal, 1998) that provide access to a diversity of resources (Alvedalen and Boschma, 2017).

The literature has paid close attention to the content of these programmes and their impact, in particular on entrepreneurial intentions (Bertrand, Meunier, and Lesage 2022; Fayolle 2018; Karimi et al. 2016; Ripollés and Blesa 2023). However, it has told us relatively little about the way in which students manage to develop their social capital within the Entrepreneurial Ecosystem (EE). As underscored by Passavanti et al. (2023) in their systematic review of the literature on entrepreneurial education, one of the challenges is to better understand the role of context, and in particular the university entrepreneurial ecosystem.

The literature on entrepreneurial education has increasingly adopted an ecosystem-based approach (Brush 2014; Miller and Acs 2017; Prokop, 2021). While the entrepreneurial education ecosystem can be seen as a sub-system of the broader entrepreneurial ecosystem (Guerero et al., 2020; Prokop and Thomson, 2022), its logic of action varies: from the creation of academic spin-offs to awareness-raising, training, and support for student entrepreneurs. The latter highlights the existence of student sub-ecosystems embedded within university entrepreneurial ecosystems (Miller and Acs, 2017). The aim of this study is to delve into this sub-ecosystem to understand the construction of social capital by students, combining structural and dynamic perspectives. In this research, the Student Entrepreneurship Sub-Ecosystem

(SESE) forms the context. The research question we address is: How do student entrepreneurs build their social capital within the context of the sub-ecosystem?

To achieve this, we draw on network theory and in particular on social network analysis. This approach is being developed in the literature on entrepreneurial ecosystems (Ancona et al., 2023). Our study applies this perspective to examine the dynamics of social capital construction among student entrepreneurs. Based on the work of Theodoraki et al. (2018), who called for the three dimensions of social capital to be adapted to EEs, and of Ancona et al. (2023), who introduced metrics to measure the structural characteristics of EEs, we dynamically measure the construction of student entrepreneurs' social capital within the SESE. We refer to a single case study, over a one-year period, of a cohort of students participating in an acceleration programme within this sub-ecosystem in the city of Strasbourg. The data includes 25 interviews with students and other actors of entrepreneurial support, participant and non-participant observations as well as other secondary data. To analyse their networks, the study focuses on the professional links contributing to the development of the entrepreneurial project. We relied on the collection of sociometric data known as name generators. This data was analysed using the network visualisation and analysis software Gephi, which enabled us to conduct a graphic and structural analysis of the networks based on the metrics that characterise the three dimensions of social capital. The data was also analysed in terms of respondent discourse in order to illustrate the logic underpinning the construction of social capital.

Our results first of all highlight the relational dynamics between student entrepreneurs. While these relationships were very strong at the beginning of the programme, they tended to fade over time, with the exception of some students who continue to help each other. The results also cover the relational dynamics with other actors in the SESE. They reveal that the network appears less dense over time and has a tendency to dissipate. The students appear to establish fewer relationships but which bring them support that is deemed more useful for the

development of their entrepreneurial projects. Over time, a distinction is created between students who develop their professional network independently and those who remain active within the SESE. The role of the latter can be seen to evolve over time, shifting from the status of student learner to that of entrepreneur with a role of intermediation within the SESE.

This article contributes to both theory and practice. Theoretically, it enriches the literature on social network analysis in entrepreneurial ecosystems (Alvedalen and Boschma 2017; Ancona et al. 2023) by proposing new metrics to assess social capital construction in the SESE. It also advances social capital theory by emphasizing the usefulness and evolution of links, beyond their structural strength (Granovetter, 1973). Additionally, it highlights the intermediary role of certain student entrepreneurs, traditionally attributed to Entrepreneurial Support Organizations (Bergman and McMullen 2022; van Rijnsoever 2022). Managerially, it offers tools for network mapping and analysing network dynamics.

In the remainder of this article, our theoretical framework is presented with an emphasis on social capital in entrepreneurship and in entrepreneurial education. The subsequent section looks at the methodological framework, built on a case study and an analysis of sociometric data. The results are then presented, highlighting the reticular dynamics at work between student entrepreneurs in the cohort, before focusing on the relational dynamics with other actors in the SESE. Lastly, the discussion section emphasises the primary theoretical and managerial contributions, before pointing to future research avenues linked to the limitations of this article.

Literature review

The importance of social capital in entrepreneurship

In the 1980s, the vision of entrepreneur moved from “*the heroic and atomistic entrepreneur to someone with a personal history embedded in a network*” (Elfring and Hulsink 2003, p.409). Aldrich and Zimmer (1986) highlighted the importance of social networks in the entrepreneurial

process in terms of providing access to opportunities and resources. They emphasised the importance of drawing on social networks to obtain resources, described by others as social capital (Nahapiet and Ghoshal 1998; Adler and Kwon 2002; Burt 1992). The network of relationships (source) generates value (resources) which can potentially lead to the growth of one's business. And so research has focused on social capital and therefore the networks needed to access the necessary resources to develop an entrepreneurial project. Many studies have underscored the importance of social networks for the entrepreneurial process and success of entrepreneurs (Cunningham, Menter, and Wirsching 2019; Spigel and Harrison 2018; Lefebvre, Radu Lefebvre, and Simon 2015; W. Stam, Arzlanian, and Elfring 2014; Stuart and Sorenson 2007; Johannisson 2000; Jack and Anderson 2002; Hoang and Antoncic 2003). Networks are seen as the most powerful of assets and one that everyone can have (Elfring and Hulsink 2003), provided they are properly organised. Entrepreneurs structure their networks according to their needs (Johannisson, 2000). They construct them in a way that is dependable so as to develop a competitive advantage and thus increase their chances of survival (Spigel and Harrison, 2018). Their position within the network is important as it modifies the identification and recognition of opportunities (Singh, 2000), the acquisition of legitimacy in the eyes of potential stakeholders (Elfring and Hulsink, 2003). Their position also modifies the constraints encountered (Stuart and Sorenson, 2005). The links developed within the network can be used to obtain advice, knowledge, information, skills, financing, other networks and power (Alvedalen and Boschma 2017; Stuart and Sorenson 2005; Elfring and Hulsink 2003).

Granovetter (1973, 1985) presented the intensity and diversity of the networks of relationships which the entrepreneur can mobilise. He distinguished between strong links, those developed with similar individuals in long-term and intense relationships, and weak links, those developed with networks linked to but outside one's usual networks. For the long-term survival of their project, it is important for entrepreneurs to strike a balance between the two types of

links (Newbert, Tornikoski, and Quigley 2013; Elfring and Hulsink 2003; 2007; Chell and Baines 2000). Strong links ensure access to the resources that an entrepreneurial project may lack and at a lower cost. Weak links are more costly in terms both of time and resources. These links ensure the project's development by making the most of any '*structural holes*' (Burt, 1992) that provide access to new resources and information favouring creativity and innovation. However, the links mobilised over the course of an entrepreneurial project are dynamics and changing. Depending on the progress of the project/business, the entrepreneur will draw in different ways on their social networks (Larson and Starr 1993; Hite and Hesterly 2001), which is why social capital is seen as a dynamic concept (Nahapiet and Ghoshal, 1998). Although strong links are important in the initial stages of business creation, the professionalisation of networks through the creation of new weak links is of major importance for entrepreneurs (Hite and Hesterly, 2001). All the more so for student entrepreneurs, who generally lack resources, legitimacy and credibility.

Social capital of student entrepreneurs in entrepreneurial education

For student entrepreneurs, the exploration of start-up business activities is concomitant to their university studies (Nielsen and Gartner 2017; Bergmann, Hundt, and Sternberg 2016). As a result, they often lack resources (Longva, 2021). What resources they do have are divided between funding their studies and creating their business. In the early stages of their entrepreneurial project (Kaandorp, Van Burg, and Karlsson, 2020), they tend to draw on their pre-existing networks, i.e. personal relationships such as with family members, friends and contacts established in an academic context (Clarysse, Mustar, and Dedeyne 2022; Kaandorp, Van Burg, and Karlsson 2020; Longva 2021). These links, although often personal, are in practice the first professional links that students call on to develop their entrepreneurial project. Often considered strong (Hite and Hesterly 2001; Granovetter, 1973), they enable them to access resources for their entrepreneurial project at a lower cost, generally financial, moral and

emotional resources or networking (Edelman et al. 2016; Bergmann, Hundt, and Sternberg 2016; Lechner, Dowling, and Welpé 2006; De Koning, 2003). Over the course of their studies, they also develop their professional network to include professors and other students, thus facilitating their access to knowledge and professional advice (Brunner, 2021; Longva, 2021). However, student entrepreneurs find it difficult to access resources beyond their habitual networks (Spigel and Harrison, 2018). Their low level of previous professional and entrepreneurial experience (Clarysse, Mustar, and Dedeyne 2022; Krueger, 2007) restricts the existence of pre-established professional networks outside the personal and academic network on which they can rely to access the resources they need to develop their entrepreneurial project (Longva 2021; Kaandorp, Van Burg, and Karlsson 2020). Compounding their young age, their lack of professional and entrepreneurial skills limits their legitimacy from the perspective of potential stakeholders (Kaandorp, Van Burg, and Karlsson, 2020). This makes it more complex to create professional links outside their personal and academic network, establish relationships of trust and therefore develop their social capital. Yet such links would enable them to overcome their limited resources (Clarysse, Mustar, and Dedeyne 2022; Longva 2021) by accessing external resources that would facilitate their survival and entrepreneurial success. They would also allow them to establish the feasibility of their project and their credibility in the eyes of other actors in the ecosystem. And so, the professionalisation of their networks is a key objective for these young entrepreneurs. However, the way in which they use their social networks over time for the benefit of their entrepreneurial projects has yet to receive much attention (Lockett et al. 2017; Rasmussen, Mosey, and Wright 2015).

Initially focused on the attributes and personality of the entrepreneur rather than on the context which influences them (Martin et al., 2013; Pittaway and Cope, 2007; Seet et al., 2018), entrepreneurial training has turned more towards the development of human capital than social capital. However, it has been pointed out that these two forms of capital are important predictors

of entrepreneurship (Davidsson and Honig, 2003; Mosey and Wright, 2007). They are a fundamental part of entrepreneurial learning since social capital, understood in terms of links or networks, reinforces human capital by generating quicker access to resources (Seet et al. 2018).

The shift from a vision of the entrepreneur as isolated towards that of the entrepreneur embedded in networks with which they interact in order to develop their project has led to the recognition of social capital as an important component of entrepreneurship (Gedajlovic et al., 2013; Loi and Fayolle, 2022). As a result, universities have broadened their support for entrepreneurship (Clarysse, Mustar, and Dedeyne 2022; Cunningham, Lehmann, and Menter 2022; Passavanti et al. 2023; Schimperna, Nappo, and Marsigalia 2022) by introducing the use of business simulations (Samašonok, Išoraitė, and Žirnelė 2020); by developing new lessons on entrepreneurship and extracurricular support activities, training courses and seminars (Bergmann, Hundt, and Sternberg 2016; Morris, Shirokova, and Tsukanova 2017; Sendouw 2019; Walter, Parboteeah, and Walter 2013); and by relying on incubators, accelerators and competitions for business plans and subsidies (Wright, Siegel, and Mustar 2017). Universities and the bodies they set up (Fayolle, 2018) increasingly help students construct their social capital (Brunner, 2021; Lans, Blok, and Gulikers 2015), integrate local professional networks (Wright, Siegel, and Mustar 2017) and thereby establish a presence within their ecosystem. These structures even play a role as an intermediary in various networks (Messeghem et al. 2018), such as the professional business network (management experts, financiers, job-hunting top managers), the local network of support structures or the structure's internal network (experts, guest speakers, other project developers). Participation in these networks enables students to access information, advice, new resources and new markets, develop skills, identify opportunities and collectively solve problems (Lefebvre, Radu Lefebvre, and Simon 2015).

Lans et al. (2015) also show that an entrepreneur's social capabilities can influence their social capital. Entrepreneurial education, and education more broadly, is a central means with which to help individuals capitalise on their skillsets, but also to develop their social capabilities. Entrepreneurs must be capable individually of integrating and constructing networks. Other studies have underscored the link between this question of resources and the capacity to construct, develop and mobilise a network (Leyronas and Loup, 2020). One's objective should not be limited to getting to know people in the different networks, but instead to interact with them so as to move one's entrepreneurial project forward. Bergmann et al. (2016) suggest indeed that context plays a role in establishing the new business set up by student entrepreneurs since their capacity to establish links can depend on the context.

Social capital construction in the context of the entrepreneurial education ecosystem

The concept of the entrepreneurial educational ecosystem, within which student entrepreneurs develop their professional network, may correspond to such a context. The literature on entrepreneurial education has increasingly turned towards an ecosystem-based approach (Brush 2014; Miller and Acs 2017; Prokop 2021). The question of the level of analysis must quickly be addressed. The pioneering studies by Regele and Neck (2012) were done at a national level. Authors such as Prokop (2021) and Miller and Acs (2017) suggested a university-level analysis. Whatever the level of analysis, the entrepreneurial educational ecosystem can be seen as a sub-system or even as a sub-ecosystem embedded within the EE. According to Guerrero et al. (2020, 765), it is made up of '*educational programs, infrastructures (incubators, research parks, technology transfer offices, business creation offices, employment offices), university regulations (business creation regulations, property rights), university culture (role models, attitudes toward entrepreneurship) as well as relationships with government, investors, industry and other socio-economic agents*'. This sub-system can reflect different logics of action (Messeghem and Cloutier, 2023). It can be oriented towards the creation of academic

spin-offs that can be managed by academic founders or by external entrepreneurs (Prokop, 2021; Prokop and Thompson, 2023). It can be oriented towards a different logic of action, that of awareness-raising, training and support for student entrepreneurs. This points to the existence of Student Entrepreneurship Sub-Ecosystems (SESEs). Such a sub-ecosystem is embedded within the university entrepreneurial ecosystem, as suggested by Miller and Acs (2017). We propose to define it as the set of actors and factors within a university that contribute to awareness-raising, training and support for student entrepreneurs. This ecosystem-based research perspective is an emerging one and has yet to sufficiently highlight the relational dynamics at work within.

We focus on sub-ecosystems at the micro level by analysing the interactions between individuals. More precisely, we adapt social network analysis to the context of the SESE. Several authors have suggested combining these research streams to enrich both theoretically and empirically the literature on EEs (Acs et al. 2017; Alvedalen and Boschma 2017; Prokop and Thompson 2023; Theodoraki, Messeghem, and Rice 2018). This is particularly relevant in the context of student entrepreneurship ecosystems since student entrepreneurs – at a relatively early stage in the creation of their business – generally lack resources and professional and entrepreneurial experience, which limits the existence of pre-established professional networks on which they could depend to develop their project (Brunner, 2021; Kaandorp, Van Burg, and Karlsson 2020; Longva 2021), at least outside their families, circle of friends or contacts developed in an academic context (Bergmann, Hundt, and Sternberg 2016; Clarysse, Mustar, and Dedeyne 2022; Edelman et al. 2016). Combining the two is also a way to better understand the structures and mechanisms at work as students are learning to navigate the EE so as to gain access to the resources they lack (Longva 2021). Our analytical framework takes into account the dynamic of social capital construction among student entrepreneurs and the influence of the passage of time on this process.

To do this, we evaluate social capital in terms of three dimensions – structural, cognitive and relational – within EEs (Theodoraki, Messeghem, and Rice 2018). These authors associate three network indicators to assess the structural dimension, i.e. the established relationships within the EE, its density and its stability. In addition to the presence of links between actors, a high density is important for the smooth running of EEs (Ancona et al. 2023). This means that actors interact extensively with each other to share information and resources. High density is particularly important for an SESE, so that students interact with other actors, establish dependable relationships, and frequently exchange knowledge and information. Intermediaries (van Rijnsoever, 2022) like incubators, accelerators, universities, or research centres can play a key role in promoting exchanges (Clarysse, Mustar, and Dedeyne 2022; Passavanti et al. 2023; Schimperna, Nappo, and Marsigalia 2022) and therefore network density. Not only do these entrepreneurial support organizations serve to put students and other actors in the sub-ecosystem in contact with one another, but they also channel information flows towards peripheral members. By controlling the flow of knowledge within the network (Newman, 2018), intermediaries can be central actors and play an important role in the construction of student entrepreneurs' social capital. The stability of the network – and therefore that of the SESE (Theodoraki, Messeghem, and Rice, 2018) – is also important for building long-term relationships based on trust for student entrepreneurs. In addition to the structural dimension, the cognitive dimension of social capital is also important. This dimension, which refers to norms, common objectives and shared languages (Theodoraki, Messeghem, and Rice 2018), can be associated with the notion of diversity, defined as *‘the presence of different classes and venture types, whose members interact regardless of the category they belong to’* (Ancona et al. 2023), insofar as it contributes to the creation of a rich and heterogeneous environment in which ideas and expertise can be shared between different actors. This dimension depends on the degree of network openness, which can be assessed in terms of heterophily and homophily

within the EE (Prokop and Thomson, 2022). It is all the more important for student entrepreneurs, who often lack resources and experience (Clarysse, Mustar, and Dedeyne 2022; Longva 2021). Finally, the relational dimension of the social capital is associated with trust, norms and obligations, but also the shared expectations of stakeholders (Nahapiet and Ghoshal, 1998; Theodoraki et al., 2018). It provides a better understanding of the nature of exchanges between students and other members of their professional network.

Methodology

To answer our research question, we opted for an exploratory analysis of a single case study (Yin 2013) of a cohort of students participating in an acceleration programme within the SESE of the city of Strasbourg. Analysing a single case study is particularly useful for understanding a complex phenomenon with different dimensions that are not easy to explain using quantifiable variables (Panetti et al. 2020), as in the case of studying the three dimensions of student entrepreneurs' social capital in a SESE. To analyse these three dimensions, we chose social network analysis, generally considered an archetype that summarises one's social life in terms of connectedness structures between individuals, groups or organisations (Hu et al. 2015) and measures of centrality (Scott and Carrington, 2011). Use of this method to study relational dynamics in EEs has been supported by several authors (Ancona et al. 2023; Theodoraki, Messeghem, and Rice 2018; Wurth, Stam, and Spigel, 2022).

Case study: Starter acceleration programme

The research field focuses on student entrepreneurs registered in an accelerator programme delivered by the PEPITE (Student Pole for Innovation, Transfer and Entrepreneurship) in Strasbourg in France. This centre was created in 2014 by the Ministry of Higher Education, Research and Innovation. It is open to any student enrolled in higher education and who wants

to develop an entrepreneurial project alongside their studies, whatever their field of study (Brunner and Schaeffer, 2024). Enrolment in this entrepreneurial centre is voluntary. The PEPITE offers students a special status known as national student entrepreneur status (*Statut National Etudiant-Entrepreneur* or SNEE in French). This status enables students to adapt their timetable to work on their project, to substitute an end-of-study internship for work on their project, or to validate certain university credits. In addition to these benefits, the centre offers training courses for students, including an intensive four-month entrepreneurship acceleration programme called ‘*Starter*’ for a select group of student entrepreneurs. The aim of this programme is to accelerate their entrepreneurial project and establish a business model and commercial action plan. Lasting four months, the Starter programme covers a diversity of services and activities such as individual and personalized support, weekly workshops run by experts, a network of mentors, breakfasts with the students every week, coworking spaces and various events over the course of the programme (Table 1).

Table 1. Starter programme activities

Participants	Starter programme activities
Members of the programme	Bootcamp: 2 days of collective and sub-group training Teambuilding: 3 days of integration Breakfast: one a week Workshop run by experts in finance, intellectual property, marketing, social media, business development: one a week Individual meeting with a PEPITE moderator: one a week Individual meeting with a mentor: every two weeks
Members of the programme and of the SESE	Programme opening event Mid-term review: pitch in the middle of the programme in front of experts Entrepreneurial fair: stand available Demo day: final pitch to investors

To take part in this programme, students must have obtained national student status, validated the idea of their entrepreneurial project through their participation in a previous entrepreneurial course at the PEPITE and be available full-time for four months to work on their entrepreneurial project.

This research focuses on a cohort of student entrepreneurs who took part in the Starter programme when it was first set up in 2019. There are several reasons for this. First, one of its objectives is to favour the development of social capital among students. It offers individual and tailored support, scenario simulation exercises, weekly workshops run by experts, access to a network of mentors, as well as networking events over a four-month period, from March to July 20219 (Table 1). Second, it only targets students with a project that is already well advanced, meaning they have already validated the idea for the project and have acquired the foundations of entrepreneurship (Gabay-Mariani and Boissin, 2021). Furthermore, it pursues a logic of embeddedness within the local EE. There are several highlights such as Bootcamp, Teambuilding, Mid-term review, Entrepreneurial fair, and Demo day (Table 1) that punctuate the programme of events (Altès-Mathieu, Authier and Hebinge, 2018) to ensure that students can present their project to actors from the local EE.

Construction and analysis of sociometric data

Primary and secondary data were collected over a one-year period. To obtain a longitudinal and immersive perspective on the construction of social capital of students within the SESE, we collected contextual data, i.e. non-participatory observations transcribed in notes, while participating in various events from March 2019 to February 2020 (Table 2). These observations were used to gather background information. They improved our knowledge of how the PEPITE respects its commitment to developing students' social capital and its relations with other actors in the local EE. Observations made during Starter programme events enabled us to gain a better understanding of the programme's objectives and to observe the relational dynamics of the students.

Table 2. Contextual data

Data source	Date	Duration (mins)
Team meeting at PEPITE	11/03/2019	60

Team meeting at PEPITE	18/03/2019	60
Committee: project selection jury	25/03/2019	120
Starter programme inauguration	06/03/2019	120
Starter programme highlight: breakfast	24/05/2019	90
Starter programme highlight: generation start-up fair	04/06/2019	300
Grand-Est regional event: 360 possibilities	28/06/2019	300
Seminar at PEPITE in Strasbourg	03/07/2019	300
Starter programme final event: final pitch from student entrepreneurs	05/07/2019	180
Pitching session run by the PEPITE	09/01/2020	300

In addition, 25 semi-structured interviews were conducted in person with 12 student entrepreneurs out of 14 who took part in the Starter programme in 2019, and with 3 moderators from the PEPITE centre of Strasbourg. In order to understand the relational dynamics at work in the SESE, the students were interviewed twice one year apart. The first interviews took place at the end of the Starter programme from July to November 2019, and the second interviews one year after their participation in the programme, from July to November 2020 (Table 3).

Table 3. Overview of interviews

Interview	Date	Interviewee (anonymized identity)	Duration (mins)
1	05/07/2019	Student entrepreneur ID 1	41
2	28/07/2020		58
3	12/07/2019	Student entrepreneur ID 101	108
4	05/10/2020		120
5	12/07/2019	Student entrepreneur ID 125	70
6	11/08/2019		52
7	13/07/2019	Student entrepreneur ID 13	44
8	13/11/2019	Student entrepreneur ID 145	120
9	06/11/2020		58
10	13/07/2019	Student entrepreneur ID 28	75
11	19/08/2020		120
12	05/07/2019	Student entrepreneur ID 29	64
13	19/08/2020		120
14	02/07/2019	Student entrepreneur ID 41	55
15	19/08/2020		50
16	13/07/2019	Student entrepreneur ID 45	63
17	03/08/2020		90
18	20/11/2019	Student entrepreneur ID 7	90
19	02/09/2020		53
20	02/07/2019	Student entrepreneur ID 72	58
21	05/08/2019		65
22	03/07/2019	Student entrepreneur ID 89	36
23	01/03/2019	Head of PEPITE centre in Strasbourg	80
24	28/08/2020	Moderator from the Starter programme	50
25	19/08/2020	Employee of PEPITE centre and manager of the biotech lab	80

To strengthen our data triangulation (Mathison 1988), we also drew on secondary data (Starter programme schedule, list of student entrepreneurs taking part, list of experts and guest speakers who contributed, 2019 and 2020 activity reports from the PEPITE unit in Strasbourg, press releases, websites and social media pages linked to the projects of the Starter student entrepreneurs). This data allowed us to identify the actors and organisations in the SESE in advance of the interviews and to improve our understanding of the relational dynamics at work in this SESE over a one-year period. The student entrepreneurs were interviewed about the characteristics of their profile and entrepreneurial project (Table 4) as well as the composition of their professional network, which helped them to develop this project.

Of the 12 students surveyed, 5 were women and 7 men. They were all aged between 20 and 40. Two students were studying for a bachelor's degree, 8 for a master's and two for a doctorate. Three students had previous professional experience (ID 1; ID 32; ID 89), but only one was related to the entrepreneurial project (ID 32). Four students set up a company in 2019 during their participation in the Starter programme (ID 7; ID 31; ID 41; ID 72), and two more the following year in 2020 (ID 28; ID 29).

Table 4. Student profiles and entrepreneurial project features

ID	Gender	Age	Level of education	Educational field	Previous professional experience	Project description	Business sector	Project progress		Number of professional links with actors in the SESE ¹	
								2019	2020	2019	2020
1	F.	29	Master's	Pharmacy	Yes	Cosmetic training	Pharmaceutics	Development	Project change – ideation	7	7
7	F.	20	Bachelor's	Humanities	No	Coaching	Consulting	Commercialisation	Commercialisation	20	15
13	M.	31	PhD	Life sciences	No	Sports betting consultancy platform	Healthcare	Commercialisation	No news	12	-
28	M.	24	Master's	Art	No	Sustainable diet consultancy platform	Food	Development	Commercialisation	18	5
29	F.	24	Master's	Art	No	Laboratory food kit	Food	Development	Commercialisation	22	29
41	M.	25	Master's	Design and ergonomics	No	3D printing engineering and design department	Design	Commercialisation	Commercialisation	10	7
45	M.	26	Master's	Engineering and entrepreneurship	No	Object to enhance value of wine bottles	Design	Development	Abandoned - leisure activity	13	11
72	F.	24	Bachelor's	Business and public administration	No	Digital marketing for restaurateurs	Food	Commercialisation	Commercialisation	11	11
89	M.	40	Master's	Entrepreneurship	Yes	Donation platform	Charity	Development	No news	11	-
101	M.	32	Master's	Law of the digital economy	Yes	Diploma and recruitment certification platform	Recruiting	Development	Development	26	22
125	F.	24	Master's	Design	No	Heated underwear for painful menstruation	Healthcare	Development	Project change - ideation	18	6
145	M.	32	PhD	Healthcare	No	Travel healthcare consultancy platform	Healthcare	Development	Development	18	10

¹ The links developed with student entrepreneurs from the same cohort of the Starter programme are not included here. This sociometric data was collected using the name generator method. The questions asked of respondents to identify their professional links are presented in Appendix 2.

To conduct a network analysis, we collected sociometric data known as name generators (Campbell and Lee, 1991; McCallister and Fischer, 1978). This technique involves asking the respondent a question that leads to the enumeration of a list of people with whom the respondent interacts in relation to a specific topic. To represent their professional network in relation to their entrepreneurial project, we asked student entrepreneurs about all of the actors who provided them help in developing their entrepreneurial project (Appendix 1). The interviews were recorded and transcribed in order to produce sociometric data, i.e. data which measures the links between individuals (Angot and Josserand, 2001). They were then analysed with the network analysis and visualisation software Gephi, which can be used to conduct a graphical and structural analysis of networks based on the metrics that characterise the three dimensions of social capital. During each interview, a grid to analyse the sociometric data of the respondent's social network was produced and checked by the respondent to ensure the validity and consistency of their responses.

Analysis of social capital dimensions

We measure the three dimensions of social capital using analytical metrics of social networks associated with EEs (Theodoraki, Messeghem, and Rice 2018; Ancona et al. 2023) (Table 5).

Structural dimension

We measure the relationships of student entrepreneurs in the SESE based on the existence of links within the network. We measure the density of networks, i.e. the frequency of interactions between network members, using graph density (Panetti et al. 2020). The density of a directed network is the ratio of the actual number of links in the network to the total number of possible links. Specifically, it is defined as follows:

$$Density = \frac{L}{n(n-1)} \quad (1)$$

where n is the number of nodes, $n(n - 1)$ the number of possible links and L the number of total links in the network. The closer this indicator is to 1, the more the network is characterised as dense, meaning that its actors interact a lot. We measure intermediaries based on betweenness centrality, which determines the number of times a node v , i.e. an actor, is on the shortest path between two nodes (two actors) (Ancona et al. 2023). For each pair of nodes, we calculate the number of shortest paths from i to j and the number of these paths that pass through v . The betweenness centrality for the node v is the sum of these proportions for all pairs of nodes other than v .

$$\textit{Betweenness Centrality} (v) = \sum_{i \neq v \neq j} \frac{\sigma_{ij}(v)}{\sigma_{ij}} \quad (2)$$

Where σ_{ij} is the total number of shortest paths from i to j and $\sigma_{ij}(v)$ is the number of these paths that pass through v . Finally, we measure network stability based on the actors who, in the SESE, are identical at two points in time, in Network_t and Network_{t+n} . Network_t corresponds to the reference network, and Network_{t+n} to the second point in time. The proportion of identical nodes at two points in time is calculated on the basis of the number of nodes in the reference network, i.e. Network_t .

$$\textit{Identical actors} (\%) = \frac{\textit{Identical nodes in Network}_t \textit{ and Network}_{t+n}}{\textit{Total nodes of Network}_t} * 100 \quad (3)$$

Cognitive dimension

We measure diversity based on the presence of different types of actors within the network of students extended to other actors in the SESE. We calculate the proportion of each type of actor as a function of the total number of nodes, i.e. actors, in the network.

Relational dimension

As the strength of a link, whether strong or weak, can change over time (Pluchart 2013, 2014; Larson and Starr 1993), we measure the relational dimension by the usefulness perceived by students of the help provided by other actors to the project (François, Lafaye, and Belarouci 2021), rather than the strength of links as developed by Granovetter (1973). We measure perceived usefulness using a 7-point Likert scale comprising a neutral median point (Hinkin 2005), where 1 indicates a non-useful link for the student in terms of developing their entrepreneurial project and 7 a very useful link.

Table 5. Adaptation of social capital dimensions to the SESE

Social capital dimensions	Network-based principles of entrepreneurial ecosystems	Metric	Definition	References
Structural				
Network links	Ecosystems links	Links	Existence of links between members.	Theodoraki et al. (2018)
Network configuration	Density	Graph density	Measures the connection between nodes. This coefficient ranges between 0 (sparse graph) and 1 (dense graph).	Ancona et al. (2023); Bell-Masterson and Stangler (2015); Feld (2012); Panetti et al. (2020); Theodoraki et al. (2018)
	Intermediaries	Betweenness centrality	Identifies those nodes which lie on many shortest paths. This coefficient is normalized between 0 (low centrality) and 1 (high centrality).	Ancona et al. (2023); Feld (2012); Roundy (2017); Stam and van de Ven (2021)
Network stability	Ecosystem stability	Identical actors	Measures of identical actors over time.	Theodoraki et al. (2018)
Cognitive				
Shared goals and language	Diversity	Types of actors	Presence of different types of actors.	Ancona et al. (2023); Bell-Masterson and Stangler (2015); Roundy (2017)
Relational				
Shared narratives, Trust, Norms, Obligations, Identification	Usefulness	Perceived usefulness	Measures the perceived usefulness of links for the entrepreneurial project on a Likert scale from 1 (link not useful) to 7 (link very useful).	(François, Lafaye, and Belarouci 2021; Pluchart 2014)

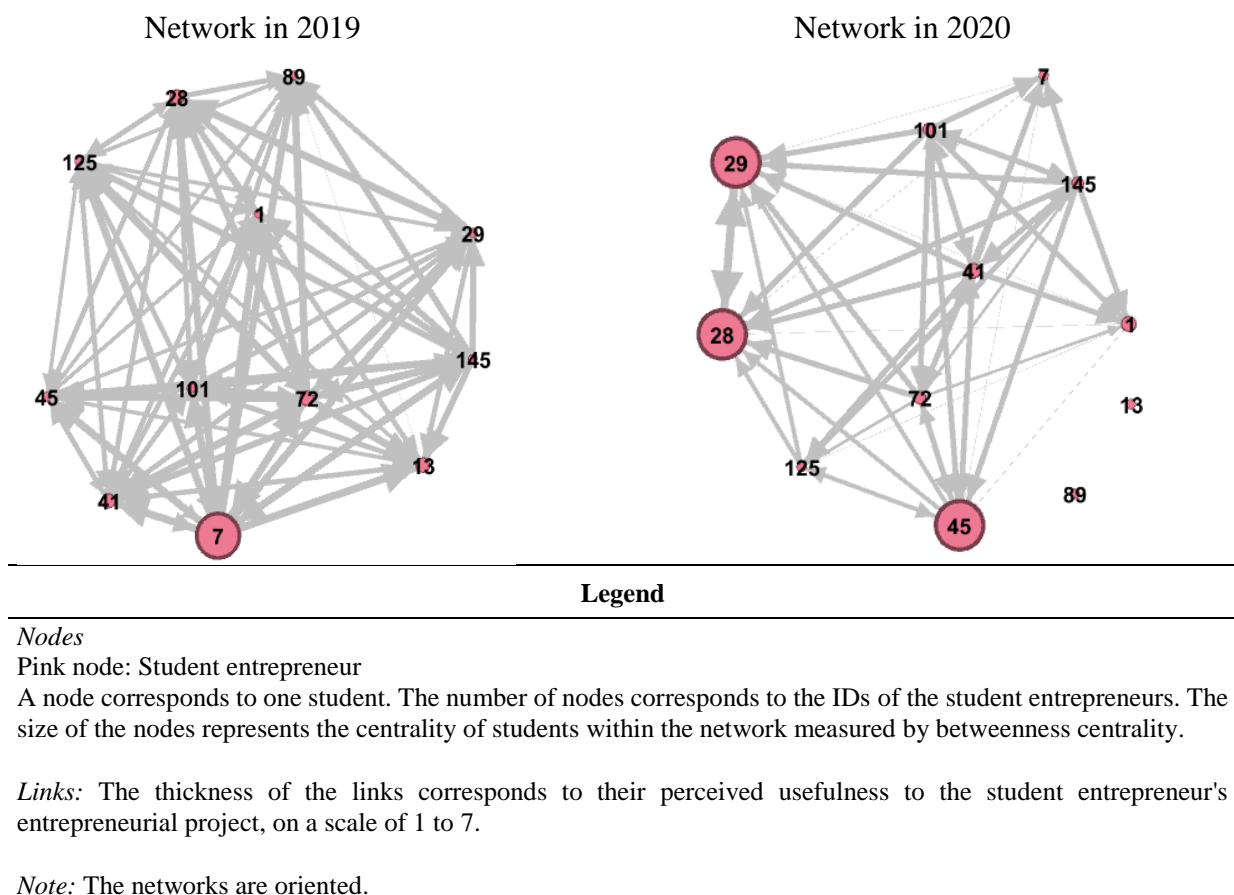
Results

We decided to study the social capital of student entrepreneurs in the SESE. It is analysed on two levels: relations between students participating in the Starter programme at the PEPITE centre, and relations with other SESE actors. To explore the evolution of the networks from one year to the next, we performed Kolmogorov-Smirnov tests on the degrees and betweenness centrality of the network representing relational dynamics on these two levels (Appendices 2 and 3).

Development of social capital with student entrepreneurs in the Starter programme

We produced a graphic representation of the network developed by student entrepreneurs with other students who had participated in the same programme one year apart (Figure 1).

Figure 1. Professional networks representing relationships between Starter programme students one year apart



Structural dimension

Each network is made up of 12 nodes, i.e. the starter programme students. Graphically, we can see that the dynamics of the relationships between the student entrepreneurs in the cohort fade over time (Figure 1). The 2019 network is made up of 105 links, dropping to 73 in 2020. The same applies to the density of the network, going from dense (0.795) to sparse (0.553). The decline in the number of links and the density of the network from one year to the next clearly shows that the dynamic of interaction between students fades over time. One year after the end of the programme, fewer students are interacting to help each other with their projects. Two student entrepreneurs (ID 89, ID 13) were no longer using these links in 2020 (Figure 1), supporting the reduction in links and network density between 2019 and 2020. If we focus on the central actors, we notice that one student (ID 7) was more central, more at the heart of relational dynamics, than the others in 2019. In 2020, three students seem to be the most active in the network (ID 45, ID 29, ID 28) and become central actors (Figure 1 and Table 6).

Table 6. Top five actors for the betweenness centrality metric within the Starter programme network

2019		2020	
Actor	Betweenness centrality	Actor	Betweenness centrality
Student entrepreneur (ID 7)	0.0909	Student entrepreneur (ID 45)	0.020996
Student entrepreneur (ID 72)	0.013636	Student entrepreneur (ID 29)	0.020996
Student entrepreneur (ID 41)	0.013636	Student entrepreneur (ID 28)	0.020996
Student entrepreneur (ID 28)	0.013636	Student entrepreneur (ID 41)	0.002814
Student entrepreneur (ID 13)	0.013636	Student entrepreneur (ID 1)	0.002814

The flow of information and knowledge is shared between several students over time, particularly those who appear to be the most active in the network. The sharing of centrality can also be explained by the fact that only some students kept in touch to share information relevant to their project. Student verbatims, summarized in Table 7, also reveal which students continue to support each other a year after completing the Starter programme.

Table 7. Verbatims illustrating the structural dimension

Verbatim 2019	Verbatim 2020
We're talking about messages every day, it's really every day (ID 72).	I'm in contact every two months with ID 72 and ID 45 (ID 28).
ID 41 and I are in the same laboratory, we talk all the time (ID 29).	I'm still in touch with some students from the starter programme like ID 41, ID 28, ID 29, ID 72, once a week (ID 45).
It was very easy to talk because you knew they were right there working (ID 145).	There are five of us still in contact, we chat every two weeks (ID 72).
It's more in the interactions, I interacted with everybody, that's why it's difficult to say one person in particular, it's really that small group (ID 145).	I'm still in contact with students from the programme, but it's informal, just catching up (ID 1).

Cognitive dimension

In 2019, Starter students are familiar with each other's projects and form a support group with shared values. One year on from the programme, the group effect is fading and has been reduced to just a few students. The verbatims summarised in table 8 show that students who help each other still do so in 2020 because they have common problems. They share common issues, even though they have different profiles and projects. ID 45 is an engineering master's student developing an object for wine bottles, ID 72 is a business and public administration bachelor's student developing digital marketing applications, and ID 101 is a law master's student developing a certification platform (Table 4).

Table 8. Verbatims illustrating the cognitive dimension

Verbatim 2019	Verbatim 2020
At each class we re-pitch, ask each other questions, they know the project very well, they know each other's values because we work a lot on values, and that makes for constructive opinions (ID 72).	ID 45 and I have had similar problems, the same organizational issues, and so because we're going through the same things, we look for information from those going through the same things as us. (ID 72).
It also brought me something fantastic in entrepreneurship, which is that ultimately we are good as a group, initially I didn't like working with people, but actually Starter is such a great group of people with good intentions, and who share your passion, it's crazy to be 20 and be an entrepreneur when no-one shares your passion, and in that respect Starter is really fantastic (ID 7).	There is a group of us where we share our tough times and useful information (ID 101). We can talk about our experiences (ID 45).

Relational dimension

The relational dynamic between the student entrepreneurs has become diluted over time. At the end of the programme in 2019, they perceived the support given by other students in the cohort as more useful in terms of developing their project than a year after their participation in the programme in 2020. The average perceived usefulness of the aid provided falls from 4.9 in 2019 to 3.2 in 2020. Furthermore, this perception is not the same for all students. The difference in perception between usefulness received and usefulness provided by one student varies greatly from student to student, ranging from 49 and 4 in 2019 to 23 and 0 in 2020. However, the sum of these differences decrease from one year to the next, from 296 in 2019 to 161 in 2020 (Appendix 4). This means that, over time, students who are still helping each other attach the same importance to the usefulness received as the usefulness provided. The few students who declared that they were still helping each other in 2020 (ID 29, 41, 45 and ID 125) shared their expertise and advice and even became each other's clients (Table 9).

Table 9. Verbatims illustrating the relational dimension

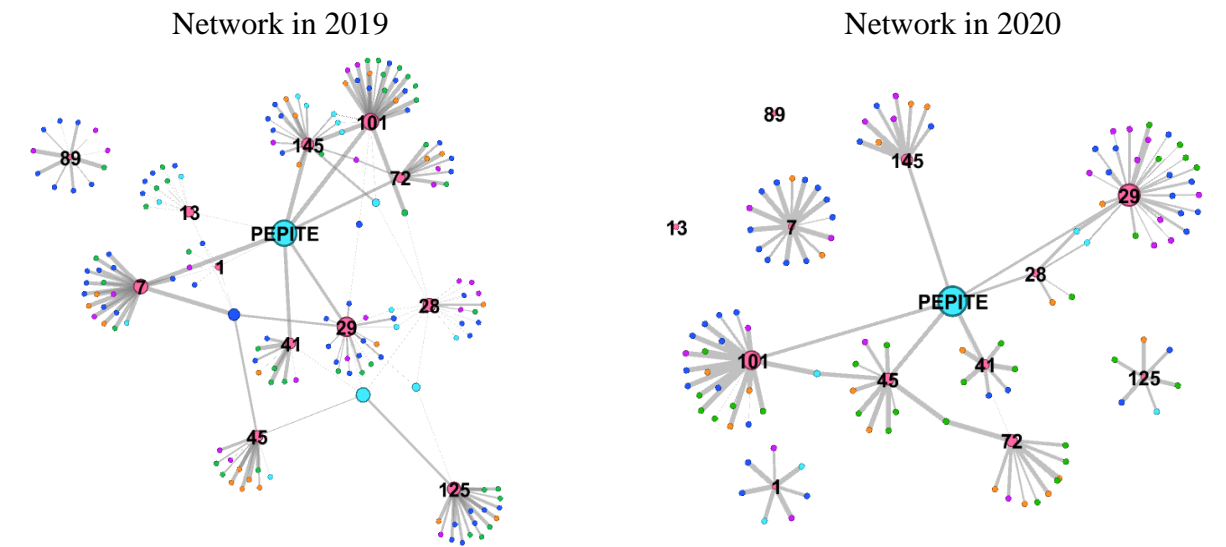
Verbatim 2019	Verbatim 2020
<p>We work quite a lot between student entrepreneurs, for example ID 72 understands accounting and so we do a lot of workshops together. ID 28 did a workshop on graphics. When I need a prototype and small parts, I go to see ID 41 (ID 29).</p> <p>The strong links we created were in the Starter programme, we all feel close to one another and it's really great. We help each other out any way we can, we give each other tips, any time someone has useful information, it's shared (ID 41).</p>	<p>ID 41 and I talk a great deal to get feedback, opinions, good advice. He tests things out and then later we can test them too (ID 29).</p> <p>I was in touch again with three students from the programme and we helped each other out. For example, I bought ID 29's product, helped ID 45 with administrative procedures (ID 125).</p>

It therefore appears that the support structure played its role in creating links between student entrepreneurs and providing mutual support at the end of the programme, but that this role was narrowed to a smaller number of heterogeneous students as time went by.

Development of social capital with other actors in the SESE

We produced a graphic representation of the network developed by student entrepreneurs with other actors in the SESE (not including the links developed with the cohort of students from the Starter programme) (Figure 2).

Figure 2. Professional network extended to other actors in the SESE



Legend

Nodes

Pink node: Student entrepreneur

Dark blue node: Expert/entrepreneur (Coaches, mentors, jurists, accountants and other experts)

Dark green node: Commercial partner (Clients, suppliers, other experimental partners)

Purple node: University (Lecturers, non-entrepreneur students)

Orange node: Personal network (Family, friends, former colleagues)

Light green node: Entrepreneurship support (PEPITE centre, funding bodies, coworking spaces, fab-lab, incubators and other actors providing start-up entrepreneurship assistance)

A node corresponds to a type of actor or organisation. The number of nodes corresponds to the IDs of the student entrepreneurs (ID). The size of the nodes represents the centrality of the actors within the network as measured by betweenness centrality.

Links: The thickness of the links corresponds to their perceived usefulness to the student entrepreneur's entrepreneurial project, on a scale of 1 to 7.

Note: The networks are not oriented.

Structural dimension

In 2019 as in 2020, the network is sparse with few links between actors. The 2019 network is made up of 169 actors with 186 links between them and is reduced in 2020 to 125 actors with 123 links. While the number of actors fell from one year to the next, their links decreased even

more, illustrating a less dynamic exchange between students and SESE actors over time. This can also be seen with density. The two networks have a low density, 0.013 in 2019 versus 0.016 in 2020, suggesting a certain fragility in the structure of the SESE, particularly in terms of the relationships maintained between students and the sub-ecosystem's other actors. Indeed, two entrepreneurs (ID 89, ID 13) no longer used these links in 2020, and three others (ID 125, ID 7, ID 1) were developing their networks individually in 2020, compared to just one in 2019 (ID 89) (Figure 2). The three students developing their network independently (ID 125, ID 7, ID 1) moved to another city between 2019 and 2020, which partly explains the fact that they no longer seem to be mobilising the SESE players in Strasbourg (Table 10).

Table 10. Verbatims illustrating the structural dimension

Verbatim 2019	Verbatim 2020
When I have a question about a particular subject or area of expertise, I can reach out to people from the ecosystem: the city, region or public investment bank (ID 145).	I've completely changed circles, even geographically, I no longer have any contact with the people from Strasbourg, at the time it was mainly the people from PEPITE (ID 1).
Of the contributors to the Starter programme, it's mainly the accountant who helped me a lot, I'm in touch with him around once a month (ID 7).	I don't really have any more contacts at PEPITE, also because I'm not in Strasbourg anymore (ID 7). I've moved to another town (ID 125). I'm in contact weekly with the PEPITE ecosystem (ID 101).

Only 43% of the actors in the 2020 network were the same as in 2019 (Table 11), which shows that students created interactions with new actors. From one year to the next, the members of the network therefore changed, particularly the entrepreneurship support structures, with only two structures remaining unchanged between the two years. This shows the instability of the network over time, with the exception of personal networks: 67% of family members, friends and former colleagues who helped students in 2020 were the same as in 2019.

Table 11. Identical actors in 2019 and 2020

	Number of identical actors in 2019 and 2020	Proportion of total number of actors in the 2019 network
All actors	73	43% ²
Student entrepreneurs	12	100%
Experts/entrepreneurs	23	38% ³
Commercial partners	17	45%
University	5	23%
Personal network	14	67%
Entrepreneurial support structures	2	13%

Nonetheless, a form of stability can be seen at the level of intermediary actors. In both 2019 and 2020, the PEPITE centre was the most central actor, followed by two student entrepreneurs (ID 29, ID 101) (Figure 2 and Table 12). It is also important to emphasize the central role of one student entrepreneur (ID 29), both in the extended network in 2019 and 2020, and in student relations in 2020 (Table 6 and Figure 1). Over time, more students took on a central role: three in 2019 (ID 29, ID 101, ID 7) and four in 2020 (ID 29, ID 101, ID72, ID145) (Table 12 and Figure 2), across all profiles and projects (Table 4).

Table 12. Top five actors for the metric of betweenness centrality within the extensive network

2019		2020	
Type of actor	Betweenness centrality	Type of actor	Betweenness centrality
PEPITE	0.407794	PEPITE	0.402461
Student entrepreneur (ID 29)	0.279603	Student entrepreneur (ID 29)	0.272161
Student entrepreneur (ID 101)	0.227808	Student entrepreneur (ID 101)	0.214835
Student entrepreneur (ID 7)	0.189087	Student entrepreneur (ID 72)	0.105691
Entrepreneurial support structure	0.184438	Student entrepreneur (ID 145)	0.101495

Cognitive dimension

While the structure of the network appeared to be undermined, from a cognitive perspective its composition remained relatively similar, with slightly more teachers, students, friends and family, and slightly fewer other support structures in 2020. In both 2019 and 2020,

² $(73/169)*100=43\%$

³ $(23/60)*100=38\%$

experts/entrepreneurs and business partners were the main actors in the student network, an indication that students were developing business relationships (Table 13).

Table 13. Network composition

Type of actors	2019		2020	
	Number of actors	Proportion of total network actors (169)	Number of actors	Proportion of total network actors (125)
Student entrepreneurs	12	7% ⁴	12	10% ⁵
Experts/entrepreneurs	60	36%	40	32%
Commercial partners	38	22%	28	22%
University	22	13%	20	16%
Personal network	21	12%	18	14%
Entrepreneurial support structures	16	10%	7	6%

In 2019, students were relying on their family and friends and seeking to establish business relationships through the Starter programme (Table 14). One year after the programme, students who had stayed in Strasbourg seemed to be both actively attached to the PEPITE centre and looking for new networks to access other resources. Students who had moved were forging links with the SESE in their new city (Table 14).

Table 14. Verbatims illustrating the cognitive dimension

Verbatim 2019	Verbatim 2020
I reach out to old friends who share information about my business in their networks and social circles (ID 145).	I share information with the current group. I would also like to be able to join another network to be pulled upwards, where I'm the one asking for advice (ID 28).
There is someone I met who would make for a very interesting future collaborator. It's another entrepreneur incubated at the same incubator as me. We met on the Generation Start-up forum organised by the PEPITE (ID 72).	I'm in contact with the ecosystem in my new region, the Parisian start-up ecosystem, my project is being incubated at my school's incubator (ID 1).

Relational dimension

The relational dimension seems to have strengthened. The student entrepreneurs maintained relationships which brought them increasingly useful assistance to develop their project from one year to the next (3.8 in 2019 and 5.1 in 2020), regardless of the type of actor concerned,

⁴ $12/169*100=7\%$

⁵ $12/125*100=10\%$

except for friends and family members, who were perceived to offer the most useful and most stable help from one year to the next (5.6 in 2019 and 2020) (Table 15).

Table 15. Perceived usefulness of the help provided by network actors

	2019	2020
Average perceived usefulness	3.8	5.1
Entrepreneurs/experts	3.7	5.2
Commercial partners	4.3	4.9
University	3	4.7
Personal network	5.6	5.6
Entrepreneurial support structures	2.9	4.7

There seems to be a real distinction between students who remained active in the SESE, and those who developed their network independently. Students who remained active in the SESE seem to have participated in its dynamics by sharing their experience, information and knowledge with other actors and with the new cohorts of student entrepreneurs from the Starter programme (Table 16). This illustrates their new role as intermediaries within the SESE.

Table 16. Verbatims illustrating the relational dimension

Verbatim 2019	Verbatim 2020
The last people who helped me were from a Mastermind I joined which helps people achieve financial independence through entrepreneurship and real estate investment (ID 7).	I follow the current and former student entrepreneurs. We have a group with the current student entrepreneurs and all the PEPITE staff. I share useful information with them, help them find interns in web development. We keep in touch, we share useful tips, we help each other out, it's fab. (ID 101)
The PEPITE is really on hand to give us advice, share their experience, and then of course we can benefit from their whole network. It's about all the pitches and all the events I take part in thanks to the PEPITE (ID 101).	Now it's the class that came after us who's asking me for information and feedback, which is to be expected. I share things with them. (ID 29)

Student entrepreneurs therefore seem to have tended towards the development of their own network with new actors who do not necessarily have common links with other students in the cohort. Over time, they appear to have developed fewer relationships but which offer them help perceived as more useful than one year earlier in terms of developing their entrepreneurial project. However, it also seems that some students have become increasingly central actors within the SESE over time. Their role seems to have evolved from that of student learner to that of entrepreneur participating in the dynamics of the sub-ecosystem.

Discussion and conclusion

For the purpose of this research, we studied how student entrepreneurs construct their social capital within the SESE. It was conducted at two levels: relations between students from the Starter programme at the PEPITE ETENA in Strasbourg and relations with other actors from the SESE. The study produced three key findings on the evolution of the social capital of student entrepreneurs. First, while these relationships were very strong during and at the end of the programme, they tended to weaken over time, except for some students who continued to help each other a year after the end of the programme despite the heterogeneity of their profiles and projects. Second, our results show that the relational dynamics with other actors from the SESE became less dense with a tendency to dissipate. However, although the students established fewer relationships, those they did form provided support deemed more useful for the development of their entrepreneurial projects. Lastly, a distinction emerged over time between students who developed their professional network in relation to their entrepreneurial project independently and those who remained active within the sub-ecosystem. The role of the latter evolved, shifting from the status of student learner to that of entrepreneur with a role of intermediation in the SESE.

Theoretical implications

This research makes three primary theoretical contributions. First, it provides a more nuanced understanding of the construction and evolution of student entrepreneurs' social capital over time. The literature in the field of entrepreneurship highlights the centrality of social capital, with some authors advocating a dynamic reading (Nahapiet and Ghoshal, 1998). Previous studies have shown that entrepreneurs' networks evolve as their projects progress (Larson and Starr, 1993). However, the literature on student entrepreneurship has predominantly focused on human capital, often overlooking the dynamics underpinning social capital. This research aligns with a growing body of work that shifts the perspective from

viewing student entrepreneurs as isolated actors to seeing them as embedded within their university entrepreneurial ecosystem (Morris, Shirokova, and Tsukanova 2017; Passavanti et al. 2023; Wright, Siegel, and Mustar 2017). One key challenge lies in understanding how student entrepreneurs professionalize their networks (Loi and Fayolle 2022; Brunner, 2021). While much of their early networking relies on pre-established links such as family, friends, and academic contacts (Clarysse, Mustar, and Dedeyne 2022; Kaandorp, Van Burg, and Karlsson 2020; Longva 2021), our findings indicate that these relationships evolve significantly over time. By focusing exclusively on professional links, this study reveals that student entrepreneurs gradually build connections with new actors. This process marks a critical shift toward the professionalization of their networks, enabling them to access knowledge, new resources, and legitimacy.

Our results also underscore the fragility of inter-student networks, which play a crucial role in the early stages of entrepreneurial projects but tend to erode as time passes. This observation contrasts with findings on other types of entrepreneurs, where networks often strengthen over time (Bøllingtoft 2012; Stephens and Miller 2022). This erosion may partly reflect the temporary nature of structured programmes and the absence of sustained activities to maintain these networks. Nevertheless, it also points to a transition toward more targeted and strategic professional relationships, illustrating the dynamic nature of network construction.

While the literature has long emphasized the importance of personal and academic networks (Clarysse, Mustar, and Dedeyne 2022; Kaandorp, Van Burg, and Karlsson 2020; Longva 2021), our study adds new insights by highlighting the dual process of network diversification and refinement over time. Specifically, we demonstrate how student entrepreneurs engage with new actors from one year to the next, thereby enriching their professional networks while navigating challenges related to the sustainability of earlier links. This transition aligns with the theoretical framework of dynamic social capital (Hite and Hesterly, 2001; Larson and Starr, 1993), further

illustrating how networks evolve in response to the context and the stage of the entrepreneurial project. By capturing these dynamics, our work bridges a gap in the literature attention (Lockett et al. 2017; Rasmussen, Mosey, and Wright 2015), shedding light on the ways student entrepreneurs develop and professionalize their networks within university ecosystems. This perspective not only advances our understanding of social capital dynamics but also underscores the importance of acceleration programmes in supporting the sustainability of entrepreneurial networks.

Our second contribution extends previous studies that have proposed adapting the notion of social capital to the field of entrepreneurial ecosystems (Theodoraki, Messeghem, and Rice 2018). The literature on EEs has emphasised the value of using social network analysis (Fernandes and Ferreira, 2022), but the measures used must be adapted to this particular context. Work by Ancona et al. (2023) paved the way for this by focusing on the network of start-ups in an ecosystem. This stream of research has developed to better account for the interactions between actors. It draws on network theory (Prokop and Thompson 2023; Theodoraki, Messeghem, and Rice 2018) to analyse their social networks. Ancona et al. (2023) propose a combination of the theory of complexity and a social network analysis to measure the structural characteristics of an EE. Although this is an interesting approach with which to understand the interactions between actors from a meso perspective, it overlooks the dynamic and evolution of the network's architecture from a micro perspective. We pursue this work of adaptation by combining a structural reading of social capital with discourse analysis and by using new measures of social capital such as link usefulness. We contribute to a more objective measure of social capital based on metrics determined by social network analysis. The chosen metrics can be used to show how the structural, cognitive and relational dimensions introduced by Nahapiet and Ghoshal (1998) evolve over time in the context of an EE. We move beyond the approaches centred on the nature of links (Granovetter, 1973) by focusing on their

usefulness (François, Lafaye, and Belarouci 2021; Pluchart 2014). Our results show that while students establish fewer relationships, these provide support deemed more useful for the development of their entrepreneurial projects. By combining the metrics determined by network analysis with discourse analysis, we can delve deeper and illustrate the logic underpinning the construction of social capital.

The third contribution relates to intermediation in the context of the SESE (Hayter, 2016). The literature is developing in this area (Prokop, 2021) even though it remains largely centred on the transfer of knowledge (Hayter, 2016) or financing (van Rijnsoever, 2022). Intermediation can be provided by ESOs like incubators or accelerators. It facilitates access to key resources in student entrepreneurship (Clarysse, Mustar, and Dedeyne 2022; Passavanti et al. 2023; Schimperna, Nappo, and Marsigalia 2022). Our results show that while traditional actors play this intermediation role, some students also manage to take it on, thereby facilitating access to crucial resources for the continuation of their projects. This form of intermediation is to be seen in light of the literature that has focused on the dynamics of networks developed within ESOs (Bøllingtoft, 2012). However, the literature on ESOs has paid little attention to the role of intermediation played by the entrepreneurs receiving support (Bergman and McMullen, 2022). Indeed, in a recent systematic review of the literature on ESOs by Bergman and McMullen (2022), this issue goes unaddressed. Our work opens up an interesting new avenue in this field by showing that this role can be taken on by different stakeholders, in particular by the entrepreneurs themselves.

Managerial implications

This research also makes several managerial contributions. First of all, by providing a better understanding and representation of the trajectory of SESEs, it can help support structures better stimulate the relational dynamics between students and with other actors in that sub-

ecosystem. Our results show that relationships can be eroded as time goes by. Yet those responsible for providing support are not necessarily aware of this. Representing the trajectory of an entrepreneurial sub-ecosystem from a reticular point of view is one way to warn them of this and enable them to take steps to strengthen relational dynamics. Second, by encouraging a focus on the level of the sub-ecosystem, this research may encourage those in charge of structures like the PEPITE centre to develop an ecosystem way of thinking, by developing a representation of their sub-ecosystem in terms of resources, interactions and governance (Cao and Shi, 2021). Through their actions, they can help establish the right conditions for student entrepreneurs to develop their social capital and move forward on their entrepreneurial projects. Finally, the reading we propose and the metrics used can also be seen as a support tool as part of a reflexive approach. Mapping professional networks can serve to raise awareness among student entrepreneurs of the construction of their social capital and pave the way for improved interactions with other actors in their sub-ecosystem, thus supporting the development of their social skills (Lans, Blok, and Gulikers, 2015). Lastly, highlighting the intermediation role played by certain students can help ESOs better valorise these entrepreneurs, who bring real value added in the development of their peers' social capital.

Limits and perspectives

This research has certain limitations that merit discussion and point to new research avenues. The first is its focus on the representations of two actors: student entrepreneurs and support structures. The richness and diversity of the data collected nonetheless compensate for this limitation. The study's aim was to understand how student entrepreneurs develop their social capital. A possible extension of this would be to study the dynamics of professional relationships between all actors in the SESE. The metrics we used could very well be adapted to this research question, making it possible to better understand this sub-ecosystem which, in our work, was not the object being studied but rather the context. Yet the emerging literature

on sub-ecosystems has tended to pay little attention to the interactions between actors, and in particular those developed by entrepreneurs (Regele and Neck 2012; Harrington 2017; Messeghem and Cloutier 2023; Theodoraki and Messeghem 2017). It is therefore important to better understand the micro-foundations of entrepreneurial sub-ecosystems from a reticular perspective. While the sample size did not allow us to identify differences based on gender or diploma type, it would also be interesting to extend the study so as to evaluate the role played by these characteristics. This would help understand whether some of them can be linked to the intermediation role taken on by some students within the sub-ecosystem.

The second limitation relates to the fact that the study concentrated on a specific geographic zone; there may be significant differences between countries, between towns in a region or even between the universities in a single city (Guerrero and Marozau 2023; Prokop and Thompson 2023). However, Strasbourg provides a university context that is conducive to student entrepreneurship and has already been the subject of other studies (Matt and Schaeffer, 2018). Extending this research to other zones would be a way to generate comparisons. While the entrepreneurial education sub-ecosystem can be seen as a generic sub-ecosystem with shared characteristics (Guerrero, Urbano, and Gajón 2020), it may be interesting to highlight the idiosyncratic nature of each sub-ecosystem in an effort to understand the factors that can influence relational dynamics.

The final limitation to be pointed out is linked to the temporality of this study. While the static-comparative approach may limit a full understanding of relational dynamics, the reliance on verbatims and the comparison of two periods provides valuable insights into their evolution. It gives us a quasi-longitudinal appreciation of the relational dynamics at work in the SESE, it would have been interesting to study these dynamics over a longer period. The difficulty lies in the duration of the support programmes and the size of the cohorts. Furthermore, student entrepreneurs are often mobile, which makes it challenging to monitor

them over longer timeframes. The shift from the micro to the meso level could be one way to overcome this limitation, taking inspiration from studies like Prokop and Thompson (2023). It could also be worthwhile to take into account the homophily, or openness, of SESEs.

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ORCID

Pauline Brunner <http://orcid.org/0000-0001-6885-5636>

Karim Messeghem <http://orcid.org/0000-0002-7540-9914>

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Appendix 1. Interview guide

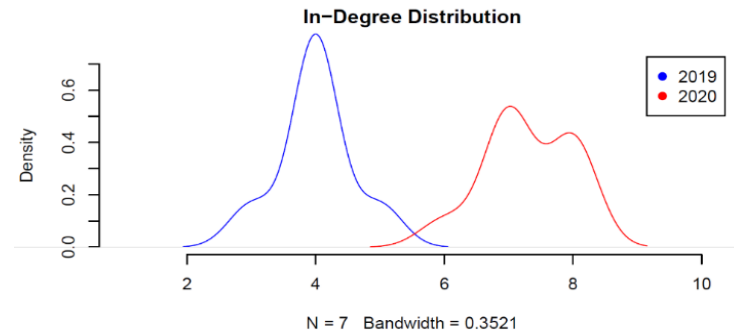
Topics	Question(s)	Objectives
1. Respondent introduction	Can you introduce yourself? (Surname, first name, education, previous professional and/or entrepreneurial experience) Can you present your entrepreneurial project to me and tell me how it came about?	Identify the respondent's profile and their project's characteristics
2. Actors present in the professional network	With whom are you in contact for the development of your project?	Identify the actors present in the respondent's professional network in relation to the entrepreneurial project.
3. Contributions made by link/actor	What does this contact contribute to your project?	Identify the help provided by actors of the network <i>This question was asked for each actor cited by the respondent.</i>
4. Networking actors	How did you get to know him/her? Who put you in contact?	Identify networking actors. <i>This question was asked for each actor cited by the respondent.</i>
5. Perceived usefulness of link/help	On a scale of 1 to 7, how useful is this contact for the development of your entrepreneurial project, where 1 is the least useful and 7 the most?	Measure the help given to the entrepreneurial project by network members on a scale of 1 to 7. <i>This question was asked for each actor cited by the respondent.</i>
6. Openness and verification of network actors	Are there other actors who help you with the development of your project that we haven't yet spoken about?	We questioned the respondent in order to collect comprehensive information about all actors in their professional network in relation to their entrepreneurial project. At the end of the interview, we went over the full list of actors cited with the help of notes taken during the interview.

Topic 1 in the interview guide produced in 2019 was replaced by two other topics in 2020.

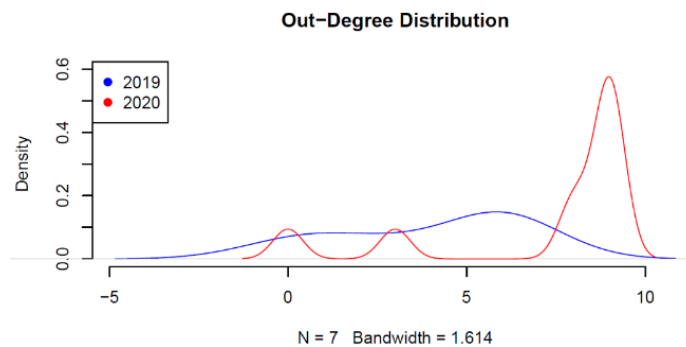
Topics	Question(s)	Objectives
Project progress	Can you explain your entrepreneurial project to me and how it has changed over the course of this year?	Identify changes in the entrepreneurial project during the year.
Social network updates	Are the members of your network from last year the same today? Are the contributions to your project the same? Is the usefulness of the help provided to your project the same?	Identify changes in the respondent's social network. <i>Using the previous grid to analyse sociometric data, each network member was checked and updated together with the respondent.</i>
Topics 2 to 6 are the same as in the initial interview guide	The questions linked to topics 2 to 6 are the same as in the initial interview guide	Identify the new actors present in the respondent's professional network who were not present one year previously.

2. Kolmogorov-Smirnov test on the relational dynamics between student entrepreneurs

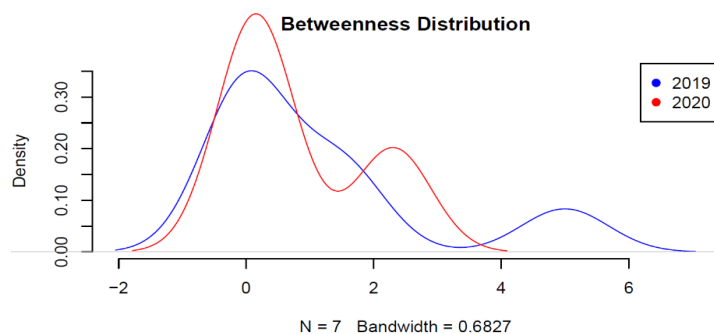
Since the networks representing the relational dynamics between student entrepreneurs are oriented networks, three tests were conducted: distribution of In-Degree, distribution of Out-degree and distribution of Betweenness.



Between 2019 and 2020, the distribution of In-Degree is significantly different because $D = 1$, $p - value = 5.142e - 05 \leq 0.05$



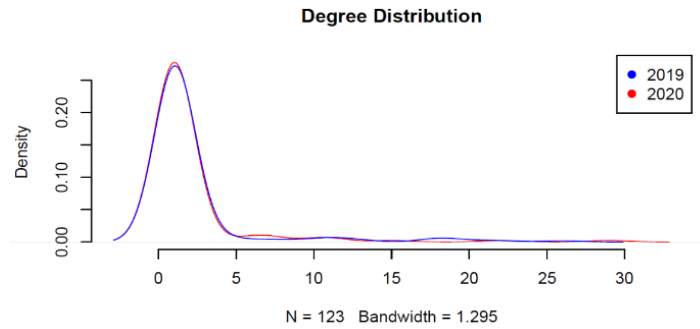
Between 2019 and 2020, the distribution of Out-Degree is significantly different because $D = 0.8$, $p - value = 0.002725 \leq 0.05$



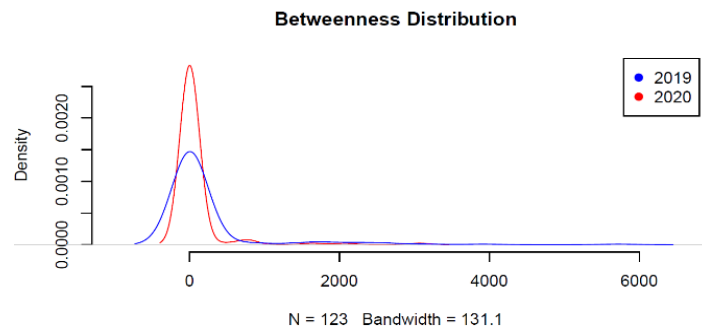
Between 2019 and 2020, the distribution of the betweenness distribution is not significantly different because, $D = 0.37143$, $p - value = 0.4105 \geq 0.05$

Appendix 3. Kolmogorov-Smirnov test on the relational dynamics with other actors in the SESE

Since the networks representing the relational dynamics with the extended network of the SESE are not oriented, two tests were conducted: distribution of Degree and distribution of Betweenness.



Between 2019 and 2020, the distribution of the betweenness distribution is not significantly different because, $D = 0.30252$, $p - value = 0.2935 \geq 0.05$



Between 2019 and 2020, the distribution of the betweenness distribution is not significantly different because, $D = 0.072545$, $p - value = 0.8479 \geq 0.0$

Appendix 4. Link usefulness matrix in 2019 and 2020

Link usefulness matrix in 2019

Student entrepreneur	1	7	13	28	29	41	45	72	89	101	125	145	sum
1	0	1											1
7	7	0	7	7	7	7	7	7	7	7	7	7	77
13	1	1	0	1	1	1	1	1	1	1	1	1	11
28	5	5	5	0	7	5	5	5	5	5	5	5	57
29			5	7	0	5		5	5				27
41	5	5	5	5	5	0	5	5	5	5	5	5	55
45	4	4	4	4	4	4	0	4	4	4	4	4	44
72	7	7	7	7	7	7	7	0	7	7	7	7	77
89									0				0
101	5	5	5	5	5	5	5	5	5	0	5	5	55
125	4	4	4	4	4	5	4	4	4	4	0	4	45
145	6	6	6	6	6	6	6	6	6	6	6	0	66
sum	44	38	48	46	46	45	40	42	49	39	40	38	515
Difference in perception between usefulness received and usefulness provided by student	-43	39	-37	11	-19	10	4	35	-49	16	5	28	296

Link usefulness matrix in 2020

Student entrepreneur	1	7	13	28	29	41	45	72	89	101	125	145	sum
1	0	1		1	1	1	1	1		1	1	1	9
7		0											0
13			0										0
28	1	1		0	7	1	1	1		1	1	1	15
29	1	1		7	0	1	1	1		1	1	1	15
41	5	5		5	5	0	5	5		5	5	5	45
45	1	1		4	4	4	0	4		1	4	1	24
72	3	3		5	5	5	3	0		3	3	3	33
89									0				0
101	5	5		5	5	5	5	5		0		5	40
125				4	4		4				0		12
145	5	5		5	5	5	5			5	5	0	40
sum	21	22	0	36	36	22	25	17	0	17	20	17	233
Difference in perception between usefulness received and usefulness provided by student	-12	-22	0	-21	-21	23	-1	7	0	23	-8	23	161