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Interaction and belongingness in two student-centered learning environments

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ABSTRACT

Extant research is inconclusive about how student-centered learning might affect peer interactions, teacher interactions, belongingness, and academic success. This study investigates the relationships in two commonly applied types of learning environments: learning communities (LCs) and problem based learning (PBL). Survey data from 425 first-year university students, enrolled in either an LC ($N = 333$) or PBL ($N = 92$) context, provide the input for path analyses to explore two conceptual models. Belongingness appears more important in LCs, whereas for PBL, formal peer interaction seems more important for academic success, which is consistent with the main focus of the two learning environments. LCs are dominantly focused on creating a safe environment and a PBL context is mainly focused on knowledge construction.

1. Introduction

Various student-centered learning environments have been implemented in university curricula in recent decades, reflecting the dominance of principles of social constructivism (Phillips, 2000; Richardson, 2003). A constructivist perspective on learning and teaching anticipates that students learn best by actively constructing knowledge during the learning process (Mayer, 2004; Nie & Lau, 2010). Many university programs have replaced passive, traditional, large, lecture-based instructional design with activated student-centered learning environments (De Jong & Pieters, 2006; Mayer, 2004; O'Donnell, 2006; Verloop & Lowyck, 2009). Student-centered small group learning is an active learning approach with intensive interaction with peers and interaction with the teacher (Baeten, Kyndt, Struyven, & Dochy, 2010; Dochy, Segers, Gijbels, & Van den Bossche, 2002). Moreover, in the small groups students learn through peer interaction, discussion, hands-on activities, and collaboration (Brouwer, 2017; O'Donnell, 2006). Students get to know each other easily when they meet frequently (Van Duijn, Zeggelink, Huisman, Stokman, and Wasseur (2003) and may have the feeling that they belong. This approach might help students construct their knowledge and meet academic requirements, as well as develop skills in preparation for their professional career (OECD, 2012), such as teamwork, relationship building, collaboration, and problem-solving abilities (Osmani, Weerakkody, & Hindi, 2017; Wellman, 2010). In addition, the learning environment seems to play a crucial role in feeling socially integrated which is important for being motivated for studying (Noyens, Donche, Coertjens, Van Daal,

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& Van Petegem, 2019).

Based on social constructivism (Vygotsky, 1978), learning in small groups is socially situated. The increasing prevalence of various forms of small group learning gives rise to the question about to what extent peer interaction, teacher interaction, and sense of belonging relate to academic success directly or indirectly in different forms of small group learning environments. Thus far, little research has undertaken empirical comparisons of the social factors that contribute to academic success in different types of small group teaching. To address that research gap, this article considers which social factors (peer interaction, teacher interaction, and belongingness) that arise in different student-centered small group learning environments affect academic success, as well as how they do so.

2. Theoretical background

2.1. Peer interaction, teacher interaction, belongingness, and academic success

In small group learning environments, students interact more easily with fellow students and with faculty (Braxton, Milem, & Sullivan, 2000; Meeuwisse, Severiens, & Born, 2010; Severiens & Schmidt, 2009) and perceive more positive social relationships and support (Prince, 2004). Tinto's (1993) interactionalist model of student retention assumes that students' interactions with fellow students and staff are associated with their academic success. Research is inconclusive about the impact of peer interactions on academic success though. Some studies indicate that interactions with fellow students or friends encourage adjustment to the university setting and a sense of feeling at home (Buote et al., 2007) and academic success (e.g., Etcheverry, Clifton, & Roberts, 2001; Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008; Robbins et al., 2004). Interactions with fellow students also contribute to academic success when peers possess complementary knowledge and skills (Buchs & Butera, 2009). But peer interaction can be unrelated or even negatively linked to academic success. For example, small group interactions might hinder academic success if working together reduces students' workload and effort (Flache, 2003; Karabenick & Knapp, 1991) or encourages free riders or social conflicts (Aggarwal & O'Brien, 2008; Pauli, Mohiyeddini, Bray, Michie, & Street, 2008).

Similarly, not all teacher interactions result in academic success. In a comparison of students from majority and minority backgrounds, Severiens and Wolff (2008) observe an effect for the majority group: High quality interactions with teachers helped them adapt deep learning and improved their academic success. But other studies find no effect of student-teacher interactions on achievement (Etcheverry et al., 2001; Wang, Cullen, Yao, & Li, 2013). The type of interaction (formal versus informal) appears relevant here; students might interact with teachers, tutors, or mentors in a formal educational context, such as asking questions after lectures, or engage in more informal interactions, such as when tutors show interest in students' personal histories. Formal interactions seem more effective (Brandl et al., 2017).

According to Komaraju, Musulkin, and Bhattacharya (2010), teachers' approachability, such that students feel comfortable approaching them, relates positively to academic success, indicated by Grade Point Average (GPA), but the teachers' off-campus contact and availability do not have any significant relation to GPA. Wang et al. (2013) instead found no effect of a relationship with instructors on achievement, whereas asking teachers for feedback (formal interaction) contributed to academic success.

A sense of belonging or belongingness refers to a perception of acceptance, appreciation, and understanding by others (Riley & White, 2016). A safe and supportive environment with positive interactions among students and between students and teachers may enhance the sense of belonging, particularly among first-year students (Brooman & Darwent, 2014; Keeffe, 2013). Contact with like-minded peers encourages this feeling of belongingness (Riley & White, 2016). Students who lack the sense that they belong at the university are at risk for non-completion of the course program (Severiens, Meeuwisse, Born, 2015; Zepke, Leach, & Prebble, 2006; Zumbunn, McKim, Buhs, & Hawley, 2014). Student-centered small group learning environments seemingly should feel safe and welcoming for students (Eteläpelto, Littleton, Lahti, & Wirtanen, 2005), which may enhance their feeling of belongingness and thus their academic success. On the one hand, peer and teacher interactions may function as antecedents of students' sense of belonging; as Johnson et al. (2007) argue, positive faculty and peer interactions make learning environments more academically and socially supportive. Zumbunn et al. (2014) identify faculty interactions as important predictors of sense of belonging, as manifested in the availability, approachability, flexibility, and respect of the teacher toward students. On the other hand, a learning environment that creates relatively small, cohesive groups may encourage a sense of belonging, because the students get to know one another well and have more frequent opportunities to meet group members (Shapiro & Levine, 1999; Smith, MacGregor, Matthews, & Gabelnick, 2004). In turn, they may sense feelings of belongingness, which further facilitate peer and faculty interactions, which then may contribute to academic success.

In summary, former research indicates that peer and teacher interactions, as well as belongingness, are relevant to academic success, though not always in the same way. In terms of their underlying social mechanisms, it is pertinent to ask: To what extent and how do peer interaction, teacher interaction, and belongingness in different learning environments contribute to academic success? The type of learning environment may have a role, and further research is needed to explore this role in detail. In this research, we focus on two commonly applied learning environments in higher education.

2.2. Student-centered small group learning environments

The actual format of student-centered small group learning varies across universities, but generally, small groups consist of 12–25 students who are guided by a tutor, mentor or teacher (Exley & Dennick, 2004). Two prominent forms, and the research focus of the current study, are learning communities (LCs) and problem-based learning (PBL).

2.2.1. Learning communities (LCs)

Learning communities rely on social constructivism concepts (Kinnucan-Welsch & Jenlink, 1998; Richardson, 2003) and generally entail formally established, small groups of students from a single cohort who share educational activities and coherent curricular experiences (Smith et al., 2004; Tinto, 2000), such that they feature several core characteristics. First, students share their knowledge actively, and through discussion and collaboration, they construct knowledge. Unlike Communities of Practice (Wenger, 1998), in formally embedded LCs, the learning goals are predefined by the study program. Second, LCs are guided by a mentor or teacher who shares knowledge and has individual, personal meetings with students. Third, individual assignments and exams and self-study remain important in this learning environment. Fourth, students attend all courses together and engage in shared curricular experiences (Tinto, 2000). According to MacGregor, Smith, Matthews, and Gabelnick (1997), LCs bring students and faculty together in cohesive groups and enable students to socialize and build peer networks for academic and social support. Finally, LCs encourage intensive contact between students and faculty (Shapiro & Levine, 1999), which may create sense of belonging in a safe learning environment.

Overall, LCs are oriented toward creating a safe environment and interaction and collaboration among community members (i.e., students and mentors/teachers), which may increase students' sense of belonging (Smith et al., 2004; Tinto, 2000). Although LCs align with social constructivism ideals (Kinnucan-Welsch & Jenlink, 1998; Richardson, 2003), the way they stimulate students' knowledge construction may vary. That is, various types of learning communities exist (Lenning & Ebberts, 1999; MacGregor et al., 1997; Smith et al., 2004), including curricular forms (i.e., co-enrollment in courses with a central theme), student types (tailored to a specific group, such as one based on excellence), living-learning formats (on-campus), and classroom forms (i.e., students collaborate and interact in their group and with teachers, as in "Freshmen Interest Groups").

2.2.2. Problem-based learning (PBL)

PBL creates a learner-centered environment, in which "learners are empowered to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem" (Savery, 2006, p. 9; see also Strobel & Van Barneveld, 2009) with six key characteristics (Barrows, 1996; Dochy, Segers, Van den Bossche, & Struyven, 2005; Hmelo-Silver, 2004; Schmidt, Van der Molen, Te Winkel, & Wijnen, 2009; Wijnia, Loyens, & DeRous, 2011). First, learning is student-centered, such that students actively and cooperatively construct their knowledge base, according to their self-formulated learning goals. Second, in PBL environments students collaborate in small groups. Third, these groups are guided and facilitated by a tutor, who stimulates the discussion in the group (e.g., by asking questions), then evaluates and monitors group processes. However, the tutor does not transfer knowledge. Fourth, a problem (i.e., description of a realistic event or phenomenon from daily life) serves as the starting point for learning (Loyens, Rikers, & Schmidt, 2006; Schmidt & Moust, 2000). After reading the problem, students start to discuss and analyse it, using their prior knowledge or common sense. Fifth, in a PBL environment, students have ample time for self-study. Sixth, the number of lectures is limited in this learning environment (Barrows, 1996; Dochy et al., 2005; Hmelo-Silver, 2004; Schmidt et al., 2009; Wijnia et al., 2011).

Overall, in PBL students are trained to work in a certain manner, then scaffold and integrate theory and practice, and finally to apply knowledge and skills to develop a solution to the central problem (Savery, 2006). PBL is considered as learning-centered with a focus on active knowledge and skills construction (Geitz, Joosten-ten Brinke, & Kirschner, 2016).

In sum, comparing the ideas behind the concepts of LCs and PBL, LCs seem to be established to support the individual learning process by creating a safe and affective learning environment, whereas in PBL the group learning and group process seems to be more focal. Therefore, an explorative comparison of the relationships between key concepts from both types of learning environments is the aim of this study to see whether these relationships differ between the two environments.

2.3. Current study

This article contains the results of two studies which were performed in two distinct student-centered small group learning environments (i.e., LC and PBL) in social sciences programs at two different Dutch universities. We explore the following central research question: To what extent are peer interaction, teacher interaction and sense of belonging directly or indirectly related to academic success in two distinct student-centered small group learning environments (i.e., LC and PBL)? Because the small group learning forms might differ in the extent to which, and how, the links of peer interaction, teacher interaction, belongingness, and academic success differ in strength and direction, we explore this in two separate studies in which we test two similar models.

In the LC-context and in the PBL-context we explore which model seems to fit most optimal. In the first model, we propose that peer interaction and teacher interaction relate to belongingness and thus to academic success, in all forms of small group teaching

Fig. 1. Expected relationships of peer interaction, teacher interaction, belongingness, and grade point average (conceptual model 1).

Fig. 2. Expected relationships of belongingness, peer interaction, teacher interaction, and grade point average (conceptual model 2).

(Fig. 1). In the second model, we anticipate that when students feel a sense of belonging to the group in a safe learning environment, it influences the extent to which they interact with their peers and interact with their teachers (Fig. 2). Both studies in the PBL and LC learning environment respectively are conducted in a sample of social sciences students. Social sciences have a rather skewed gender balance with more female students than male students (CBS, 2019). We control for gender, because previous research shows that in general, female students obtain higher grades than male students (Schneider & Preckel, 2017; Voyer & Voyer, 2014) and female and male students differ in their willingness to share knowledge and interact in small groups (Espinosa & Kovárík, 2015).

3. Method

In this comparative and explorative survey design study we report results from two separate studies, carried out at two Dutch universities.

3.1. Sample

For both studies of whole first-year cohorts (2013) were approached in the social sciences faculty with either an LC or PBL learning environment. For the first study first-year social sciences students from a university in the northern part of the Netherlands were asked to participate. We received responses from 333 students (response rate 90%). These students were embedded in LCs and included 88 men (26%) and 245 women (74%), with a mean age of 19.4 years ($SD = 2.1$). On average, 11 or 12 students in each of the 30 LCs participated in this study.

The sample for the second study includes 92 first-year social sciences students from a university in the western part of the Netherlands (response rate 99%). These students were embedded in PBL groups; there were 5 men (5%) and 87 women (95%), with a mean age of 20.8 years ($SD = 4.1$). On average, 10 or 11 students from 9 PBL groups participated in this study.

3.2. Learning environments and research context

3.2.1. Learning communities

The LCs consisted of small groups of 11 or 12 students. The LCs revolve around a central Bachelor-1 course in the social sciences, with weekly mandatory group meetings during the complete academic year, covering academic writing, critical thinking, study behaviors, career preparation, and professionalization. The LC group composition is fixed for all courses in the first semester. After the first semester, the LC group composition is only fixed for the central course. Students thus meet fellow students from other LCs during courses other than the central course. The LCs are guided by a mentor. A mentor teaches the course and conducts feedback meetings with students to discuss, among other things, their academic progress. The mentor is not only a teacher, but also a coach. Therefore, the meetings generally encourage trusting relationships, because they allow for discussions of both academic and personal challenges and circumstances. Extracurricular activities are not formally part of the course program. The group composition of the LCs is made by the educational office in the beginning of the academic year and remains the same for all lectures, tutorials, and practicals during the first semester and for the central Bachelor-1 course during the full academic year. Students in LCs meet frequently and collaborate on assignments in various courses (see Brouwer, 2017).

3.2.2. Problem-based learning

The Bachelor-1 PBL curriculum consists of eight periods of five weeks each. Each five-week period includes a course related to pedagogical or educational sciences (and courses were offered sequentially). In each course, students meet twice per week in small groups with a maximum of 12 students (Wijnia et al., 2011), in which they work under the supervision and guidance of a tutor, who scaffolds students' efforts during problem discussions (Schmidt & Moust, 2000; Schmidt, 1983; see Wijnia et al., 2011 for an extensive description). Two students in the group take turns in the roles of chair and scribe (Loyens, Kirschner, & Paas, 2011). In addition to the two mandatory tutorial group meetings (6 h. per week), an optional lecture takes place once per week (1.5 h.), and there is a mandatory practical session (3 h. per week) (Wijnia et al., 2011).

Ample time (30 h. per week) is reserved for individual self-study. At the end of each five-week period, a course test covers students' recall of the content of that specific course. Furthermore, students' professional behavior as a chair, scribe, and group member is assessed by the tutor. In each five-week course, new groups of students are formed by the educational office. Therefore,

Table 1
Characteristics of learning communities and problem-based learning.

	Learning Communities Dutch university BA Psychology (P) BA Sociology (S)	Problem-based learning Dutch university BA Pedagogical sciences
Focus	Learning environment Creating small groups; safe environment	Teaching method Actively problem solving; Structured learning process around several steps
Level	First-year	First-year
Environment	Classroom	Classroom
Group size	12–13 students	11–12 students
Members	Students Mentor/ teachers	Students Tutors
Objectives	Predefined	Predefined
Learning goals	Predefined	Defined by the students themselves
Composition	Static group composition: Based on assigned enrollment by the university; fixed group composition for all courses in the first semester. Thereafter, fixed composition only for the central course.	Changing group composition: Based on assigned enrollment by university; fixed group during the course, which takes five weeks (8 periods of five weeks per year; group composition differs per period)
Formation	Random; predefined	Random; predefined
Participation	Mandatory	Mandatory tutorial group meetings and practical sessions; lectures optional
Core/central course	Academic skills (P) Study work groups (S)	PBL environment in full Bachelor program
Frequency	All lectures and tutorials. Collaboration during all lectures, tutorials, and group assignments.	Two tutorial group meetings per week (6 hrs.) Weekly lecture (2 hrs.) Weekly practical session (3 hrs.)
Mentor/Teacher guidance	During regular meetings and three times a year in feedback meetings (P). During meetings (S). Mentor is teacher and coach.	During the weekly meeting. Tutor is coach and assessor: assessment of professional behavior; guidance of (social) process.

students participate in eight tutorial groups and eight practical groups during the academic year.

See [Table 1](#) for an overview of the characteristics of both types of learning environments in our studies.

3.3. Procedure

In both the LC and PBL contexts, students were invited to complete a paper-and-pencil questionnaire during an LC meeting or a PBL tutorial group meeting in the final period of Bachelor-1 during the 2013–2014 academic year, i.e., at the end of the academic year (June 2014). Students' background information, including their gender and age, as well as information about their academic success, was obtained from either the university administration office (LC context) or the university database (PBL context).

In advance of the survey, students were informed about the research aims and procedure and gave their consents to obtaining their grades for research purposes. All students participated voluntarily. In accordance with the regulations of the Central Committee on Research Involving Human Subjects (CCMO) in the Netherlands, the data were stored anonymously.

3.4. Measurements

Peer interaction, teacher interaction, and belongingness were measured in both LCs and PBL learning environments. Although the surveys in the learning environments differed, the scales reflected the same concepts, as used in prior research ([Meeuwisse et al., 2010](#); [Severiens, Ten Dam & Blom, 2006](#)). The wording of the items of the different scales represents the content of the construct in the specific learning environment (i.e. LC and PBL), which implies content validity of the scales in these learning environments ([Drenth & Sijtsma, 2006](#)). The wording of the items also represents the difference between the teachers in the PBL-context and the mentor as a teacher and a coach in the LC-context. We describe the general measures including a specification of similarities and differences below; for an overview of the wording and factor loadings of the items in the surveys for the two learning environments, see [Table A1](#) in the [Appendix A](#).

All students answered the questionnaire items on 5-point rating scales, ranging from 1 = “strongly disagree” to 5 = “strongly agree.” The scales measuring the key concepts, namely, peer interaction, teacher interaction, and belongingness, are internally consistent in both learning environments; the Cronbach's alphas vary between 0.71 to .87. [Table 2](#) contains the scale descriptives.

3.4.1. Peer interaction

The three-item scale for peer interaction, indicating to what extent students perceive study-related interactions with their fellow students, came from a formal social interaction scale ([Meeuwisse et al., 2010](#); [Severiens et al., 2006](#)). Example items are, “Fellow students listen to my remarks” and “I work well with fellow students.” The third item of the scale was phrased differently in the LC and PBL contexts, respectively, ‘I learn from my fellow students through discussion, collaboration, etc’ and ‘Contact with fellow students has a positive influence on my study performance’. Despite this difference in phrasing, both items represent formal peer

Table 2

Scale reliability, descriptive statistics, and bivariate correlations for each learning environment.

		α (k)	M	SD	1	2	3	4
LCs								
1.	Peer interaction	.74 (3)	3.92	.50	1.00			
2.	Teacher interaction	.78 (5)	3.57	.68	.25**	1.00		
3.	Belongingness	.87 (2)	3.96	.67	.49**	.28**	1.00	
4.	Academic success		5.64	1.72	.02	-.19**	.16*	1.00
PBL								
1.	Peer interaction	.71 (3)	3.76	.65	1.00			
2.	Teacher interaction	.71 (4)	3.26	.67	.38**	1.00		
3.	Belongingness	.77 (2)	3.89	.74	.46**	.34**	1.00	
4.	Academic success		6.64	.91	.26*	-.03	.22*	1.00

Note. ** $p \leq .001$. * $p \leq .05$.

interaction.

3.4.2. Teacher interaction

Teacher interaction reflected how students perceived the availability of their teachers, the option to ask questions, and the perceived impact of such contact on their academic progress. These items come from a formal academic interaction scale, focused on the interaction between students and teachers (Meeuwisse et al., 2010; Severiens et al., 2006). The first three items of the teacher interaction scale are similar in the PBL and LC-context. Example items include, “Teachers take the time to answer my questions, e.g. after lectures” or “Teachers have time to answer questions.” The other items represent the differences of the learning environment. Because the mentor is a coach in the LC, two items were added to the survey in the LC-context which measure the specific role of the mentor for the students, i.e., the interest of the mentor perceived by the students and the extent the mentor influences students’ academic performance. In the PBL-context, one item was added which measures the extent that teachers know the qualities of their students. Overall, the items represent formal teacher interaction within each of the context.

3.4.3. Belongingness

Belongingness was measured with items that indicate to what extent students like to be at the university, such as “I like going to the faculty” or “I like the atmosphere here.” These items were derived from the sense of belonging scale provided by Meeuwisse et al. (2010).

3.4.4. Academic success

The measure of academic success relied on weighted average grades, calculated by weighing students’ grades by the achieved credit points (European Credits), divided by the maximum credit points students could have obtained after one academic year (i.e., 60 credit points).

3.5. Statistical analyses

The proportion of missing cases varied between 2.4% (academic success) and 23.6% (peer interaction, teacher interaction, belongingness). The Little’s MCAR (missing completely at random) test resulted in a significant chi-square, indicating that the data were not missing completely at random ($\chi^2(14) = 136.17$, $p < .001$). The variables are MAR (missing at random), because they relate to the observed data. For the analysis, the missing values were replaced using SPSS version 23, which imputed the missing data five times (e.g., De Leeuw, Hox, & Huisman, 2003; Little & Rubin, 1987).

To address the central research question, we applied path analysis in MPlus Version 7.2 (Muthén & Muthén, 1998-2013; Muthén & Muthén, 1998). Students were nested in LCs or PBL groups, so both studies controlled for interdependency among the fellow students in the same group, using maximum likelihood estimation with robust standard errors (MLR) to adjust for the standard errors, which is also appropriate for handling MAR. Several indices indicate the overall goodness of fit of the tested model, including the ratio of the chi-square and degrees of freedom (χ^2/df), comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square (SRMR). Indications of good fit are a nonsignificant χ^2/df ratio, RMSEA values less than 0.06, SRMR at 0.08 or below, and CFI and TLI close to or greater than .95 (Hu & Bentler, 1999; Kline, 2011). Bias-corrected bootstrapped 95% confidence intervals (CI) also reveal the indirect effects (Shrout & Bolger, 2002).

4. Results

4.1. Descriptive statistics and correlations

Table 2 contains, in addition to the reliabilities, means, and standard deviations of the scales, the bivariate correlations among the

Table 3

Standardized estimates of model 1 and model 2 for academic success (GPA) at the end of the first year in the LC and PBL environments.

Variables	Model 1 LCs Standardized coefficients (SE)	Model 1 PBL Standardized coefficients (SE)	Variables	Model 2 LCs Standardized coefficients (SE)	Model 2 PBL Standardized coefficients (SE)
Belongingness^a			Peer interaction^a		
Peer	.45**	.39*	Belongingness	.49**	.46**
interaction	(.06)	(.12)		(.05)	(.11)
Teacher	.16**	.19	Teacher interaction^a		
interaction	(.05)	(.14)	Belongingness	.28**	.34*
				(.06)	(.10)
GPA^a			GPA^a		
Belongingness	.22**	.16	Belongingness	.22**	.16
	(.07)	(.10)		(.06)	(.10)
Peer	-.02	.25**	Peer	-.02	.25*
interaction	(.04)	(.06)	interaction	(.06)	(.09)
Teacher	-.26**	-.18*	Teacher	-.26**	-.18
interaction	(.06)	(.09)	interaction	(.06)	(.10)
Gender	.16*	.02	Gender	.16*	.02
	(.06)	(.07)		(.06)	(.05)
Fit indices					
χ^2 (df)	6.78 (3)	2.60 (3)	χ^2 (df)	2.11(2)	1.10 (2)
CFI	.962	1.00	CFI	.999	1.000
TLI	.912	1.03	TLI	.996	1.087
RMSEA	.062	.000	RMSEA	.013	.000
CI 90%	[.00; .12]	[.00;.17]		[.00;.11]	[.00;.17]
SRMR	.034	.023	SRMR	.016	.018

Notes. $N_{PBL} = 92$; $N_{LC} = 333$. In all models, peer interaction correlates significantly with teacher interaction (model 1 LCs: .25**; model 1 PBL: .38*; model 2 LCs: .14*; model 2 PBL: .26*).

^a Endogeneous variables.

** $p \leq .001$.

* $p \leq .05$.

variables for the two learning environments. The average scores on the social factors (i.e., peer and teacher interaction and belongingness) were slightly higher in LCs than in PBL settings. The bivariate correlation analysis also shows that peer interaction, teacher interaction, and belongingness relate positively to one another in LCs and in PBL settings. Surprisingly, in LCs teacher interaction relates negatively to academic success, but for PBL, we find no significant correlation. In both learning environments, belongingness relates positively to academic success.

4.2. Path analysis

To test the conceptual models, featuring the expected relationships of peer interaction, teacher interaction, belongingness, and academic success at the end of the academic year, while controlling for gender, we relied on path analyses. For our research aim, to gain an understanding of the factors that affect academic success in different student-centered small group learning environments, we need to test the conceptual models in the learning environment contexts separately. Then we can explore and compare how academic success might be explained by different social aspects in each learning environment, directly or indirectly. Table 3 shows the standardized estimates of models 1 and 2 for academic success derived from both conceptual models (Figs. 1 and 2); Fig. A1 (Appendix A) depict the preferred model for the LC. For the PBL context, both models are equally preferred and therefore depicted in Figs. A2 and A3, respectively.

4.2.1. Learning communities

We test the first conceptual model (Fig. 1) in the LC environment, with an indirect effect for peer interaction and teacher interaction on academic success through belongingness, as well as direct effects of peer interaction and teacher interaction on academic success, while controlling for gender. The fit indices for this model reveal $\chi^2(3) = 6.78$, $p = .08$, CFI = .962, TLI = .912, RMSEA = .062 [.000;.124], and SRMR = .034. Peer and teacher interactions relate indirectly to academic success through belongingness ($b^*_{\text{peer}} = .10$, 95% CI [.04; .16]; $b^*_{\text{teacher}} = .04$, 95% CI [.01; .07]). Teacher interaction indicates a negative relationship with academic success.

For the second conceptual model (Fig. 2) in the LC environment, we include an indirect effect for belongingness on academic success through peer interaction and teacher interaction, while again controlling for gender. The model fit is good: $\chi^2(2) = 2.11$, $p = .35$, CFI = .999, TLI = .996, RMSEA = .013 [.00;.11], and SRMR = .016. We find an indirect, negative effect of belongingness on academic success through teacher interaction, while controlling for gender ($b^* = -.07$, 95% CI [-.11; -.03]). Belongingness relates directly and positively to academic success; peer interaction shows a non-significant relation to it.

4.2.2. Problem-based learning

The test of the first conceptual model (Fig. 1) in the PBL environment provides the following fit indices, suggesting a good fit of the data: $\chi^2(3) = 2.60$, $p = .46$, CFI = 1.00, TLI = 1.03, RMSEA = .000 [.00;.17], and SRMR = .023. Peer interaction is positively related, and teacher interaction negatively related, to academic success at the end of the year. Peer interaction contributes positively to the feeling of belongingness, but it is not subsequently related to academic success. We find no indirect effects.

In contrast with the LC context, in the second model in the PBL context, belongingness relates only indirectly to academic success through peer interaction ($b^* = .12$ [.01, .23]). Belongingness contributes positively to teacher interaction, but teacher interaction does not enhance academic success. The model yields a good fit to the data: $\chi^2(2) = 1.10$, $p = .58$, CFI = 1.00, TLI = 1.09, RMSEA = .000 [.00;.17], and SRMR = .018.

4.2.3. Model comparison

We cannot statistically test which model is optimal, because the models are not nested (Kline, 2011), but we used fit indices to determine that the second model is preferable to the first model in the LC context (cf. TLI). In the PBL context, the preferred model is equivocal. Based on parsimony, the first model would be preferable to the second model. To be more specific, this first model is more parsimonious with higher degrees of freedom than the second model. However, the second model may be equally preferred because of similar relative fit indices close to the maximum values of CFI and TLI and close to the minimum values of RMSEA and SRMR.

Comparisons of the two models in the LC and PBL contexts reveal that in the LC setting (Table 3), belongingness directly and positively contributes to academic success (Fig. A1), whereas in the PBL setting, peer interaction contributes to academic success directly and positively (Figs. A2 and A3). Belongingness is not related to academic success for PBL (Fig. A2), but belongingness is related to peer interaction (Fig. A3). In both contexts, teacher interaction relates negatively to academic success, but for PBL, it is marginally significant in the first model (Fig. A2) and non-significant in the second model (Fig. A3).

Overall, belongingness and peer interaction seem to have different roles in the two learning environments, such that in LCs, belongingness contributes directly to academic success, whereas for PBL, peer interactions make this direct contribution. Furthermore, in LCs, belongingness contributes to peer interaction, but peer interaction does not influence academic success. For PBL, peer interaction relates to belongingness (Fig. A2) and belongingness relates to peer interaction (Fig. A3). Yet belongingness does not enhance academic success (Fig. A2) or only indirectly through peer interaction (Fig. A3).

5. Conclusions and discussion

Modern universities increasingly implement student-centered small group learning environments in their curricula, but little is known about which social factors contribute to academic success in varied environments or how they do so. Despite some inconclusive findings about the effects of social factors, such as peer interaction, teacher interaction, and a sense of belonging, on academic success, active learning and knowledge construction seemingly should enhance academic success (Hotchkiss, Moore, & Pitts, 2006; Stassen, 2003; Yorke & Thomas, 2003; Zepke et al., 2006). Various learning environments might focus on different elements, such that they vary in the extent to which and how social factors contribute to academic success. This article extends previous research by exploring how three social factors - peer interaction, teacher interaction, and sense of belonging - contribute to academic success in two distinct, student-centered, small group learning environments.

The current article thus expands the evidence showing that LCs and PBL contribute to academic success, but in different ways. Beyond the tests of the models in each learning environment, the explorative model comparison shows that in LCs, belongingness contributes positively to academic success, whereas in PBL peer interaction contributes directly to academic success. Bearing in mind that the sample of PBL was rather small and that the relative fit indices were equivocal, these findings suggest that LCs provide a safe learning environment, in which students feel a sense of belonging, whereas for PBL through students' interactions the focus is on academic aspects, such as building knowledge about a central problem. These findings are consistent with the most prominent mechanisms of the two learning environments. In a LC context, cohesive small groups form and encourage safety and belongingness (Shapiro & Levine, 1999; Smith et al., 2004); in a PBL context, formal interactions with fellow students are stimulated, encouraging collaboration and discussion of central problems (Loyens et al., 2006; Schmidt & Moust, 2000).

Surprisingly, we find a negative effect of teacher interaction on academic success in both contexts. We measured this form of interaction by the perceived availability of teachers and their willingness to answer questions. Komarraju et al. (2010) similarly find no significant impact of teachers' availability on academic success. When students perceive that teachers are involved and available, it does not mean they actually make use of or approach the teachers for support. Accordingly, further research should specify distinct kinds of interactions between students and teachers and their varying impacts on academic success. Another explanation might be that weaker students need to interact more with teachers and mentors, to explain the subject matter or study skills. When students are successful, they might consider their teachers less involved, simply because the teachers did not sense a need to approach them to provide extra assistance. In further research, a more qualitative approach (e.g., interviews with students) could shed light on the possible reasons for the negative relation between teacher support and achievement (Ritchie, Lewis, McNaughton Nicholls, & Ormston, 2014).

This research offers a novel explorative comparison of two student-centered small group learning environments at two universities and explores different conceptual models. Along with these strengths, it contains some limitations. First, the two learning environments differ in more ways than their respective small group designs. In addition to regional differences, the specific social science discipline (sociology and psychology for LCs, pedagogical sciences in PBL) as well as the gender balance differs. Moreover, because of the difference in number of respondents the statistical power for the PBL analysis was lower. This could affect the outcomes. Therefore, it will be important to replicate these studies in different learning environments and fields of study and possibly

with multiple cohorts for every learning environment under study, which will increase the power of the statistical analysis. It should be noted that because of the variation in group processes within LC contexts (Lenning & Ebbers, 1999; MacGregor et al., 1997; Smith et al., 2004), it seems more challenging to replicate the findings in the LC-context than in the PBL context. The PBL-context has a more pre-defined structure of the learning process, though also here variation may exist (Dochy, Segers, Van den Bossche, & Gijbels, 2003; Wijnia et al., 2011). Second, our studies are cross-sectional rather than longitudinal, so causal inferences are impossible. Continued research might test our conceptual models longitudinally to draw causal inferences. Third, we used self-reports only; the external validity of our findings could be increased by adding observations of interactions, perhaps obtained with video recordings of the small groups. Fourth, the two studies measure similar concepts, which allows for comparisons, but the instruments are not identical in both learning contexts, due to slightly differences in the terminology used in LCs and PBL (e.g., “The mentor or study advisor is available to me” versus “Teachers are available to their students”). This variation requires caution when interpreting the differences in results. However, the measures of peer interaction, teacher interaction, and belongingness were all estimated with items derived from existing scales (Meeuwisse et al., 2010; Severiens et al., 2006), which should minimize these possible differences.

To conclude, the findings of the current research reveal how different social factors may contribute to academic success in LCs and PBL groups. The different focus in each learning context may be traced to their outcomes. The safe and social environment of the LC context with its focus on cohesive group formation fosters belongingness and hence peer interaction, but does not contribute to academic success, whereas a sense of belonging enhances academic success directly. In a PBL context, with its focus on collaboratively analysing and solving a problem, peer interaction relates directly to academic success. Although students perceive, on average, less peer interaction with PBL than in LCs, this form of interaction contributes to academic success directly in PBL settings. The findings thus may imply that different foci in learning environments seem to create different pathways to academic success. Combining PBL with LCs might offer a good way to provide students with a learning environment that optimizes their belongingness while also increasing their academic success. We leave that question to further research.

Appendix A

Fig. A1. Preferred (second) model in LC context based on fit indices.
Notes. Significant ($p < .05$) and standardized coefficients are displayed.

Fig. A2. Preferred (first) model in PBL context based on parsimony.
Notes. Significant ($p < .05$) and standardized coefficients are displayed.

Fig. A3. Preferred (second) model in PBL context based on relative fit indices.
Notes. Significant ($p < .05$) and standardized coefficients are displayed.

Table A1
Overview of items applied in two learning environments.

Items (translated into English)	LCs	Factor loading	PBL	Factor loading
Peer interaction	Fellow students listen to my remarks.	.814	Fellow students listen to my remarks.	.852
	I collaborate well with fellow students.	.886	I collaborate well with fellow students.	.889
	I learn from my fellow students through discussion, collaboration, etc.	.729	Contact with fellow students has a positive influence on my study performance.	.639
Teacher interaction	The mentor or study advisor is available to me.	.635	Teachers are available for their students.	.859
	My mentor asks me enough about my studies.	.793	Teachers approach me to enquire about my study progress.	.620
	Teachers take the time to answer my questions (e.g., after lectures).	.541	Teachers have time to answer questions.	.699
	The mentor is interested in my studies.	.887		
	Contact with the mentor positively influences my academic performance.	.770		
Belongingness	I like the atmosphere here.	.939	Teachers know my qualities.	.730
	I like going to the faculty.	.939	I enjoy the atmosphere here. I like to come to the faculty.	.903 .903

Note. Factor loadings based on an exploratory factor analysis.

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