Student-to-student connectedness in higher education: a systematic literature review

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Abstract

Student-to-student connectedness is promoted by active, student-centered learning processes. It is a socio-psychological result of interpersonal communication and behavior in the classroom, which emulates belonging, cohesiveness, and supportiveness among peers. Currently, two survey instruments exist—Dwyer et al.'s (Commun Res Rep 21(3):264–272, 2004. https://doi.org/10.1080/08824090409359988) Connected Classroom Climate Inventory and Johnson's (Commun Res Rep 26(2):146–157, 2009. https://doi.org/10.1080/08824090902861622) amendment thereof, which have been used for nearly two decades to gain insight into instructional processes in face-to-face environments. However, research on student-to-student connectedness is relatively limited in the context of modern, technology-mediated learning environments. Arguably, where student-to-student connectedness is most urgently needed because of the decrease in face-to-face contact time between students and their instructors within online and hybrid learning environments. This study is a systematic literature review that presents a synthesis of twenty-four peer-reviewed journal articles, which empirically investigate student-to-student connectedness within face-to-face, hybrid, and online environments. The documentation of data is organized in accordance to the six aspects of activity theory (subjects, objects, mediating artifacts, rules, community, division of labor) to provide a basis for understanding the dynamics of each research report, as well as to assist identifying the trends and gaps in the literature, thereby expediting future research on this topic.

Keywords Student-to-student connectedness · Connected classroom climate · Connected classroom climate inventory · Activity theory · Literature review · Higher education

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Introduction

In learning environments operating through face-to-face (F2F) and technology-mediated modes, communication and human interaction can either positively or negatively influence the learning atmosphere. The research field began by examining supportive and defensive communication behaviors (Gibb 1961), with a focus toward instructor-to-student interactions (Dwyer et al. 2004). This trend responded to traditional instructor-centered pedagogy, which positioned instructors as the disseminator of knowledge. In other words, instructors were the research focus because it was their responsibility to lead most classroom activities. In these settings, the instructor's control was typically authoritative (Baumrind 1966) and both the environment as well as student activities were designed to maximize the instructor's ability to communicate, denying the possibility for students to interact with each other, in a potentially disruptive way (Merrett and Wheldall 1993). However, in recent decades, the widespread adoption of active learning and student-centered pedagogies (Bonwell and Eison 1991; Michael 2006; Prince 2004) has substantially increased the prominence of active learning classrooms that operate in parallel with out-of-class technology-mediated environments. In this pedagogical approach, students are responsible for their own learning and are prompted to work in teams and cultivate knowledge through peer interaction and engagement (cf. Brooks 2017; MacLeod et al. 2018a). These types of learning environments are gaining recognition due to the way they exercise students' higher-order thinking skills, such as analyzing, evaluating, and creating (Anderson et al. 2001; Krathwohl 2002). They also emphasize communication and collaboration, which are key twenty-first century skills (Partnership for 21st Century Learning 2007). Accordingly, the scope of research in the field of student-centered learning has been broadened substantially from both pedagogical and technological changes. Within this scope, the element of student-to-student connectedness has become critical as an approach through which to understand the quality, influence, and effect of peer relationships on student learning.

Student-to-student connectedness (or the connected classroom climate or CCC) refers to students' perception of a supportive and cooperative communication environment between peers in the classroom (Dwyer et al. 2004). Student-to-student connectedness is important because it has been shown to increase classroom participation (Sidelinger and Booth-Butterfield 2010; Sidelinger et al. 2011a) and be positively associated with various forms of student learning (e.g., cognitive, affective, and self-regulated learning) (Johnson 2009; Prisbell et al. 2009; Sidelinger and Booth-Butterfield 2010; Sidelinger et al. 2011a, b, 2015). In addition, the "time, place, path, and/or the pace" of learning is redistributed through technology-mediated learning environments, which has increased students control over their learning process (National Education Association 2011, p. 1). This enables procedural opportunities for student learning, however, it is predicated on an, at least partial, removal of the instructors' F2F contact time with students (which is a fundamental concept of a hybrid or online instructional approaches). Such removal of an instructor's F2F contact time with students

elevates the importance of student-to-student communication and relationships, which suggests student-to-student connectedness to be a very critical factor for positively influencing student success and wellbeing as technology continues to integrate with and alter traditional learning processes (MacLeod et al. 2018b).

The absence of connectedness has also been linked to some negative effects such as low self-esteem, loneliness, and depression (Baumeister and Leary 1995). Particularly in the context of technology-mediated learning environments, individuals can be socially and physically isolated in ways that traditional F2F classroom environments prevent. This issue is gaining traction as a critical challenge to combat in technology-mediated learning environments. Specifically, researchers and instructors are seeking methods to increase student-to-student connectedness through technology-mediated environments, arguably where the student support-mechanism is most needed. Thus, a systemic literature review is needed to develop knowledge continuity extending between F2F and technology-mediated environments.

Since Dwyer et al.'s (2004) conceptualization of student-to-student connectedness was proposed, much research has been published across the domains of communication, education, and computer science. The current body of research is scattered across a wide variety of different disciplinary journals, under various terminology, which makes it difficult to interpret comprehensively. Thorough reviews of previous research can provide an effective means for establishing the foundations of knowledge, identifying gaps in the literature, and strengthening research fields (Webster and Watson 2002). Therefore, this systematic literature review presents a synthesis of existing research to expedite future exploration of the important issue of student wellbeing, which is gaining recognition as the higher education sector increasingly incorporates more personalized digital learning exeriences into the curriculum.

Theoretical framework

Student-to-student connectedness

The term 'connectedness' is generally interpreted two ways. First, a broad definition of connectedness is "when a person is actively involved with another person, object, group, or environment, and that involvement promotes a sense of comfort, well-being, and anxiety-reduction" (Hagerty et al. 1993, p. 293). This conceptualization is supported by Townsend and McWhirter's (2005) literature review on the topic and is similar to another prominent definition, which describes connectedness as an ability to "feel comfortable and confident within a larger social context than family and friends" (Lee and Robbins 1995, p. 233). Both of these representative definitions, among others (cf. Lee et al. 2001; Rovai 2002), are similar insofar as they conceptualize connectedness to include perceptions of a complex measure of the social and environmental context. In contrast to this broad definition, a secondary interpretation is specific to a student-focused category of classroom climate research, which emphasizes peer relationships and interaction in formal educational contexts. Student-to-student connectedness is defined as "student-to-student perceptions of a supportive and cooperative communication environment in the classroom"

(Dwyer et al. 2004, p. 267). In other words, connectedness is a strong bond within peer groups that encourages students to more openly express themselves and participate in communication with others (Allen 2000).

Student-to-student connectedness has been described as a socio-psychological result of interpersonal communication and behavior that emulates belonging, cohesiveness, and supportiveness among peers (MacLeod 2018). In this sense, *belonging* refers to the need for interpersonal relations between people of similar qualities and values, who provide a sense of comfort, confidence, and security (Lee and Robbins 1995). *Cohesiveness* refers to students' interest in learning about each other and gaining knowledge about and from their peers (Fraser et al. 1986). *Supportiveness* refers to individuals' actions that emulate respect, positively influence others, and improve the overall sense of the within-group community among peers in the classroom.

To the best of our knowledge, two survey instruments exist to assess student-to-student connectedness. First, Dwyer et al. (2004) conceptualized, developed, and showed preliminary evidence of instrument reliability for measuring student-to-student connectedness in higher education. Their instrument, the Connected Classroom Climate Inventory (CCCI), consists of 18 items. Second, Johnson (2009) conducted a validity study that utilized confirmatory factor analysis to verify the consistency of the CCCI as a single dimension and suggested that dropping five items could result in a 13-item instrument with an improved model fit.

Our previous work (MacLeod and Yang 2018) identified that no reviews had been conducted on the topic of student-to-student connectedness and preliminarily summarized the literature based upon a review of empirical citations for Dwyer et al.'s (2004) CCCI. This systematic literature review expands the depth of the review in four aspects: (1) rather than only exploring the empirical citations of Dwyer et al.'s (2004) CCCI, this study explores empirical citations from both the initial CCCI and Johnson's (2009) shortened 13-item instrument; (2) this study considered almost double the quantity of search results that have been published in the last year previously associated with Dwyer et al.'s (2004) instrument; (3) the reference lists of selected journal articles were checked (e.g., through a snowball search), which provided a more exhaustive level of detail beyond the "cited by" list of references indexed by Google Scholar; and (4) the level of reported detail for examining the selected journal articles was increased and supported analytically through the constructs of activity theory. Therefore, this systematic literature review provides a critically enhanced level of clarity for understanding the topic of student-to-student connectedness.

Activity theory

Activity theory was influenced by many interrelated contributions of nineteenth century scholars, including Hegel in philosophy, Darwin in biology, and Marx in social sciences (Engeström 1987). Activity theory typically represents an evolution of Vygotsky's (1978) cultural-historical activity theory, which initialized from the notion of activity *mediation*. Vygotsky clarified the idea that individuals could not be understood

without analyzing both the individual itself, as well as the influence of mediating activities. However, Vygotsky's interpretation of activity only accounted for individuals. In the present, the most prominent conceptualization of activity theory has been expanded to account for individuals' actions, as well as the collective activity of the system (Engeström 1987; Leont'ev 1981). This interpretation of activity theory describes six interrelated factors, including subjects, objects, mediating artifacts, rules, community, and the division of labor.

Methodology

Given that the instrumentation for measuring student-to-student connectedness is limited, this systematic review examines the citations of Dwyer et al.'s (2004) and Johnson's (2009) CCCI. Dwyer et al.'s (2004) CCCI was designed to measure connectedness among students in a supportive and cooperative communication environment in the university classroom. The 18-item CCCI scale using Likert-type items ranging from 1 (strongly disagree) to 5 (strongly agree), was found to contain a single factor, to have an overall reliability of alpha=0.94, which showed that the CCCI is a reliable, unidimensional instrument with initial evidence of validity. Johnson's (2009) CCCI is a modified version of Dwyer et al.'s (2004) CCCI. A 13-item measure, which excluded five items loading less than 0.40 in the original model of Dwyer et al.'s (2004) CCCI, was a better fit for these data than the 18-item model. Reliability of the 13-item scale was alpha=0.91.

Arksey and O'Malley's (2005) methodological framework was used to examine citations of Dwyer et al.'s (2004) and Johnson's (2009) CCCI. The methodological framework included the following procedures: developing the research questions, identifying and refining a selection of relevant research, describing the documentation of data, and synthesizing and reporting the results.

Developing the research questions

Research questions were developed in order to provide a guide for examining the selected publications of this systematic review. The research questions were proposed as follows:

RQ1. What student-to-student connectedness scores have been reported?
RQ2. To what extent does student-to-student connectedness influence learning?
RQ3. To what extent does student-to-student connectedness influence communication and behavior?
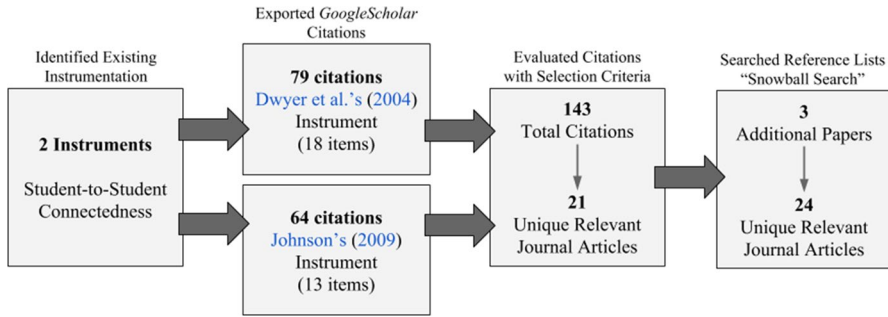RQ4. To what extent are demographic variables understood in association with student-to-student connectedness?

Fig. 1 Overview of the literature search and selection procedures

Identifying and refining a selection of research

Figure 1 illustrates the process of identifying and refining the selection of relevant research. Google Scholar was utilized to identify the body of research. In order to identify all potentially related publications, the complete list of "cited by" references for the CCCI (Dwyer et al. 2004; Johnson 2009) was exported from Google Scholar. At the time that this was conducted (May 11, 2018), Google Scholar showed that 143 citations were associated with the CCCI. More specifically, 79 citations were documented for Dwyer et al.'s work and 64 citations were associated with Johnson's refined CCCI instrument. In total, these search results constituted more than three times the quantity of publications considered (46 citations) in our preliminary review.

We modified the search criteria from our preliminary review to refine a selection of key research in the present systematic literature review. The initial list of 143 publications was refined to 24 publications based upon the following selection criteria:

1. Research must have been published in English.
2. Research must have been peer-reviewed journal articles.
3. Research must have used the CCCI for empirical research.
4. Research must have used the complete 13 or 18 item version of the CCCI.
5. Research participants must have been enrolled in higher education.

Google Scholar was used here is as a starting platform to identify research that cited the two CCCI (i.e. Dwyer et al. 2004; Johnson 2009). Although Google Scholar provides a way to search a wide range of academic literature, in recognition of the potential limitations of Google Scholar's indexing protocol, we conducted a "snowball" search of reference lists in order to obtain a more thorough level of systematic rigor. Given that this snowball search only amounted to identifying 3 additional journal articles (see Fig. 1), it was believe that the search methodology was sufficiently inclusive.

Describing the documentation of data

The selected journal articles were reviewed based upon the analytical framework of activity theory. Activity theory was proposed to describe how the environment around individuals influences cognitive development and the nature of human task behavior (Engeström 1987; Vygotsky 1978). Although several interpretations of activity theory exist (cf. Engeström 1987, 2015; Leont'ev 1981; Vygotsky 1978), the most prominently recognized model describes activity as a system of six major influencing variables: (1) subjects, (2) objects, (3) mediating artifacts, (4) rules, (5) community, and (6) division of labor (Engeström 1987; Leont'ev 1981). *Subject* personifies the individual engaged in an activity, including the degree status and the sample size. Undergraduate and graduate degree statuses were the two types identified in the research. Research sample sizes ranged from 22 to 908. *Objects* describes an intention that motivates an activity (e.g., a physical or mental outcome). *Mediating artifacts* embodies the resources facilitating a stimulus–response process while acting upon an object (e.g., classroom tools and settings). Classroom tools were rated as either basic ICT or advanced educational software, and four types of classroom settings were identified, including traditional F2F, the cloud classroom, the hybrid classroom, and synchronous smart classrooms. *Rules* represents the governing directives and constraints of a system, which are established by some type of authority figure. Rules were described as the course subject and national culture of the participants, which can be used to help explain the activity context and learner constraints. *Community* refers to the climate of interpersonal interaction within the activity system. In this study, community was described as the student-to-student connectedness score reported by the empirical research. *Division of labor* references the degree of cooperation among participants in the community while acting upon an object. Division of labor illustrated the extent to which authors provided explanation describing their class size(s) and/or activity group sizes which students' were required to work. Table 1 provides a description of the selected journal articles. Table 2 provides details of the selected journal articles in accordance with the six analytical perspectives of activity theory.

Synthesizing the results

RQ1: Overview of the Reported Scores Research Question One queried the descriptive data reported for student-to-student connectedness. Among the 24 peer-reviewed journal articles, which reported data on the full 13-item and 18-item CCCI constructs (Dwyer et al. 2004; Johnson 2009), the majority of research has been conducted within traditional F2F classrooms. However, student-to-student connectedness has also been examined in cloud classrooms (MacLeod et al. 2018b; Yang et al. 2019), compared between F2F and hybrid instructional delivery approaches (Broeckelman-Post and Hosek 2014; Broeckelman-Post and Pyle 2017; Xu et al. 2018), and examined in synchronous smart classrooms (Li

Table 1 Description of the selected journal articles

ID	Authors	Publication date	Article title	Journal/book title	Issue	No.	Pages
1	Dwyer, Bingham, Carlson, Prisbell, Cruz, and Fus	2004	Communication and connectedness in the classroom: development of the connected classroom climate inventory	Communication Research Reports	21	3	264–272
2	Carlson, Dwyer, Bingham, Cruz, and Prisbell	2006	Connected classroom climate and communication apprehension: correlations and implications of the basic course	Basic Communication Course Annual	18	6	1–27
3	Prisbell, Dwyer, Carlson, Bingham, and Cruz	2009	Connected classroom climate and communication in the basic course: associations with learning	Basic Communication Course Annual	21	1	151–172
4	Bingham, Carlson, Dwyer, and Prisbell	2009	Student misbehaviors, instructor responses, and connected classroom climate: implications for the basic course	Basic Communication Course Annual	21	7	30–68
5	Johnson	2009	Connected classroom climate: a validity study	Communication Research Reports	26	2	146–157
6	Sidelinger and Booth-Butterfield	2010	Co-constructing student involvement: an examination of teacher confirmation and student-to-student connectedness in the college classroom	Communication Education	59	2	165–184
7	Frisby and Martin	2010	Instructor-student and student–student rapport in the classroom	Communication Education	59	2	146–164
8	Sidelinger, Myers, and McMullen	2011	Students' communication predispositions: an examination of classroom connectedness in public speaking courses	Basic Communication Course Annual	23	1	248–278

Table 1 (continued)

ID	Authors	Publication date	Article title	Journal/book title	Issue	No.	Pages
9	Sidelinger, Bolen, Frisby, and McMullen	2011	When instructors misbehave: an examination of student-to-student connectedness as a mediator in the college classroom	Communication Education	60	3	340–361
10	Sidelinger, Bolen, Frisby, and McMullen	2012	Instructor compliance to student requests: an examination of student-to-student connectedness as power in the classroom	Communication Education	61	3	290–308
11	Myers and Claus	2012	The relationship between students' motives to communicate with their instructors and classroom environment	Communication Quarterly	60	3	386–402
12	Gascoigne	2012	Toward an understanding of the relationship between classroom climate and performance in postsecondary French: an application of the classroom climate inventory	Foreign Language Annals	45	2	193–202
13	Johnson	2013	Student in-class texting behavior: associations with instructor clarity and classroom relationships	Communication Research Reports	30	1	57–62
14	Sollitto, Johnson, and Myers	2013	Students' perceptions of college classroom connectedness, assimilation, and peer relationships	Communication Education	62	3	318–331
15	Broeckelman-Post and Hosek	2014	Using in-class versus out-of-class peer workshops to improve presentational speaking	Basic Communication Course Annual	26	1	57–94

Table 1 (continued)

ID	Authors	Publication date	Article title	Journal/book title	Issue	No.	Pages
16	Johnson and LaBelle	2015	Examining the role of self-disclosure and connectedness in the process of instructional dissent: a test of the instructional beliefs model	Communication Education	64	2	154–170
17	Sidelinger, Bolen, McMullen, and Nyeste	2015	Academic and social integration in the basic communication course: predictors of students' out of class communication and academic learning	Communication Studies	66	1	63–84
18	Myers, Goldman, Atkinson, Ball, Carton, Tindage, and Anderson	2016	Student civility in the college classroom: exploring student use and effects of classroom citizenship behavior	Communication Education	65	1	64–82
19	Broeckelman-Post and Pyle	2017	Public speaking versus hybrid introductory communication courses: Exploring four outcomes	Communication Education	66	2	210–228
20	Hsu and Huang	2017	Are international students quiet in class? The influence of teacher confirmation on classroom apprehension and willingness to talk in class	Journal of International Students	7	1	38–52
21	MacLeod, Yang, Zhu, and Shi	2018	Technological factors and student-to-student connected classroom climate in cloud classrooms	Journal of Educational Computing Research	56	6	826–847
22	Xu, Yang, and MacLeod	2018	STEP on connected classroom climate in a hybrid learning environment	International Journal of Innovation and Learning	23	4	430–443

Table 1 (continued)

ID	Authors	Publication date	Article title	Journal/book title	Issue	No.	Pages
23	Yang, Feng, and MacLeod	2019	Understanding students' acceptance of cloud classrooms: integrating UTAUT and connected classroom climate	Journal of Educational Computing Research	56	8	1258–1276
24	Li, Yang, MacLeod, and Dai	2019	Developing the rotational synchronous teaching (RST) model: examination of the connected classroom climate	Australasian Journal of Educational Technology	31	1	116–134

Table 2 Documentation of the data based upon activity theory

ID	Mediating artifacts	Rules		Division of labor	Community			Subject		Object
	Classroom tools	Course subject	National culture	Group/class setting	Instrument type	CCC item mean score and SD	CCC Scale mean score and SD	Degree status	Sample (n)	Learning outcomes
1	Traditional F2F	Communication studies	USA	Not specified	18 Item	N/A	71.0 (9.9)	Undergrad	564	Not within the research scope
2	Traditional F2F	Communication studies	USA	Not specified	18 Item	N/A	70.9 (9.2)	Undergrad	523	Not within the research scope
3	Traditional F2F	Public speaking	USA	Not specified	18 Item	N/A	72.2 (10.1)	Undergrad	437	CCC was associated with affective and cognitive learning
4	Traditional F2F	Public speaking	USA	Not specified	18 Item	N/A	71.0 (10.0)	Undergrad	542	Not within the research scope
5	Traditional F2F	Communication studies	USA	Not specified	13 Item	N/A	46.0 (7.7)	Undergrad	197	CCC was associated with affective learning
6	Traditional F2F	Communication studies	USA	Not specified	18 Item	N/A	59.3 (11.8)	Undergrad	434	CCC was associated with self-regulated learning
7	Traditional F2F	Communication studies	USA	Not specified	18 Item	N/A	61.9 (13.0)	Undergrad	232	CCC was associated cognitive and affective learning

Table 2 (continued)

ID	Mediating artifacts	Rules		Division of labor	Community			Subject		Object
	Classroom tools	Course subject	National culture	Group/class setting	Instrument type	CCC item mean score and SD	CCC Scale mean score and SD	Degree status	Sample (n)	Learning outcomes
8	Traditional F2F	Public speaking	USA	Not specified	18 Item	N/A	74.0 (11.0)	Undergrad	368	CCC was associated with enhancing communication competence
9	Traditional F2F	Communication studies	USA	Not specified	18 Item	N/A	67.4 (14.4)	Undergrad	187	CCC was associated with affective and self-regulated learning
10	Traditional F2F	Multidisciplinary	USA	Small, medium, and large classes	18 Item	N/A	69.1 (14.1)	Undergrad	375	Not within the research scope
11	Traditional F2F	Communication studies	USA	Not specified	13 Item	N/A	42.6 (8.7)	Undergrad	174	Not within the research scope
12	Traditional F2F	French	USA	Not specified	18 Item	1st Yr: 4.08 (.50) 2nd Yr: 3.98 (.54) 4th Yr: 4.35 (.32)	N/A	Undergrad	252	CCC was associated with higher course grades
13	Traditional F2F	Multidisciplinary	USA	Not specified	18 Item	N/A	67.0 (10.6)	Undergrad	345	Not within the research scope

Table 2 (continued)

ID	Mediating artifacts	Rules		Division of labor	Community			Subject		Object
	Classroom tools	Course subject	National culture	Group/class setting	Instrument type	CCC item mean score and SD	CCC Scale mean score and SD	Degree status	Sample (n)	Learning outcomes
14	Traditional F2F	Communication studies	USA	Not specified	18 Item	3.53 (.67)	N/A	Undergrad	170	Not within the research scope
15	In-class versus out-of-class	Public speaking workshop	USA	Not specified	18 Item	N/A	G_1: 72–73 G_2: 69–75	Undergrad	56	Not within the research scope
16	Traditional F2F	Not specified	USA	Not specified	18 Item	N/A	62.4 (12.1)	Undergrad	351	Not within the research scope
17	Traditional F2F	Public speaking	USA	Not specified	13 Item	4.13 (.61)	53.8 (7.9)	Undergrad	427	CCC was associated with peer learning
18	Traditional F2F	Multidisciplinary	USA	Not specified	18 Item	N/A	58.3 (13.3)	Undergrad	416	Not within the research scope
19	Traditional F2F and hybrid	Public speaking and communication studies	USA	Not specified	18 Item	N/A	T_1:65.2(8.2) T_2:71.5(11.2)	Undergrad	908	Not within the research scope
20	Traditional F2F	Multidisciplinary	USA (International Students)	Not specified	18 Item	N/A	66.2 (14.7)	Undergrad	121	CCC was associated with language competence
21	Cloud classroom	Multidisciplinary	China	Not specified	18 Item	3.63 (.55)	65.3 (9.9)	Undergrad	641	Not within the research scope
22	Traditional F2F and hybrid	Educational Technology	USA	Individual work	18 Item	F2F: 4.08(.80) H: 4.23(.74)	73.4 (9.0) 75.9 (8.6)	Graduate	22	Not within the research scope

Table 2 (continued)

ID	Mediating artifacts	Rules		Division of labor	Community			Subject		Object
	Classroom tools	Course subject	National culture	Group/class setting	Instrument type	CCC item mean score and SD	CCC Scale mean score and SD	Degree status	Sample (n)	Learning outcomes
23	Cloud classroom	Marxist Principles	China	Not specified	18 Item	2.91 (.91)	N/A	Undergrad	284	Not within the research scope
24	Synchronous smart classrooms	Mathematics	China	Groups of 5–8 students	18 Item	3.79 (.41)	68.3 (7.3)	Undergrad	305	Not within the research scope

et al. 2019). These findings suggest that many opportunities remain to clarify the role of student-to-student connectedness in a variety of different technology-mediated environments.

Studies have reported on their findings in student-to-student connectedness in two different ways. Most commonly, the research method has used scale-mean scores, which is equal to the sum of the 18-item scores for the construct. A secondary method is to report item-mean scores, which is equal to the average of the 18-item score for the construct. Research has reported a scale-mean score range of roughly 58–76. The item-mean score range was 2.91–4.35. The results were generally observed to be higher in F2F environments in comparison to online environments, although there were some exceptions (cf. Frisby and Martin 2010; Johnson and LaBelle 2015; Myers et al. 2016; Sidelinger and Booth-Butterfield 2010). One comparative study showed slightly higher student-to-student connectedness scores in a hybrid course when compared to F2F (Xu et al. 2018). However, in general, both scores were higher than average, which was likely due to the relatively small research sample size. Broeckelman-Post and Pyle (2017) also examined hybrid course delivery in a comparison student and found to significant differences for student-to-student connectedness between the two environments. Future research should further investigate student-to-student connectedness among different instructional delivery modes.

RQ2: Influence on Student Learning Research Question Two considered the influence of student-to-student connectedness on students' learning. Figure 2 provides a summary of the student-to-student connectedness research related to student learning. In general, studies have suggested that student-to-student connectedness can positively influence students' learning from a variety of perspectives, including cognitive learning (Frisby and Martin 2010; Gascoigne 2012; Prisbell et al. 2009), affective learning (Frisby and Martin 2010; Johnson 2009; Prisbell et al. 2009; Sidelinger et al. 2011a), self-regulated learning (Sidelinger et al. 2011a; Sidelinger and Booth-Butterfield 2010), and peer learning (Sidelinger et al. 2015). Despite many positive associations between student-to-student connectedness and students' learning, the majority of research has been based on self-reporting measures of learning. For instance, one study investigated the difference between how much the student
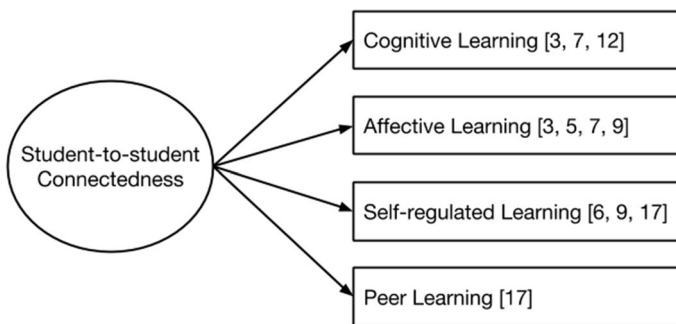

Fig. 2 Studies examining student learning

believed they had learned and how much they believed they could have learned with the ideal instructor (*learning loss*), through a two-item cognitive learning assessment (Prisbell et al. 2009). A second approach to cognitive learning was based on a ten-item instrument addressing students' recall, knowledge, understanding, and skills development (Frisby and Martin 2010). Gascoigne (2012) identified a positive association between higher levels of student-to-student connectedness and higher overall course grades. However, all of these studies were conducted in F2F environments. Thus far, no research on students' learning has been conducted in technology-mediated environments. Future research is necessary to provide more robust and scientific evidence of student learning outcomes, particularly in ways that utilize observational data both within F2F and technology-mediated environments.

RQ3: Influence on Communication and Behavior Research Question Three queried the influence of student-to-student connectedness on communication and behavior. Figure 3 provides a summary of the student-to-student connectedness research related to communication and behavior. Almost all studies have shown positive results from the students' perspective. For instance, student-to-student connectedness has shown positive associations with students' classroom assimilation (Sollitto et al. 2013), participation (Sidelinger et al. 2011a), and in-class involvement (Sidelinger et al. 2011a; Sidelinger and Booth-Butterfield 2010). Student-to-student connectedness has also been observed to reduce students' communication anxiety (Bingham et al. 2009; Sidelinger et al. 2011b) and improve self-perceived communication competence (Sidelinger et al. 2011b) as well as secondary language English
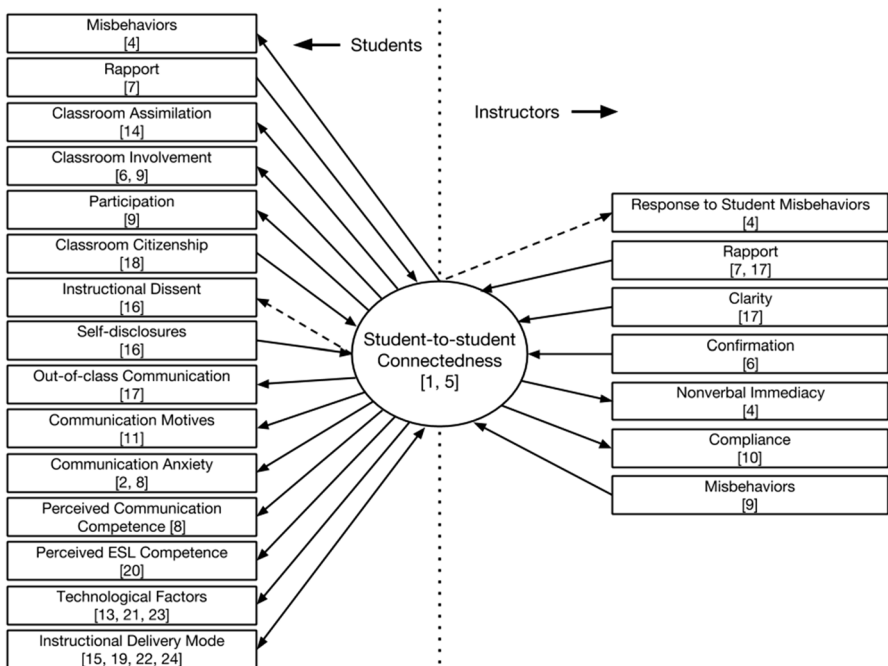

Fig. 3 Studies examining communication and behavior

competence (Hsu and Huang 2017). Students' self-disclosure (Johnson and LaBelle 2015), rapport (Frisby and Martin 2010), and classroom citizenship behavior (Myers et al. 2016) have also shown positive influence on student-to-student connectedness. Additionally, certain types of students' motives to communicate with their instructor were associated with student-to-student connectedness. For instance, relational, functional, participatory, and sycophantic motives were related to student-to-student connectedness, while excuse-making communication was not related (Myers and Claus 2012).

In general, less research has examined student-to-student connectedness from the instructors' perspective rather than that of the students. To our knowledge, no research has examined the influence of student-to-student connectedness on instructors' motivation, job satisfaction, attitudes, and acceptance of new educational technologies or pedagogical approaches, for instance. However, one study, conducted from the perspective of the instructor, demonstrated that an increase in the level of student-to-student connectedness can affect instructors' behavior, such as their willingness to comply with students' requests (Sidelinger et al. 2012). In addition, two other studies found that student-to-student connectedness can be positively influenced by instructors' communication and behavior, including their confirmations (Sidelinger and Booth-Butterfield 2010) and rapport (Frisby and Martin 2010). However, there is evidence for a positive influence on student learning, regardless of the instructor's behavior. For example, through the mediation between instructor apathy and students' self-regulated learning and willingness to talk in class (Sidelinger et al. 2011a). Student-to-student connectedness also seems to mediate instructor misbehaviors (e.g., irresponsibility and derisiveness) through self-regulated learning (Sidelinger et al. 2011a).

RQ4: Observation of Demographic Variables Research Question Four was concerned with the observation of demographic variables in relation to student-to-student connectedness. In the present, most research has been conducted in the context of the USA at the undergraduate level of higher education. Additionally, most research explored student samples learning communication-related subject matter, with only a few multidisciplinary (Hsu and Huang 2017; Johnson 2013; MacLeod et al. 2018b; Sidelinger et al. 2012) and other subject examinations (Gascoigne 2012; Li et al. 2019; Xu et al. 2018; Yang et al. 2019). To a similar extent, research has primarily been conducted in English speaking contexts, although the instrumentation has been translated and utilized in Mandarin (e.g., MacLeod et al. 2018b) and some research has been conducted within foreign language education (Gascoigne 2012; Hsu and Huang 2017). One study was identified that translated the instrument into Turkish (Sağkal et al. 2015), however, the study was also published in Turkish, so it did not meet the research criteria for this systematic literature review.

Research has examined student-to-student connectedness from the perspective class size, time, and delivery mode. First, research shows that large classes (e.g., greater than 51 students) report significantly lower levels of student-to-student connectedness in comparison to small classes (e.g., 25 or less students) (Sidelinger et al. 2012). Second, research suggests that student-to-student connectedness may increase overtime when measured multiple times throughout the academic semester (Broeckelman-Post and Hosek 2014). However, such increases were only observed

as significant among student samples participating in out-of-class workshops. In class workshop samples were not observed as significantly increasing overtime. Broeckelman-Post and Hosek's findings highlight an interesting phenomenon which directs future research toward examining the intricacies between in class and out-of-class environments. Third, with respect to instructional delivery mode, two comparative studies indicate delivery mode may not significantly influence student-to-student connectedness. The two studies that examined traditional and hybrid delivery modes showed no significant different between perception of student-to-student connectedness (Broeckelman-Post and Pyle 2017; Xu et al. 2018). Therefore, students may equally benefit from their connectedness, regardless of some variability in instructor's contact hours.

Threats of validity

The findings of the present study should be considered in respect to some limitations. First, the data was primarily identified through Google Scholar. While we have made efforts to ensure article not indexed by Google Scholar were included (e.g., through the snowball search of reference lists), the research methodology must be considered in light of the potential for error. Second, our evaluation of student-to-student connectedness is exclusively based upon quantitative data. Given that no studies were excluded that utilized a qualitative research design, there appears to be a research methodology gap. Future research should aim to utilize qualitative data to triangulate the existing quantitative research findings. Third, this study provides a vantage of findings among peer-reviewed empirical journal articles. Very few relevant conference papers were identified and excluded from the scope of this study. However, it is worth noting that two master theses (Davenport 2015; Golsan 2012) and three doctoral dissertations (MacLeod 2018; Sovine 2015; Sohn 2016) were identified and excluded from the present analysis. Finally, it is worth noting that the authors of this study published four the twenty-four journal articles examined (~17%). While the authors have made purposeful effort to be systematic in their methodology and impartial in their report, readers should aware of the potential "researcher bias" issue which may be beyond the researchers' awareness.

Conclusion

Since the introduction of the Connected Classroom Climate Inventory in 2004 (Dwyer et al. 2004), it has become apparent that student-to-student connectedness positively influences students' well-being and academic success in face-to-face environments. Student-to-student connectedness has been observed as positively related to an array of beneficial student learning outcomes and has been shown to support learning amidst imperfect instructional conditions. Most recently, student-to-student connectedness research has trended toward technology-mediated learning environments and it should be expected that student-to-student connectedness will become an even more critical factor under such environmental conditions, which

require at least a partial absence of traditional F2F instructional support. However, research within technology-mediated learning environments remains in the preliminary stages. This is particularly the case as it relates to the associations between student-to-student connectedness and student learning outcomes within technology-mediated learning environments, which has yet to be explored.

A systematic and objective search of the relevant literature yielded only two versions of instumentation which measure the construct of student-to-student connectedness. Johnson's (2009) shorter 13-item adaptation, which provides a more extensively validated tool, is currently being utilized less frequently than the original 18-item CCCI. However, Johnson (2009) had received nearly the same number of citations at the time that this review was conducted and the publication should be considered as an important piece of the foundation of related knowledge. To the best of the authors' knowledge, this systematic literature review, which includes a side-by-side examination of empirical citations for both instruments, provides the most comprehensive and consolidated synthesis of related findings available to date.

Given the pedagogical and technological shifts toward student-centered and technology-mediated learning practices, a growing body of research is expected to be published in the coming years. In the present, the subject-specific and socio-cultural demographics of research are overwhelmingly weighted toward the United States, among communication and public speaking-related disciplines. From this perspective, additional research is needed among different types of informal and computer-mediated environmental conditions, as well as among different demographics of participants. Additionally, longitudinal research is necessary to interpret the effects of student-to-student connectedness on remaining institutional issues of the present, such as student retention and degree completion in higher education.

Compliance with ethical standards

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

Ethical approval No human participants were involved in the scope of this study.

Informed consent No human participants were involved in the scope of this study.

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