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Cooperative Learning Reduces the Gender Gap in Perceived Social Competences. A Large-Scale Nationwide Longitudinal Experiment

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Abstract

Considering the evolving and unpredictable job market, adaptability is an important skill for young adults. Such adaptability implies that schools need to teach key social competences, like communication, collaboration or problem solving. In this area, a gender gap has consistently been found, showing that boys display social competences less than girls. A large-scale nationwide multi-lab longitudinal experiment—the ProFAN project—was conducted in France among more than 10,000 vocational high-school students. Its primary goal was to develop and test an intervention promoting a range of psychological and psycho-social variables in vocational high schools, including social competences. This two-year long, three-wave field experiment compared the effects of a cooperative learning method—the Jigsaw classroom, that entails positive goal and resource *interdependence*—to two other control conditions: one that involves cooperation with resource *independence*, and the other that remains business-as-usual. The present article focuses on the differential development of perceived social competences of adolescent boys and girls over time, comparing the three pedagogical methods. Results of longitudinal multilevel modelling replicate the gender gap in perceived social competences and show that this gap widens with time. However, and most importantly, the analyses revealed that such widening of the gender gap was greater in the two control conditions than in the Jigsaw condition, in which the evolution of boys' and girls' perceptions of social competences remained similar over time. Contributions to the understanding of the development and teaching of social competences in education settings are discussed.

Keywords: cooperative learning, Jigsaw classroom, positive interdependence, gender, social competences

Educational Impact and Implications Statement

Social competences, like communication and collaboration, are key to adapt in today's ever-changing job market, and boys are usually found to be less skilled with social competences than girls. In a nationwide longitudinal intervention, we explored how schools can promote essential social competences in a way that compensates this gap. In our study involving over 10,000 vocational high school students, we found that boys lag behind girls in reporting and valuing social competences and that this gap widens over time. However, implementing a Jigsaw classroom—a cooperative learning method with positive goal and resource interdependence—was effective in refraining this gap from increasing. These findings emphasize that the Jigsaw classroom allows all students to practice social competences and reduces the gender gap in social competences.

Cooperative Learning Reduces the Gender Gap in Perceived Social Competences. A Large-Scale Nationwide Longitudinal Experiment

"We are at the beginning of a revolution that is fundamentally changing the way we live, work, and relate to one another" (Schwab, 2017, p. 1). This statement made by Klaus Schwab in the first lines of his book *The Fourth Industrial Revolution* provides a picture of the future of the job market as evolving, changing sometimes unpredictably, with new sectors emerging and others fading out. As a consequence, the ability to adapt has become an essential competence for a professional career, which should be fostered in educational systems (Griffin & Hesketh, 2003). The capacity to adapt depends on a large set of so-called soft skills, which encompass personal qualities, interpersonal skills, and other forms of knowledge about social interaction (Schulz, 2008). Soft skills are distinguished from hard skills, usually defined as cognitive abilities and specific technical competences needed for academic or professional success (Heckman & Kautz, 2012). For a long time, hard skills were considered to be the most important predictor of professional success (Kyllonen, 2013), but soft skills have since also proven to be an important component of long term professional and personal success (Cimatti, 2016; Heckman & Kautz, 2012; Ibrahim et al., 2017).

It is likely that future jobs will have new requirements, not only in terms of specific professional abilities and knowledge—hard skills—but also in terms of adaptability through soft skills (Cobo, 2013; Lippman et al., 2015; Snape, 2017). Young adults concerned by the transition to the job market will particularly need a specific type of soft skills: social competences. These competences were traditionally defined as effectiveness in managing social interactions (Rose-Krasnor, 1997), leading to the creation and maintenance of interpersonal relationships (Sarason et al., 1985). More recently, the definition of social competences has broadened to include concepts as diverse as the ability to collaborate, the ability to take initiatives or to solve problems collectively, but also communication and

creativity (Gaussel, 2018). It may soon fall on educational institutions to train new generations to develop these social competences that are essential for adaptation in the new professional landscape (Lippman et al., 2015; Snape, 2017).

The present research investigates the role of repeated interdependent collaborations at school in the evolution of students' perceptions of their social competences. In particular, we will address the potential of a specific cooperative learning method, the Jigsaw classroom, that involves both goal interdependence (i.e., all group members pursue the same goal) and resource interdependence (i.e., each group member possesses a unique portion of the learning materials, Aronson et al., 1978; Roseth et al., 2019). This study specifically aims to investigate the usefulness of the Jigsaw classroom in closing the well-documented gender gap, whereby girls report higher levels of social competences than boys (e.g., Ford, 1982; Tan et al., 2018). The study is part of a large-scale nationwide longitudinal experiment conducted in collaboration with the French Ministry of National Education. The participants are vocational high-school students, a highly relevant population for this research question: These students are likely to face considerable changes in their professions in the near future that will require them to adapt to unpredictable professional contexts (Frey & Osborne, 2017; Mouzakitis, 2010).

Social Competences as Adaptive Soft Skills

Social competences are specific soft skills that can be viewed as an individual's repertoire of socially suitable responses and behaviours such as sharing, helping, cooperating, initiating interpersonal relationships, interacting with others, or dealing with conflicts (Smart & Sanson, 2003). In children, social competences can strongly determine how they behave and learn at school (McClelland & Morrison, 2003; Montroy et al., 2014; Wentzel, 1991). Later, during the adolescence-adulthood transition, they are associated with general well-being and successful career development (Murakami et al., 2009; Pinto et al., 2012; Smart &

Sanson, 2003).

Having high levels of social competences also leads people to increased perceived self-efficacy – one's positive beliefs in their own abilities in a particular situation (Salavera et al., 2017). Perceived self-efficacy in turn predicts the activities people choose to be involved in, but also their commitment, persistence, efforts invested, and consequently the probability of success and good performance in these activities (Bandura, 1977). These competences also yield a generalized positive impact on educational level, professional success, and general well-being (e.g., Anderson-Butcher et al., 2008; DiPrete & Jennings, 2012; Durlak et al., 2011; Wentzel, 1991). Furthermore, social competences do not only benefit the individuals who possess them, but also the groups they are associated with by improving the members' and the group's achievement and productivity, as well as the quality of the relationships within the group (Johnson & Johnson, 2005).

Gender and Social Competences

Although the importance of social competences is rather consensual in the scientific community, gender differences in these competences have been a source of debate for several years (Rose-Krasnor, 1997). Even if some studies show similar social competences for men and women (e.g., Salavera et al., 2017; Taylor & Hood, 2011), a majority of studies tend to conclude that significant gender differences exist with men often displaying lower social competences than women (Ford, 1982; Sarason et al., 1985; Smart & Sanson, 2003; Tan et al., 2018). Women are generally higher than men on some specific social competences like empathy (Adams, 1983; Ford, 1982; Smart & Sanson, 2003), or knowledge of socially desirable behaviours (Sarason et al., 1985). From childhood and throughout adolescence, girls are more likely than boys to show pro-social behaviours and social competences, whereas boys are more likely to act in an aggressive or disruptive way (Mayberry & Espelage, 2007; Smart & Sanson, 2003; Walker, 2005).

For adolescence, some authors have explained these differences by pointing to girls being more mature than boys: Measuring teenagers' social competences would reflect different developmental stages for girls and boys in terms of maturity (Ford, 1982; Sarason et al., 1985; Smart & Sanson, 2003). An alternative explanation is based on differential socialization for boys and girls. On the one hand, whether it is within the family, at school or in society in general, girls are asked to be cooperative and responsible more frequently than boys, which can foster the development of social competences. On the other hand, boys are more often encouraged than girls to be emotionally neutral, which does not foster the development of social competences (Smart & Sanson, 2003). In fact, family and the media, but also peers and schools are well-known for perpetuating gender differences among children and adolescents (Arnon et al., 2008; Leaper & Friedman, 2007; Wood & Eagly, 2002).

Moreover, so-called gender-specific academic cultures may favour these socialization differences, with girls having a more study-oriented culture than boys, leading to better achievement for girls (Sicard, Darnon, et al., 2021; Sicard, Martinot, et al., 2021; Van Houtte, 2004); indeed, appearing as "real men" (Huyge et al., 2015, p. 12) for boys may involve rejecting the academic culture as this culture is often viewed as feminine (Sicard, Darnon, et al., 2021). Similar findings have been obtained worldwide, with girls systematically reporting higher engagement in school and better academic performances than boys (Lam et al., 2012). Another interesting result reported by Van Houtte (2004), when comparing general vs. technical/vocational schools, is that 16-17-year-old boys in technical/vocational education tended to be reactant against a possible study-oriented culture when their academic achievement was low. Similarly, gender-specific academic culture impacting through socialization with peers can also explain this tendency: King (2016) showed that boys perceiving their peers as having negative attitudes toward learning had less motivation, more disaffection and lower achievement in school than girls. Overall, these findings could reflect a

social competences gender gap: Girls may be more socialized to adapt to the social requirements of school and professional environments and boys would be less trained to do so. In sum, some debate notwithstanding, the gender gap in social competences for teenagers and young adults seems robust.

Perceived Social Competences

In addition to observable competences, how people perceive their own social competences can influence the way they approach a task and thereby their performance (Bouffard et al., 2013). Classic research in social psychology has long shown the importance of perceived competence in predicting behaviour (Ajzen, 1985; Bandura, 1977; Deci & Ryan, 1985; Ryan & Deci, 2000). People hold many beliefs about their own abilities, the amount of effort they can provide, others' abilities, and luck (Skinner et al., 1990). These beliefs contribute to the perception people have of their own competence, which in turn determines their decision to take part in certain activities, their degree of involvement (Sneegas, 1986), and the outcome of these activities, such as school success or failure (Skinner et al., 1990). Thus, people tend to take part in activities for which they think they have suitable competences and will avoid activities in which they feel less competent.

Furthermore, competence has been described as a basic psychological need, and perceiving oneself as competent is crucial for optimal psychological functioning, as it is for motivation, growth, well-being and psychological health (Deci & Ryan, 1985; Ryan, 1982), as well as social relations (Butera & Darnon, 2017; Festinger, 1954). Low competence perceptions may reduce motivation and emotional regulation (Deci & Ryan, 1985; Ryan, 1982), increase negative emotions (anxiety, anger, boredom, lack of curiosity) and withdrawal behaviours (avoidance, ignorance, simulation, lack of involvement and persistence) that could lead to lower school performance (Miserandino, 1996).

Importantly, the gender differences reported above for observational measures of

social competences have also been found with self-reported measures of social competences, i.e., asking people how they perceive their own social competences: Boys showed greater self-reported impulsivity than girls, and girls perceived themselves as more helpful and empathic than boys (Torres et al., 2003). Thus, the general research question addressed with the current study is how to devise an intervention that would reduce the gender gap in perceived social competences.

In the present research, perceived social competences were measured by a self-report, but also by measuring the students' perception of the expected utility of these social competences. A longstanding research tradition in educational psychology has pointed out that students engage in school-related activities (study, participation, constructive relations, …) when they can see some value in these activities (Eccles et al., 1983; Eccles & Wigfield, 2020). This value comprises three varieties: Intrinsic value is related to the pleasure or interest attached to the activity, attainment value to personal importance given to the activity, and utility value to the ability of the activity to fulfil a goal, a requirement or a desired outcome (Eccles et al., 1983). Utility value, in particular, appears to be especially relevant for the present research. We have noted above that social competences may be useful to adapt to a changing environment, and indeed the definition of utility value is tied to people's strategic considerations: "We conceptualize utility value or usefulness in terms of how well a particular task fits into an individual's present or future plans" (Eccles & Wigfield, 2020, p. 5). In this respect, a complementary line of research has shown that interventions aimed at making students perceive the utility of a given academic activity have proven to be effective in promoting students' learning and achievement (Hulleman & Harackiewicz, 2021). In sum, in addition to using self-reported measures of perceived social competences, the present study also assesses to what extent students consider the traits they are reporting as having some utility value.

Cooperation, Interdependence, and the Jigsaw Classroom

How can the regular practice of cooperation in the classroom reduce the gender gap in perceived social competences? Cooperative learning techniques are well-known educational techniques. In addition to promoting better learning outcomes and achievement, better psychological health, and self-esteem, some of them also involve practicing a wide range of social competences and promotes interpersonal relationships through mutual help, communication, perspective-taking, information-sharing and trust (Butera & Buchs, 2019; Johnson & Johnson, 2005).

In cooperative learning, small work groups are set up so that students learn together in a way that facilitates the knowledge acquisition of the individual and the group (Johnson & Johnson, 2005; Roseth et al., 2008). A central feature of cooperative learning is positive interdependence (Johnson & Johnson, 2005, 2009, 2015). Positive goal interdependence occurs when the success of each member of a group depends on the actions of all the members of the group (Deutsch, 1949). Working together to attain a common goal favours positive interactions, such as trusting each other and sharing information, encouraging each other and accepting mutual influence (Johnson & Johnson, 1974), coordinating and communicating with their schoolmates (Johnson et al., 1993), and constructively managing any conflicts (Buchs, Butera, Mugny, et al., 2004; Butera et al., 2019; Lee & Roseth, 2022; Smith et al., 1981).

The positive impact of such promotive behaviours has been documented on a wide range of variables: it helps dealing with stress, improves psychological and physical health as well as self-esteem and self-worth, has positive effects on interpersonal relationships, enhances motivation, productivity, achievement and performance in some cases, and reduces absenteeism and competence threat (Buchs et al., 2010; Butera & Buchs, 2019; Johnson et al., 1989; Johnson & Johnson, 2005; Roseth et al., 2019). All these positive effects were found to

be higher with positive interdependence and cooperation than in competitive or individualistic contexts (Hattie, 2008; Johnson & Johnson, 2005). To sum up, cooperative learning and positive interdependence stimulate the acquisition of social competences.

However, to implement cooperative learning in educational contexts, simply presenting common learning goals to students may not be sufficient; indeed, each student must feel responsible for attaining their learning goal, as well as helping their groupmates attain the same goal (Johnson & Johnson, 2005). Thus, along with positive goal interdependence, positive resource interdependence may also be needed, by which each student has a part of the resources (say, a text) that needs to be combined with the resources other groupmates possess if the group is to succeed (Buchs, Butera, et al., 2004; Buchs et al., 2021; Johnson et al., 1989).

These principles lie at the heart of one of the many cooperative learning methods, namely the Jigsaw classroom (Aronson et al., 1978). This method consists of several steps. In a classroom, students are first divided into small Jigsaw groups (say, 3-5 students), and each student receives a part of the subject to be learned. After the students have read the material on their own, “expert groups” are formed, bringing together the students who read the same material. This step allows them to understand their part of the subject by asking questions and also by helping others understand (Roseth et al., 2019). Next, the students return to their Jigsaw groups and present their part. The idea is that in every Jigsaw group, all the students—like the pieces of a puzzle—are necessary because they have crucial information. At the end of the procedure, the students must answer a quiz about the topic so that the importance of circulating the information well in their groups is highlighted.

Over the years, the Jigsaw method has been shown to promote greater self-efficacy (Darnon et al., 2012; Nichols, 1996), greater competence perception (Buchs et al., 2016), more effective problem-solving skills (Kramarski & Mevarech, 2003), greater help given to

others (DeVries & Edwards, 1974), and more constructive verbal interactions (Gillies, 2003). Some criticism has recently emerged about the effectiveness of this method as far as performance and achievement are concerned (Roseth et al., 2019; Stanczak et al., 2022). However, for the present research, we were more interested in how this method fosters perceived social competences.

The ProFAN Experiment

The ProFAN Experiment is a large-scale nationwide multi-lab longitudinal experiment launched by the French Ministry of Education. It lasted four years and involved many key players in the French educational system such as school inspectors, head teachers, academic supervisors, researchers from seven laboratories in France and Switzerland, more than a thousand teachers, and about 10,000 students (see below). Its goal was to develop and test an intervention to promote a number of psychological and psycho-social variables in vocational high schools, including social competences. Indeed, students at these vocational high schools are training for future jobs, in a social environment that could be radically modified due to the digitalization of society and the likely disappearance of many of the jobs they are training for. Thus, these students particularly need to acquire, develop, and practice social competences to adapt to fast-changing job markets and work environments.

Our team devised a two-year, three-wave field experiment with two cohorts, in which we implemented cooperative learning with positive interdependence at the classroom level in 108 French vocational high schools. The present article reports the results of this experiment as far as perceived social competences are concerned.

Study Overview and Hypotheses

In the present study, we report the results from the ProFAN Experiment that investigate the effect of cooperative learning (here, the Jigsaw classroom) on the differential development of perceived social competences of boys and girls over time. The first two

hypotheses are based on the reviewed literature, and the third one is our focal hypothesis. Our first hypothesis, based on the aforementioned gender gap in social competences, was that adolescent girls would display better perceived social competences than adolescent boys. Moreover, as our sample consists of adolescents in the last two years of vocational high school, a gender-specific socialization effect as described by Van Houtte (2004) could be expected. Our second hypothesis was therefore that gender differences in perceived social competences would increase due to more time spent in these specific socialization contexts (i.e., school, peers, vocational path).

Our third experimental hypothesis tests the interaction effect of the pedagogical method with time and gender on perceived social competences. As no gender gap has been highlighted by the literature in the development of social competences when using cooperation with resource interdependence (Buchs, Butera, Mugny, et al., 2004; Buchs et al., 2016; Butera & Buchs, 2019; Johnson et al., 1989; Johnson & Johnson, 2009, 2009, 2015; Kramarski & Mevarech, 2003; Roseth et al., 2019; Smith et al., 1981), we expect that the gender gap development over time (showing a higher level of perceived social competences in adolescent girls compared to boys), is reduced in the Jigsaw classroom as compared with control conditions (detailed below).

Materials and Methods

Transparency and Openness

We report all data exclusions (if any), all manipulations, and all measures in the study, and we follow JARS (Appelbaum et al., 2018). Data were analyzed using Stata/SE 18.0 (StataCorp, 2023). This study's design, hypotheses and analyses were not pre-registered. The sample size was determined by the requirements of the overarching national project. Raw imputed data, the analysis code, log files of the analyses, and Supplemental Online Material (SOM) are available on the Open Science Framework (OSF) page of the project

https://osf.io/qarxk/?view_only=e772332576a5421cbf61b3092e567ac9

Participants

For this study, we used the sample included in the ProFAN longitudinal research program. This program was conducted from 2017 with randomly selected classes in chosen French high schools belonging to ten "Académies" (the educational administrative unit in France). The program was mandatory for students included in the selected classes, as it was part of their curriculum without adding any additional workload compared to non-selected classes. The main objective of the project was to test the impact of cooperative learning (Jigsaw classroom) on a wide range of variables (the full list is available from the authors upon request). The present sample consisted of 10,163 students (54.47% females[1], mean age 16.43 years) from two cohorts (starting in 2017 and 2018), who participated in the program for two years, the last two years of high school. The students came from 108 French vocational high schools and followed one of three possible vocational paths: sales, health services, or electricity. The 2017 wave contained 223 classes of students attending their penultimate year of high school and 228 classes of students attending their last year, whereas the 2018 wave had 221 classes in the penultimate year and 215 classes in the last year.

It is worth noting that no filters were applied as a function of teachers' compliance with the instructions. As this study was designed as a large-scale field experiment, we wanted to document the effects as they would appear if the intervention was implemented as a large-scale educational policy.

Procedure

The material of the ProFAN experiment was developed beforehand by our team of

[1] Gender was retrieved from the official records of schools and of the French Ministry of Education. The sample included 5,221 girls, 4,227 boys, and 715 missing values due to a change in encoding method in high schools, beyond the control of the ProFAN experiment. As gender was also asked to students at the first time point—but including even more (1,209) missing values—the official records' gender variable was completed with the self-report gender variable, resulting in a sample of 5,536 girls, 4,503 boys, and 124 remaining missing values.

researchers in collaboration with educational inspectors. The material was uploaded to an online platform specifically designed for ProFAN. This platform was crucial to the correct running of the study. In addition to providing the material, the platform also served to collect and centralize the data.

The experiment included four main components. First, it included an online questionnaire measuring a wide range of variables, including perceived social competences, repeated at three time points (see Figure 1): at baseline, at the end of the first year and at the end of the second year. Students answered these questionnaires on the ProFAN platform. They had 1-hour sessions in computer rooms during school time to complete each one of the three questionnaires. Second, students also had 1-hour sessions to complete some online activities in which they were asked to discuss and exchange with some other students (we mention these activities for the sake of full disclosure, but the results related to these activities will not be discussed in this article). Third, pedagogical material was created specifically for the experiment, and was used as pedagogical content in all conditions (see below) to ensure that only the method varied. The pedagogical sequences were built based of the subjects of the participants' regular curriculum. The subjects targeted in ProFAN were French, mathematics, and materials related to the vocational path of students, namely sales, health services, or electricity. These pedagogical sequences were used to implement the conditions (see below)—i.e., students were asked to work on and learn these pedagogical sequences in the manner corresponding to the condition they were in. During the ProFAN experiment, students went four times through three (subjects) pedagogical sequences (for a total of 12 sequences over two years). Fourth and finally, the ProFAN experiment included the report of students' grades in the three targeted school subjects (mentioned here for the sake of full disclosure but not reported in this article).

During the whole experiment, the roles of the school inspectors and of the teachers

were essential. School inspectors had to ensure the proper functioning of each stage of the experimentation. This included making sure that the online platform was working and reporting any technical issues, checking each class participation on the platform, and keeping an eye on the timeline by sending reminders if needed, helping the teachers during the implementation if needed, reporting any issue encountered during this process, and managing students' absences. As for teachers, they had to manage time for students to answer the questionnaires and perform the activities on the platform, support students during the whole process of the experiment, train the pedagogical sequences by applying the study protocol, create the students' groups by following the instructions given by the online platform, transcribe on the platform students' grades and any related observations, and communicate with the school inspectors about students' absences and/or potential issues.

As stated earlier, the ProFAN experiment was a two-year, three-wave program. At the very beginning, in each selected vocational high school, students across all conditions received the same general message: "You have been chosen to participate in a study on teaching and learning in vocational high schools". As can be seen in Figure 1, the timeline of the first year was as follows: baseline questionnaire at time 1, online activities at time 1, first pedagogical sequence, first grades and observations, pedagogical sequence for time 2, second grades and observations, questionnaires at time 2, and online activities at time 2. As also displayed by Figure 1, the timeline of the second year was as follows: third pedagogical sequence, third grades and observations, fourth pedagogical sequence, fourth grades and observations, questionnaires at time 3, and online activities at time 3. In the present study, we focus on the perceived social competences variables included in the questionnaires answered at the three time points by the students, as a function of the conditions.

Figure 1

Conditions

At the beginning of the longitudinal experiment, schools were assigned to three different conditions to work on the pedagogical sequences mentioned in the above section. Two control conditions: Condition 1 – Business-as-usual, and Condition 2 – Resource independence; and one experimental condition: Condition 3 – Jigsaw.

In Condition 1 – Business-as-usual (see Roseth et al., 2019 for a similar condition), students worked on the pedagogical sequences in a business-as-usual setting: Teachers were simply asked to teach the pedagogical sequences as they usually do.

In Condition 2 – Resource independence, students worked on the pedagogical sequences in a cooperative way (positive goal interdependence) but with resource independence (e.g., Buchs et al., 2004, 2021). This condition was introduced for two reasons: First, to assess the effect of cooperation with resource interdependence (Jigsaw) as compared to cooperation with resource independence, and second because teachers very often claim that they assign cooperative work in class although they very rarely use resource interdependence. This condition took place in 2 stages: First, small groups were formed by the teachers guided by the online platform. Second, as each student had access to the whole pedagogical sequence at hand, a collective assignment was directly carried out on the content of the sequence, without any instruction on how students had to organise the work and the assignment. Students were randomly assigned to new groups at the beginning of each lesson to avoid any bias deriving from specific group effects.

In Condition 3 – Jigsaw classroom, cooperation with positive resource interdependence between students was implemented following the Jigsaw method. This condition included 5 stages: first, for each pedagogical sequence, the content of the pedagogical sequence (in French, mathematics, or the specific vocational teaching) was randomly assigned to randomly composed groups of 3 to 5 students (i.e., Jigsaw groups). Second, each student worked individually on one sub-section of the pedagogical sequence.

Third, students working on the same sub-section were grouped together (expert groups, Aronson et al., 1978). Fourth, each student returned to their Jigsaw groups to present the sub-section they worked on to the other members of the group. Fifth and finally, each group produced a collective assignment requiring the articulation of the various pedagogical sub-sections.

Data collection

Data were collected on the dedicated platform using an online questionnaire. This questionnaire contained 251 items (the full list is available from authors upon request) including the ones on social competences (see below), which were assessed at three different time points: The beginning of the first year (before the experimental manipulation), the end of the first year and the end of the second year (see Figure 1). Students filled out the questionnaire during school hours in the schools' computer rooms.

Measures

The main dependent variable of this study was perceived social competences, a general theoretical term that has been operationalized in different ways. For this research, we measured it through two constructs: self-reported social competences and social utility of social competences.

Self-reported social competences. Students were asked to report the extent to which they perceived they possessed a set of social competences with the Social Competence Teen Survey (SCTS). This questionnaire was developed in 2010 by Child Trends for the Flourishing Children Project, promoted by the Templeton Foundation (http://www.childtrends.org). It was created for teenagers and evaluates the general social competences needed to get along well with others and function constructively in groups.

The scale has been tested in the United States with 12 to 17 year-old adolescents and reached good reliability scores (α between .69 and .79) and concurrent validity (Riley, 2018).

The original questionnaire contained nine items in total; however, the fourth item ("Do you get along well with people of different races, cultures, and religions?") was removed from the present questionnaire after translation in French because it contained "race", a word that is not used in the same way in French. Students had to evaluate the items on a 5-point Likert scale ranging from "*Not at all like me*" to "*Exactly like me*". A social competences score was then computed by calculating the mean responses on the eight items for each student. The higher their score, the higher their self-reported social competences. The scale reached good internal reliabilities at the three time points which can be seen in Table 1, along with items, means and standard deviations. Differences in *Ns* are due to missing values.

Utility value of social competences. Students' perceived utility value of social competences was assessed with a part of a scale developed for the purpose of the ProFAN experiment. It is based on the World Health Organisation's classification of social competences—called *life skills* by WHO (https://apps.who.int/iris/bitstream/handle/10665/63552/WHO_MNH_PSF_93.7A_Rev.2.pdf?sequence=1&isAllowed=y). Students' general perception of social competences was assessed with three scales: social desirability of social competences ("in general, people are liked when they have this kind of competences"), their perceived self-efficacy in these social competences ("I am quite good at it myself"), and the utility value of these social competences. As the first two scales did not yield any significant results, we do not report their results in detail in the present study, but they are available from the authors upon request.

For the utility value scale, seven main social competences were displayed (Table 1) and students were asked to evaluate the utility of each of these competences in today's world. Utility was thus assessed using the sentence "it is useful to have this kind of competences", and students were asked to answer on a 7-point Likert scale going from "*Not at all*" to "*Very*

much". Mean responses were then calculated for each student at each time point. The score indicated the perceived utility value of social competences: the higher the score the more the students identified social competences as useful. The scale reached good internal reliabilities at the three time points which can be seen in Table 1, along with items, means and standard deviations. Differences in *Ns* are due to missing values.

Table 1

Importantly, as can be seen in Table 2, a confirmatory factor analysis including all items of both scales showed that a two-factor solution obtained acceptable indices, confirming that the two constructs are separate. Intercorrelations between all items of all instruments for the three time points are available in Tables S1, S2 and S3.

Table 2

Data analyses

We used four-level multilevel modelling to analyse the longitudinal data in Stata. Specifically, we built a model with within-participant observations (level-1 units) nested in students (level-2 units), further nested in classes (level-3 units)[2] and schools (level-4 units). Time was treated as a categorical variable, enabling us to estimate specific wave-to-wave changes (e.g., similar to fixed-effects panel modelling; see Allison, 2009). To prevent bias in the estimation, we also estimated the student-level random slope of the two dummies of time variable, which represents the extent to which the statistical effect of time varies from one student to another (Usami & Murayama, 2018). For reasons related to computational feasibility, covariance terms were omitted from the model.

The objective was to document changes in social competences across waves for each of our two focal outcome variables as a function of the three conditions and gender. To test

[2] The class identifier corresponded to the classes students were enrolled in during the first year of the two-year period under investigation in this research. While a small number of students may have changed classes during the two-year span, this only impacted a negligible percentage (1%) of the sample. As a result, the use of cross-classified models was deemed unnecessary.

our three hypotheses, we built three sequential models: Model 1 included only main effects to test gender differences in social competences; Model 2 added the interaction between gender and time to test if social competences developed differently for boys and girls; and Model 3 tested our focal hypothesis on the three-way interaction between gender, time, and the conditions.

Several variables were controlled across the three models and for both outcome variables: the vocational paths students followed (sales, health services, or electricity), their socioeconomic status[3] (M = 89.88, SD = 19.79), their age (M = 16.43, SD = 0.87), the cohort to which they belonged (2017 or 2018), and students' self-reported relative achievement[4] at the beginning of the ProFAN project (M = 3.04, SD = 0.87). Level-1 control variables were grand-mean-centred.

Following current recommendations (Sidi & Harel, 2018), multiple imputation by chained equations (MICE) with 20 imputed datasets was used to handle missing data on the time-constant variables, namely, gender (0.26% missing), socioeconomic status (9.87%), age (6.90%), and self-reported achievement (6.45%). We used pairwise deletion to handle missing data on time-varying variables. Differences in the number of observations across the analyses were due to differences in the pattern of missing values on the time-varying outcome variables (self-reported social competences or utility value of social competences).

Below is the multilevel regression equation of the full model:

$$Y_{\mathrm{ijkl}} = \beta_{0000} + \sum_{n=1}^{2}\left(\left(\beta_{n000} + u_{nj}\right) \times \mathrm{Time}_{n_{\mathrm{ijkl}}}\right) + \beta_{0100} \times \mathrm{Gender}_{\mathrm{jkl}} + \sum_{n=1}^{2}\left(\beta_{000n} \times \mathrm{Condition}_{n_{\mathrm{l}}}\right) +$$

$$\sum_{n=1}^{2}\left(\beta_{n100} \times \mathrm{Time}_{n_{\mathrm{ijkl}}} \times \mathrm{Gender}_{\mathrm{jkl}}\right) + \sum_{n=1}^{2}\sum_{m=1}^{2}\left(\beta_{100(\mathrm{n+m})} \times \mathrm{Time}_{m_{\mathrm{ijkl}}} \times \mathrm{Condition}_{n_{\mathrm{l}}}\right) + \sum_{n=1}^{2}\left(\beta_{010n} \times \mathrm{Gender}_{\mathrm{jkl}} \times \mathrm{Condition}_{n_{\mathrm{l}}}\right) +$$

$$\sum_{n=1}^{2}\sum_{m=1}^{2}\left(\beta_{110(n+m)} \times \mathrm{Time}_{m_{\mathrm{ijkl}}} \times \mathrm{Gender}_{\mathrm{jkl}} \times \mathrm{Condition}_{n_{\mathrm{l}}}\right) + \beta_{\mathrm{ij00}} \times \mathrm{Control}_{\mathrm{ij00}} + w_{000\mathrm{l}} + v_{00\mathrm{kl}} + u_{0\mathrm{jkl}} + e_{\mathrm{ijkl}}$$

[3] Based on the French national "Social Position Index", min. = 38, max = 179, *M* at the national level = 103.
[4] "When you think about your school grades, how do you compare with other students in your high school who are the same age as you?" From 1 = I am among the lowest achievers, to 5 = I am among the best.

…i = 1, 2, …within-participant observations, j = 1, 2, …participants, k = 1, 2, …, classes, l = 1, 2, …, schools, where Y_{ijkl} is the outcome, $Control_{ij00}$ is a vector of the control variables, u_{nj} are the time slope residuals, e_{ijkl}, u_{0jkl}, v_{00kl}, and w_{000l} are the level-1 to level-4 error terms.

The full models are reported in Tables 3 and 4. To improve readability, these tables display coefficient estimates and standard errors for dichotomous/continuous variables, while they report omnibus chi square tests[5] for polytomous variables. Note that some of these omnibus tests were used to test our second and third hypotheses and, when significant, we compared the standardized differences between genders on each outcome variable at Time 3 to quantify the reduction of the gender gap elicited by the use of the Jigsaw classroom.

Results

Self-reported Social Competences

Our first hypothesis was supported, B = -0.10, SE = 0.02, $p < .001$ (see Model 1). As expected, girls had higher self-reported social competences than boys.

Our second hypothesis, which focused on the interaction between gender and time, was also supported, χ^2 (2, N = 23,341) = 7.32, $p < .001$ (see Model 2). As expected, and as illustrated by the diverging lines in Figure 2, gender differences in self-reported social competences changed over time: The gap increased by 0.03 points from time 1 to time 2 (B = -0.03, SE = 0.02, p = .031) and by 0.07 points at time 3 (B = -0.07, SE = 0.02, $p < .001$).

Most importantly, our third and focal experimental hypothesis, which focused on the three-way interaction between the conditions, gender, and time, was marginally supported, χ^2 (4, N = 23,341) = 2.09, p = .079 (see Model 3). This interaction indicated that gender differences in self-reported social competences did not change similarly over time in each

[5] We generated the omnibus chi-squared statistics by conducting postestimation tests that assessed the joint significance of the relevant dummy-coded variables (e.g., to estimate the omnibus main effect of the condition, by testing the joint significance of $Condition_{1l}$ and $Condition_{2l}$). Alternatively, generating the chi-squared statistics by comparing the deviance of a constrained model (not including the variable to be estimated) to the deviance of an augmented model (including the variable) yields the same results.

condition. As illustrated in Figure 2, the increase in gender differences was more pronounced in the two control conditions (i.e., Business-as-usual and Resource independence), as compared with the Jigsaw classroom condition.

To assess the practical significance of this finding (i.e., to determine the extent to which the intervention curbed the widening gender gap in self-reported social competences), we compared the standardized differences between boys and girls on the self-reported social competences variable at the end of the experiment. These comparisons enabled us to quantify, in percentages, the reduction in effect size (i.e., the standardized difference between boys and girls) in the focal condition compared to each of the two control conditions (for a similar approach, see Borman et al., 2021; Hadden et al., 2020). The gender gap at Time 3 was reduced by 27% in the Jigsaw classroom condition (β = -.16, *SE* = .05, p = .001) when compared to the Business-as-usual condition (β = -.22, *SE* = .05, $p < .001$), and by 20% when compared to the Resource independence condition (β = -.20, *SE* = .05, $p < .001$). In summary, in the two control conditions, boys reported lower social competences than girls at Time 3. In the experimental condition, this gap was reduced by a fifth to a quarter, suggesting that the Jigsaw method is an effective way to reduce gender differences in self-reported social competences.

Table 3

Figure 2

Utility Value of Social Competences

Our first hypothesis was supported, *B* = -0.17, *SE* = 0.03, $p < .001$ (see Model 1). As expected, girls perceived higher utility value of social competences than boys.

Our second hypothesis, which focused on the interaction between gender and time, was also supported, χ^2 (2, *N* = 23,329) = 21.56, $p < .001$ (see Model 2). As in the first analysis, and as illustrated by the diverging lines in Figure 3, gender differences in the

perception of utility value of social competences changed over time: The gap increased by 0.14 points from time 1 to time 2 (B = -0.14, SE = 0.03, $p < .001$) and by 0.21 points at time 3 (B = -0.21, SE = 0.03, $p < .001$).

Most importantly, our third and focal experimental hypothesis, which focused on the three-way interaction between the conditions, gender, and time, was also supported, χ^2 (4, N = 23,329) = 2.93, p = .020 (see Model 3). Once again, this interaction indicated that gender differences in perception of utility value of social competences did not change similarly over time in each condition. As illustrated in Figure 3, the increase in gender differences was more pronounced in the two control conditions (i.e., Business-as-usual and Resource independence), as compared to the Jigsaw classroom condition.

As in the first model, to assess the practical significance of this finding (i.e., to determine the extent to which the intervention curbed the widening gender gap in the utility value of social competences), we compared the standardized differences between boys and girls on the utility value of social competences variable at the end of the experiment. The gender gap at Time 3 was reduced by 50% in the Jigsaw classroom condition (β = -.15, SE = .05, p = .002) when compared to the Business-as-usual condition (β = -.35, SE = .05, $p <$ .001), and by 25% when compared to the Resource independence condition (β = -.20, SE = .05, $p < .001$). In summary, and similar to what has been found for self-reported social competences, in the two control conditions, boys reported lower perceived utility value of social competences than girls at Time 3. In the experimental condition, this gap was reduced at least by a quarter (when compared to Resource independence) and even halved (when compared to Business-as-usual), suggesting that the Jigsaw method is an effective way to reduce gender differences in perceived utility value of social competences.

Table 4

Figure 3

Robustness check

The modelling strategy employed in this research uses a growth curve modelling framework but treats time as a discrete variable (for relevant research, see Liu et al., 2012). Although this modelling strategy was selected a priori, it represents only one of several reasonable analytic specifications (Silberzahn et al., 2018). Consequently, we conducted a series of robustness checks to further test our hypothesis using different analytical approaches (for a similar procedure, see Macchia & Whillans, 2021). As in the main analysis, MICE was used to handle missing data.

First, we repeated the analysis using a standard growth curve modelling approach, treating time as a continuous instead of a categorical variable. As shown in the second row of Table 5, we reproduced the effects for Hypothesis 1 (i.e., the main effects of gender) and Hypothesis 2 (i.e., the gender × time interactions), but not the effects pertaining to Hypothesis 3 (i.e., the gender × time × condition interactions). This is perhaps unsurprising, as this analytical approach captures linear growth curves rather than idiosyncratic changes over time (Usami & Murayama, 2018). Yet in our case, and as illustrated by Figures 2 and 3, the effects of time as a function of gender and condition are not linear.

Second, we repeated the analysis using fixed-effect panel regression modelling (Allison, 2009). This approach uses participant-based dummy variables to yield unbiased estimates of the pooled within-participant effects of time, as well as the variations in these effects between groups of participants. Moreover, this approach is often regarded as the gold standard for analysing longitudinal data (Osgood, 2010), and is arguably more powerful and parsimonious than multilevel modelling (McNeish & Kelley, 2019). However, as the model discards all observed/unobserved individual differences, it cannot be used to estimate the effect of time-constant variables, meaning that we could not examine Hypothesis 1. As shown in the third row of Table 5, we reproduced the effects for Hypotheses 2 and 3. For the latter,

the gender × time × condition interactions were even clearer than in the main analysis for both the self-reported social competences, χ^2 (2, N = 23,329) = 2.78, p = .025, and the utility value of social competences, χ^2 (2, N = 23,329) = 3.65, p = .006.

Third, we repeated the analysis using first-difference regression modelling (Allison, 2009). This approach uses the so-called first-difference estimator to yield unbiased estimates of both the changes between two consecutive waves, as well as the variations in these changes among different groups of participants. This approach is a useful complement to the fixed-effect model, although it cannot be used to estimate the effect of time-constant variables either, meaning that we could not examine Hypothesis 1. As shown in the fourth row of Table 5, we reproduced the effects for Hypotheses 2 and 3. For the latter, the gender × time × condition interactions were again clearer than in the main analysis for both the self-reported social competences, χ^2 (2, N = 13,230) = 6.42, p < .001, and the utility value of social competences, χ^2 (2, N = 13,219) = 6.42, p < .001.[6]

Table 5

Discussion

The goal of the present study was to test the focal hypothesis that the gender differences in terms of perceived social competences found in the literature could be reduced by working with a Jigsaw classroom with positive resource interdependence, as compared to cooperation with resource independence and business-as-usual.

Hypotheses 1 and 2 expected to replicate what is documented in the literature. The results confirmed that girls self-report social competences to a higher extent than boys (H1), and that this gender difference increases with time (H2). Moreover, the results on self-reported social competences provided support for our focal hypothesis (H3). The gender gap

[6] The sample size in the first-difference regression models is naturally reduced compared to other models, as it focuses on wave-to-wave changes. In essence, rather than including observations from Waves 1, 2, and 3, it examines transitions from Wave 1 to Wave 2, and from Wave 2 to Wave 3.

that increased over time in the two control conditions did not increase in the Jigsaw classroom condition, i.e., when students had worked over two years with the Jigsaw classroom method. Beyond the significance tests, inspection of effect sizes at Time 3 of the intervention revealed that the gender gap was reduced in the Jigsaw classroom condition by one fifth (compared to the cooperation with resource independence condition) to one quarter (compared the Business-as-usual condition). This suggested that the Jigsaw classroom contributed to a more parallel development of boys' and girls' perceptions of their own social competences over time, i.e., limiting a widening gender gap over time on perceived social competences.

The results on the perception of utility value of social competences were similar for H1 and H2, and also provided support to our focal hypothesis (H3), by revealing that when students worked regularly with the Jigsaw classroom, adolescent boys and girls had a very similar evolution over time of their perception of the utility value of social competences. However, when cooperating with resource independence and in a business-as-usual setting, boys' and girls' perception of utility value appeared to diverge over time, with boys' views on perceived utility decreasing compared to girls. Again, inspection of effect sizes at Time 3 of the intervention revealed that the gender gap was reduced in the Jigsaw classroom condition by one quarter (compared to the cooperation with resource independence condition) to one half (compared to the Business-as-usual condition). From these results, we infer that the Jigsaw classroom contributed to maintaining a similar evolution of their perception of utility value of social competences over time, while the other conditions over time displayed the gender differences documented in the literature (Ford, 1982; Sarason et al., 1985; Smart & Sanson, 2003; Tan et al., 2018).

One surprising outcome in this study is the initial level of perceived social competences for both genders. As can be seen in Figures 2 and 3, self-reported and perceived utility value of social competences are not significantly different between boys and girls at the

first time point. In our first hypothesis, we expected a main effect of gender, and also that socialization effects might accentuate gender differences in social competences with time (H2). As our sample comprises students from the last two years of vocational school, the socialization effects of peers and school should have already occurred. Then, how can we explain these equal levels of social competences between genders at the initial time of this study? A possible explanation can come from the vocational aspect of the high schools involved in the sample. In fact, students in these schools begin their professional integration—i.e., internships in their vocational path—during these last two years. Thus, the impact of the socialization effects coming from the professional environment may not be as strong *before* the start of these internships. Moreover, the relevance and necessity of social competences could be significantly emphasized by this beginning of socialization in the work environment. Supporting this interpretations, Van Houtte argued that low-achieving boys in technical/vocational school may be reactant toward a study-oriented culture which in turn incites them to "overdo their masculinity" (2004, p. 171). In the present context, boys, when starting their internship, might realize they do not possess the required social competences to be successful in their future work environment, and might react against learning them. However, when trained properly—with, for example, regular positive resource interdependence exercises—boys might feel more competent and therefore be more willing to recognize the usefulness of these competences.

Another surprising outcome in this study is the pattern of change in both outcome variables over time. When looking at Figures 2 and—particularly—3, there seems to be first a decrease in both variables between Time 1 and Time 2, followed by an increase between Time 2 and Time 3, forming a sort of U-shaped curve. As this pattern took place in all three conditions and with both outcome variables, it cannot be attributed to one particular learning method, nor to the intrinsic characteristics of one outcome variable. Two potential

explanations—not necessarily mutually exclusive—can be proposed. First, a situational effect close to the one mentioned above: Before and at the beginning of the last two years of vocational high school, students may have an idealized vision of social competences. However, when they are confronted with the professional world—i.e., at the beginning of internships during Year 1—, they may all (boys and girls) realize their potential weaknesses, hence the drop at Time 2. After the initial "shock", they (more particularly girls) may adapt to the professional world and thus re-evaluate more positively their own social competences, producing the increase visible at Time 3.

A second potential explanation could be linked to the *disruption hypothesis*, "which proposes that the biological, social, and psychological transitions from childhood to adolescence are accompanied by temporary dips in some aspects of personality maturity" (Soto & Tackett, 2015, p. 360). These dips were particularly found in the literature in mean levels of agreeableness, conscientiousness, and openness to experience (Denissen et al., 2013; Soto et al., 2011; Van den Akker et al., 2014), important components of social competences and relevant dimensions in working environments (Hurtz & Donovan, 2000; Soto, 2019). The decrease in both our outcome variables from Time 1 to Time 2 could thus be linked to these maturity dips. Moreover, the fact that both outcome variables seem to increase again from Time 2 to Time 3, even in the Business-as-usual condition, can be related to findings showing that the maturity dip tends to reverse itself during early adulthood years (Soto et al., 2011). However, as can be seen in Figures 2 and 3, this increase is more pronounced for girls than for boys if students are not trained with cooperative learning methods involving resource interdependence, as in the Jigsaw classroom condition of our study.

Contributions

Overall, the results presented above provide important contributions to the reviewed literature. Firstly, we replicated and confirmed the gender gap favouring girls in perceived

social competences previously documented by Torres and colleagues (2003), and we expanded this finding by showing a trend toward an increase in this gap over time, if not addressed. It seems plausible that this increase effectively comes from socialization, whether it is from gender-specific academic cultures in vocational high school classrooms or from the professional environment made salient by internships (Van Houtte, 2004).

Secondly, and most importantly, the findings of the present research point to a specific method and mechanism that may address such a gender gap in perceived social competences: We found that implementing cooperative learning with positive resource interdependence (the Jigsaw classroom)—and not just cooperation with resource independence—can reduce the developing gender gap in perceived social competences. These findings are in line with the literature showing a positive effect of cooperative learning and positive resource interdependence on social relations and group processes (Buchs et al., 2004; 2021; Johnson & Johnson, 2005). The present study shows that such positive effect extends, in particular, to perceived social competences. It is noteworthy that the present study was conducted with a vocational high school sample, i.e., students who will likely need these social competences when they leave school and enter a changing and unpredictable work environment. The digitalisation of society is already having an impact on today's professional landscape, and many of the jobs vocational schools are training their students for may not exist tomorrow (e.g., Frey & Osborne, 2017).

Likewise, and thirdly, results on perceived utility value of social competences appeared to be parallel to results on self-reported social competences. The fact that the same interaction effect appears on both measures highlights the robust nature of the results. In addition, it supports the plausibility of using the Jigsaw method in regular classes to promote social competences. As noted in the literature review, if students view social competences as useful for their future, they are more likely to adopt them. Working in an academic

environment where resource interdependence—and the social competences required to deal with it—are needed (here, the Jigsaw classroom) might therefore be considered an effective tool that develops utility value of social competences (Hulleman & Harackiewicz, 2021).

The importance of the present study is not only related to its results, but also to the size and scope of the experimental intervention underpinning the results. The effects reported are the outcome of the largest-scale field experiment testing the Jigsaw method ever devised, conducted in ten different regions of the same country (France), and implemented directly by teachers. This suggests that the method devised here could be directly used in ordinary classes, as the sample is large enough to resemble the implementation conditions of a new educational policy. This leads us to the fourth contribution of the present study, which pertains to the value of observing results of implemented interventions in ecological contexts. As noted in the literature on interventions, methodological rigor is necessary to correctly assess the expected effects in controlled conditions in the field (e.g., Walton & Wilson, 2018). However, the benefits of conducting large-scale and longitudinal experiments like this one is that we can observe how the intervention works in real-life classrooms. Specifically, although the experimental design was carefully crafted in advance and participating teachers received the specific materials and instructions at the right time through a dedicated platform, given the geographical dispersion and the sheer size of the intervention, we could not be present to observe the quality of actual implementation in class. We, therefore decided to not filter out classes that failed to comply with the instructions, nor did we code the variability in implementation to assess "the barriers a group of people face and the kind of change that would be most welcome" (Walton & Wilson, 2018, p. 622). This might be very useful in early stages of research on a new mechanism, but in the present research we were working with one of the most researched cooperative classroom methods—the Jigsaw classroom—and wanted to observe what the effect would be if a nationwide educational policy was introduced.

Indeed, interventions in the educational domain may be hampered when they are at odds with teachers' beliefs (Yeager et al., 2022), and—more specifically with cooperative learning—when students are not prepared to appreciate the importance of cooperation (Buchs et al., 2016) or when cooperation is promoted in otherwise competitive educational structures (Butera et al., 2021, 2024). Our results showed that the Jigsaw classroom has the potential to reduce the gender gap in social competences, even in the face of the extreme variability of implementation that necessarily occurs in real-life classrooms.

Limitations and Future Research

Besides these contributions to the literature, some limitations of the present research must be recognized. First, during the ProFAN experiment, no researcher was physically present in the classrooms with the teachers to ensure the proper functioning of the conditions and materials. Thus, we were not able to capture the fine-grained mechanisms that led to our results, namely from positive interdependence to a more equal perception of social competences between genders. That is unfortunately the downside of conducting such large-scale experiments in real-life teaching conditions.

The second limitation of the present research concerns the sample. In fact, working with vocational high schools was particularly relevant for the present research project, as students in this schools will need these social competences in their future. However, it should be noted that these students tend to have a social class profile that is not particularly diversified. The lack of social class diversity may be a downside on the one hand, but their particular profile can be seen as a strength on the other hand, because students from lower class backgrounds are an understudied population in the educational literature. Either way, it is important to note that the present findings may need to be replicated on other samples from other types of schools or from other age ranges.

Finally, future research could investigate in greater depth the impact of socialization

effects *over time*. In fact, we interpreted the increase of the gender gap over time in the present study as due to socialization, but this is just a supposition, and more studies are needed to fully confirm this hypothesis. Future research could therefore study the role of socialization in different contexts (e.g., school vs work environment) in the emergence of the gender gap in perceived social competences, and how cooperative learning methods such as the Jigsaw classroom could intervene at early stages of socialization to reduce this gap.

Conclusions

Men and women may not be equally equipped to face *The Fourth Industrial Revolution* depicted by Klaus Schwab (2017), at least in terms of the social competences needed to adapt to such a "revolution". However, in the present research we showed that the Jigsaw method has promising effects on an otherwise widening gender gap in perceived social competences in adolescents. As these competences are essential for adaptation to an upcoming, unpredictable job market, young adults like students at vocational high schools can benefit from a training with the potential to ensure a more uniform development of social competences between boys and girls.

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Figures

Figure 1

Timeline of the ProFAN experiment

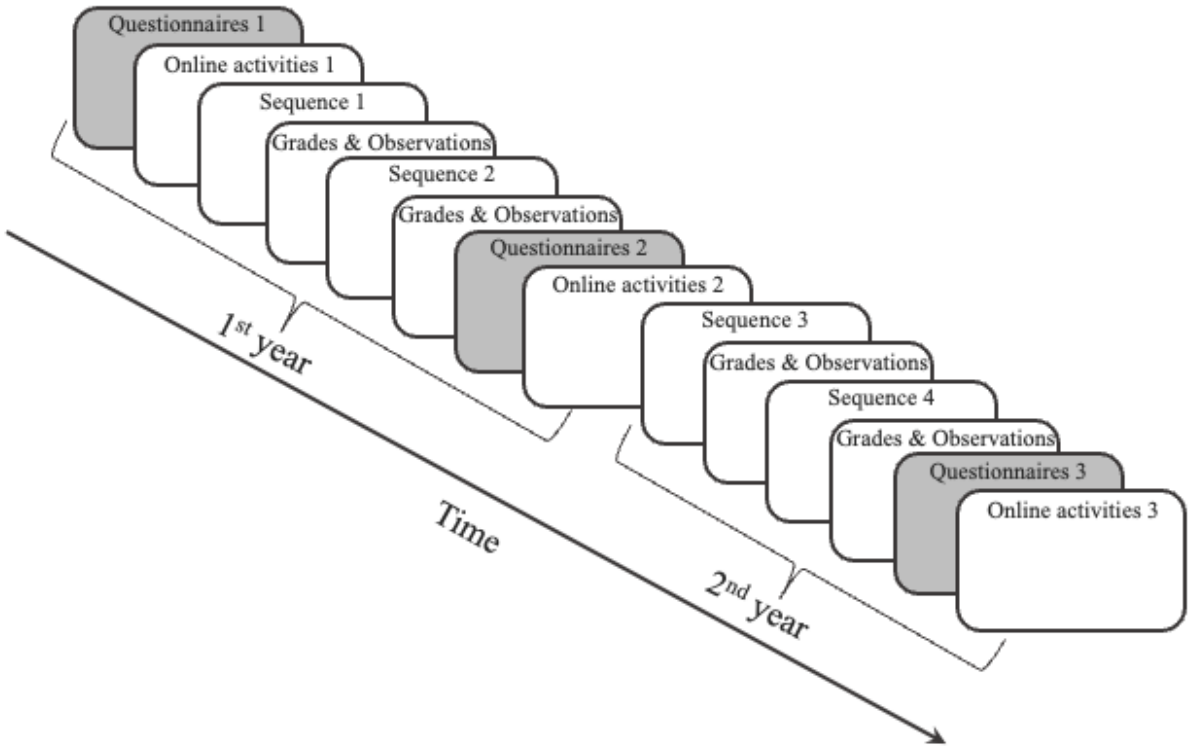
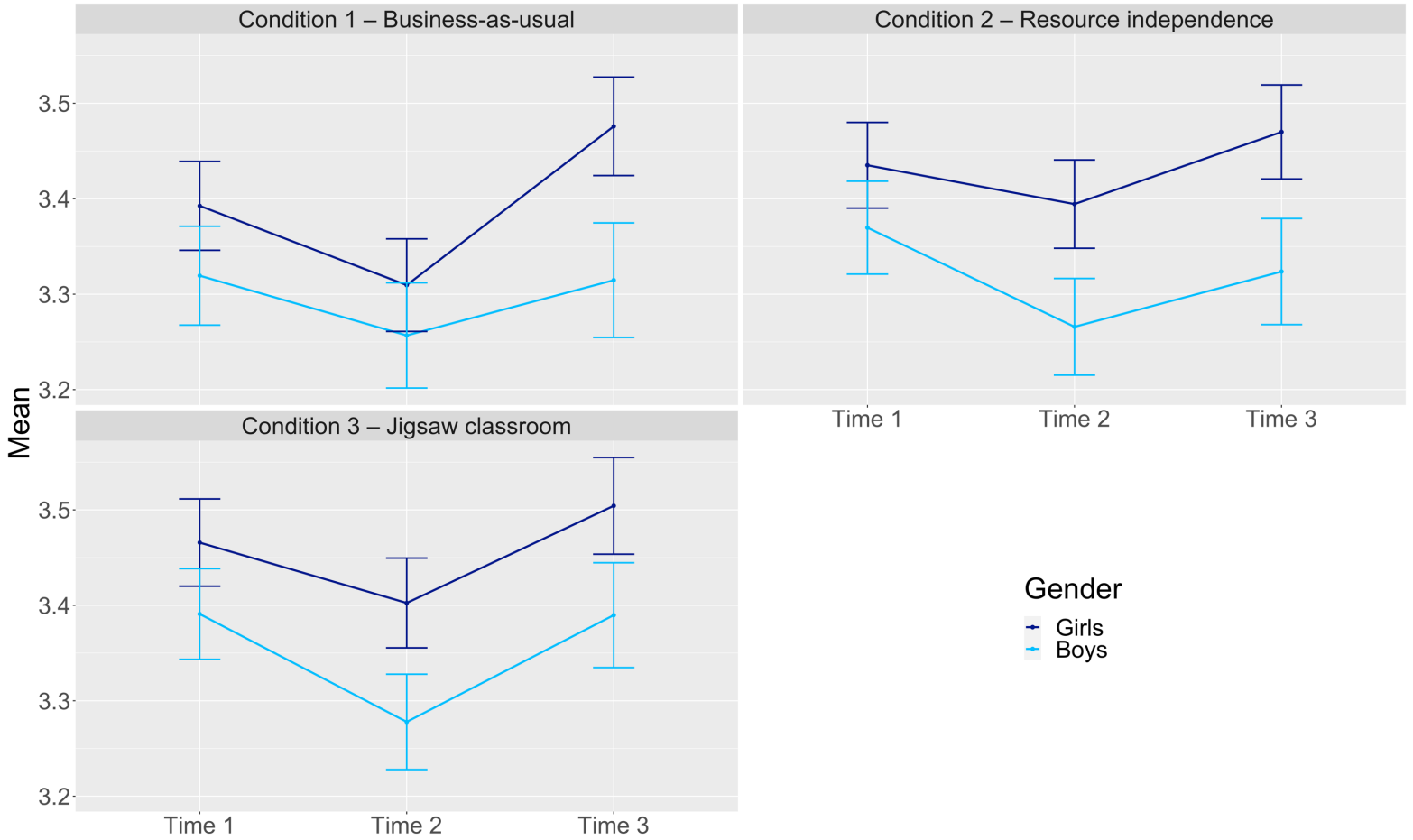


Figure 2

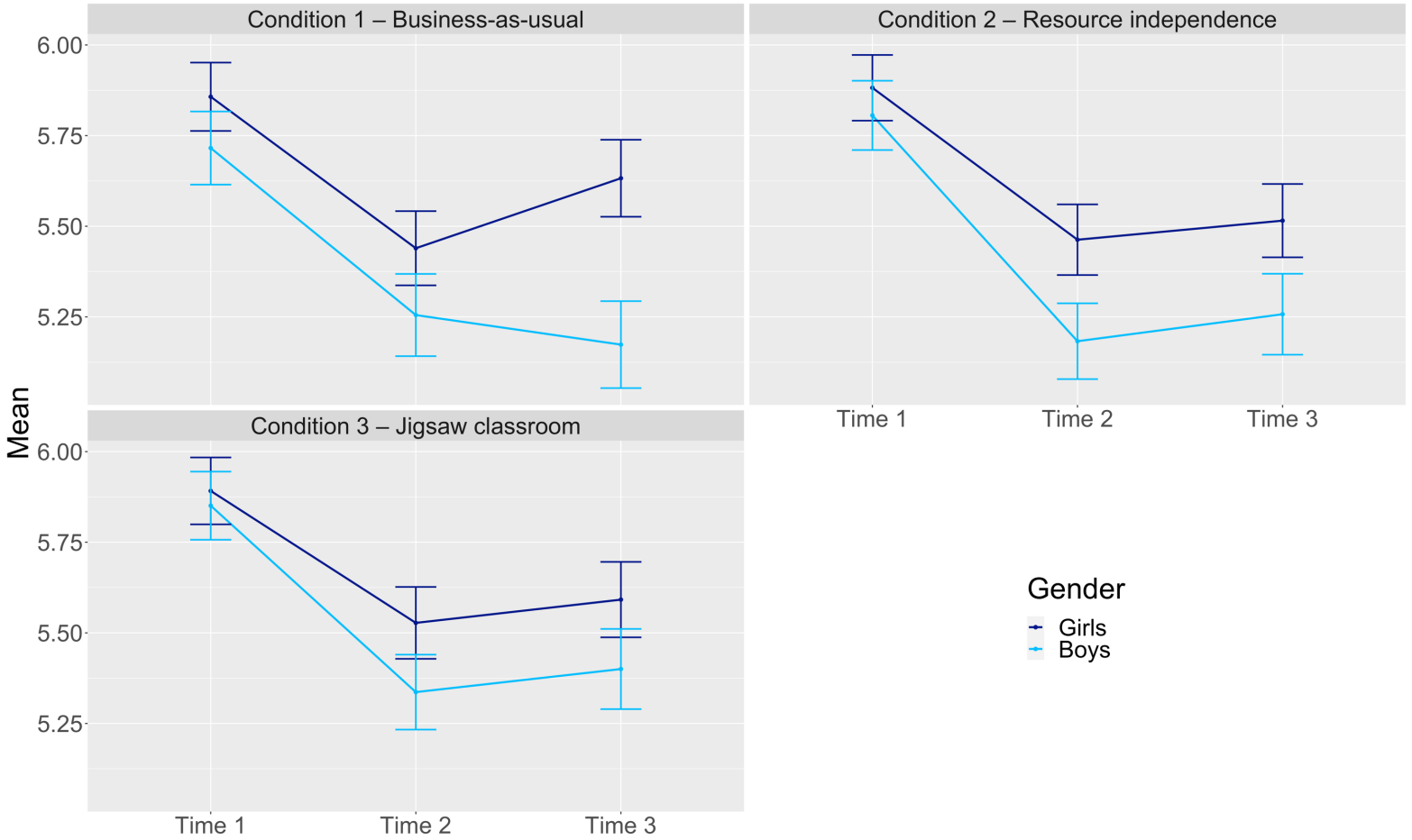
Self-reported Social Competences assessed with the SCTS, by Conditions, Gender, and Time



Note. Predicted means and their corresponding standard errors and 95% confidence interval of Model 3 testing the focal hypothesis on the three-way interaction.

Figure 3

Utility Value of Social Competences, by Conditions, Gender, and Time



Note. Predicted means and their corresponding standard errors and 95% confidence interval of Model 3 testing the focal hypothesis on the three-way interaction.

Tables

Table 1

Means, Standard Deviations and Internal Reliabilities of all Items at each Time Point, and Correlations between the Two Variables

Items	T1			T2			T3		
	M	*SD*	α / ω	*M*	*SD*	α / ω	*M*	*SD*	α / ω
Self-reported social competences (N_{T1} = 9014, N_{T2} = 7811, N_{T3} = 6516)	3.40	0.71	0.72 / 0.76	3.34	0.74	0.78 / 0.82	3.45	0.75	0.81 / 0.85
SC1	3.22	1.30		3.23	1.22		3.34	1.16	
SC2	3.57	1.29		3.40	1.23		3.53	1.17	
SC3	3.62	1.11		3.55	1.11		3.67	1.08	
SC4	3.58	1.11		3.48	1.08		3.55	1.06	
SC5	2.61	1.39		2.70	1.31		2.86	1.26	
SC6	3.12	1.23		3.08	1.16		3.18	1.11	
SC7	3.97	1.13		3.82	1.14		3.97	1.10	
SC8	3.47	1.18		3.42	1.12		3.51	1.09	
Utility value of social competences (N_{T1} = 9010, N_{T2} = 7807, N_{T3} = 6512)	5.82	1.15	0.91 / 0.93	5.39	1.38	0.94 / 0.95	5.50	1.38	0.95 / 0.96
UV1	5.69	1.49		5.23	1.68		5.41	1.64	
UV2	5.65	1.42		5.25	1.55		5.41	1.51	
UV3	5.68	1.48		5.32	1.58		5.42	1.54	
UV4	5.77	1.43		5.34	1.57		5.47	1.53	
UV5	6.09	1.35		5.58	1.61		5.65	1.58	
UV6	5.96	1.34		5.52	1.55		5.58	1.52	
UV7	5.90	1.53		5.50	1.62		5.55	1.56	

Note. Correlations between Self-reported social competences and Utility value of social competences: r_{T1} = 0.44, r_{T2} = 0.52, r_{T3} = 0.58. Self-reported social competences: SC1 = I avoid making other kids look bad; SC2 = If two of my friends are fighting, I find a way to work things out; SC3 = When I work in school groups, I do my fair share; SC4 = Do you listen to other students' ideas?; SC5 = Do you control your anger when you have a disagreement with a friend?; SC6 = Can you discuss a problem with a friend without making things worse?; SC7 = Do you follow the rules at a park, theatre, or sports event?; SC8 = Do you respect others' point of view, even if you disagree?. Utility value of social competences: UV1 = Knowing how to organise oneself when working with others; UV2 = Knowing how to choose a solution in a group; UV3 = Knowing how to negotiate when not everyone agrees; UV4 = Knowing how to perform a task with others; UV5 = Knowing how to communicate; UV6 = Knowing how to defend one's point of view; UV7 = Knowing how to manage one's emotions.

Table 2

Confirmatory Factor Analysis (CFA) of a Two-Factor Solution for Eight Items of Self-Reported Social Competences and Seven Items of Utility Value of Social Competences at Time 1

		Loadings	
Factor	Item	Unstandardized (*SE*)	Standardized
Factor 1:			
Self-reported social competences	SC1	.474 (.015)	.364
	SC2	.603 (.015)	.468
	SC3	.543 (.013)	.488
	SC4	.629 (.012)	.568
	SC5	.588 (.016)	.425
	SC6	.657 (.014)	.535
	SC7	.601 (.013)	.532
	SC8	.741 (.013)	.627
Factor 2:			
Utility value of social competences	UV1	1.040 (.014)	.700
	UV2	1.106 (.013)	.778
	UV3	1.112 (.014)	.751
	UV4	1.174 (.013)	.823
	UV5	1.114 (.012)	.828
	UV6	1.050 (.012)	.784
	UV7	1.075 (.014)	.704
		Model fit	
RMSEA		.061	
RMSEA 90% CI		[.059, .063]	
SRMR		.044	
CFI		.94	
TLI		.93	
$\chi^2(89)$		3050.86, $p < .001$	

Note. N_{used} = 9'010. Factors are given by constraining factor- variances to 1 for all factors; factor correlation is equal to factor covariance, which is .534. RMSEA = root mean square error of approximation; SRMR = standardized root mean squared residual; CFI = comparative fit index; TLI = Tucker-Lewis Index.

Table 3

Summary of the Multilevel Models Predicting Students' Self-Reported Social Competences

	Model 1 (Gender)		Model 2 (Gender × Time)		Model 3 (Gender × Time × Condition)	
	B	*SE*	*B*	*SE*	*B*	*SE*
Fixed effects						
Intercept	3.115***	0.047	3.103***	0.047	3.107***	0.048
Gender (boys)	-0.098***	0.018	-0.071***	0.019	-0.075*	0.030
Time	χ^2 (2) = 69.90***		χ^2 (2) = 43.74***		χ^2 (2) = 12.58***	
Condition	χ^2 (2) = 3.22*		χ^2 (2) = 3.16*		χ^2 (2) = 2.50^t	
Time × Gender			χ^2 (2) = 7.32***		χ^2 (2) = 1.93	
Time × Condition					χ^2 (4) = 2.44*	
Gender × Condition					χ^2 (2) = 0.03	
Time × Gender × Condition					χ^2 (4) = 2.09^t	
Control Variables						
Self-reported general mean grade	0.118***	0.007	0.118***	0.008	0.118***	0.007
Age	0.014^t	0.007	0.014^t	0.007	0.014^t	0.007
Socioeconomic status	-0.000	0.000	-0.000	0.000	-0.000	0.000
Vocational path	χ^2 (2) = 19.55***		χ^2 (2) = 19.33***		χ^2 (2) = 19.24***	
Cohort (2018)	0.051**	0.016	0.051**	0.016	0.051**	0.016
Random effects						
School residual variance (level 4)	0.062	0.013	0.063	0.013	0.064	0.013
Class residual variance (level 3)	0.099	0.011	0.099	0.011	0.100	0.011
Student residual variance (level 2)	0.491	0.006	0.491	0.006	0.491	0.006
Time 2 slope residual variance	0.127	0.033	0.128	0.033	0.127	0.033
Time 3 slope residual variance	0.276	0.017	0.276	0.017	0.275	0.018
Residual variance (level 1)	0.492	0.006	0.491	0.006	0.491	0.006
Model statistics						
χ^2 *(df)*	45.07 *(11)*, $p < .001$		39.31 *(13)*, $p < .001$		22.99 *(23)*, $p < .001$	

Note. *** $p < .001$, ** $p < .01$, * $p < .05$, $^t p < .1$. The analytical sample is composed of N_{obs} = 23,341 from 9,618 students in 599 classes and 108 schools.

Table 4

Summary of the Multilevel Models Predicting Students' Perceived Utility Value of Social Competences

	Model 1 (Gender)		Model 2 (Gender × Time)		Model 3 (Gender × Time × Condition)	
	B	*SE*	*B*	*SE*	*B*	*SE*
Fixed effects						
Intercept	5.471***	0.084	5.434***	0.084	5.395***	0.087
Gender (boys)	-0.167***	0.028	-0.085**	0.031	-0.041	0.049
Time	χ^2 (2) = 530.34***		χ^2 (2) = 216.52***		χ^2 (2) = 63.31***	
Condition	χ^2 (2) = 1.33		χ^2 (2) = 1.28		χ^2 (2) = 0.14	
Time × Gender			χ^2 (2) = 21.56***		χ^2 (2) = 5.66**	
Time × Condition					χ^2 (4) = 2.27^t	
Gender × Condition					χ^2 (2) = 1.09	
Time × Gender × Condition					χ^2 (4) = 2.93*	
Control Variables						
Self-reported general mean grade	0.208***	0.012	0.208***	0.012	0.208***	0.012
Age	-0.056***	0.012	-0.056***	0.012	-0.056***	0.012
Socioeconomic status	0.001^t	0.001	0.001^t	0.001	0.001^t	0.001
Vocational path	χ^2 (2) = 11.41***		χ^2 (2) = 11.09***		χ^2 (2) = 10.72***	
Cohort (2018)	0.046	0.033	0.046	0.033	0.046	0.033
Random effects						
School residual variance (level 4)	0.156	0.025	0.157	0.025	0.156	0.025
Class residual variance (level 3)	0.269	0.017	0.270	0.017	0.271	0.017
Student residual variance (level 2)	0.704	0.010	0.705	0.010	0.705	0.010
Time 2 slope residual variance	0.649	0.023	0.651	0.023	0.651	0.023
Time 3 slope residual variance	0.728	0.023	0.727	0.023	0.726	0.023
Residual variance (level 1)	0.863	0.010	0.860	0.010	0.860	0.010
Model statistics						
χ^2 *(df)*	129.09 *(11)*, $p < .001$		113.13 *(13)*, $p < .001$		65.50 *(23)*, $p < .001$	

Note. *** $p < .001$, ** $p < .01$, * $p < .05$, $^t p < .1$. The analytical sample is composed of N_{obs} = 23,329 from 9,616 students in 599 classes and 108 schools.

Table 5

Robustness Tests for the Three Hypotheses for both Outcome Variables using the Four Different Analytical Methods.

	Self-reported social competences			**Utility value of social competences**		
	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 1	Hypothesis 2	Hypothesis 3
Multilevel model treating time as a discrete variable (main analysis)	$Z = -5.57^{***}$	$\chi^2\ (2) = 7.32^{***}$	$\chi^2\ (4) = 2.09^{t}$	$Z = -5.90^{***}$	$\chi^2\ (2) = 21.56^{***}$	$\chi^2\ (4) = 2.93^{*}$
Growth curve model treating time as an interval variable	$Z = -5.57^{***}$	$\chi^2\ (1) = 16.47^{***}$	$\chi^2\ (2) = 3.81$	$Z = -5.80^{***}$	$\chi^2\ (1) = 41.44^{***}$	$\chi^2\ (4) = 1.04$
Fixed-effect panel regression	n/a	$\chi^2\ (2) = 9.24^{***}$	$\chi^2\ (4) = 2.78^{*}$	n/a	$\chi^2\ (2) = 23.88^{***}$	$\chi^2\ (4) = 3.65^{**}$
First-difference regression	n/a	$\chi^2\ (2) = 58.48^{***}$	$\chi^2\ (4) = 6.42^{***}$	n/a	$\chi^2\ (2) = 474.98^{***}$	$\chi^2\ (4) = 6.42^{***}$

Notes. *** $p < .001$, ** $p < .01$, * $p < .05$, ^{t} $p < .10$. It is not possible to test for Hypothesis 1 using the fixed-effect and first-difference estimators, as these approaches focus on within-participant change over time and cannot estimate the effect of time-constant variables.