

Virtually Isolated: Social Identity Threat Predicts Social Approach Motivation via Sense of Belonging in Computer-Supported Collaborative Learning

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19 Abstract

20 Collaboration improves multiple academic and social outcomes. Accordingly, computer-supported
21 collaborative learning (CSCL) can be beneficial in distance education contexts to overcome the
22 issues specific to online learning (e.g., underperformance, low identification with university).
23 Distance universities often attract a substantial number of non-traditional students (e.g., students with
24 disability, students with migration background). Despite their representation, non-traditional students
25 face negative stereotypes and associated social consequences, including social identity threat,
26 diminished sense of belonging, and less motivation for social interactions. In the context of online
27 learning, where there is little individuating information, social categories like socio-demographic
28 group memberships become salient, activating stereotypes. Consequently, socio-demographic group
29 memberships can have detrimental consequences for the integration of non-traditional students. The
30 purpose of the present study was to a) determine the extent of social identity threat for students in
31 higher distance education, b) explore the social consequences of this threat in the same context, c)
32 validate these findings through longitudinal analyses embedded in a CSCL task, and d) use learning
33 analytics to test behavioral outcomes. In a longitudinal study with three measurement occasions over
34 eight weeks ($N = 1,210$), we conducted path analyses for cross-sectional associations and Random

35 Intercept Cross-Lagged Panel Models for longitudinal predictions. The results showed that non-
36 traditional students mostly reported higher social identity threat than traditional students. While the
37 expected longitudinal within-person effects could not be demonstrated, we found stable between-
38 person effects: students who reported higher levels of social identity threat reported also lower social
39 approach motivation mediated by lower sense of belonging. Exploratory analyses of actual online
40 collaboration during CSCL offer potential avenues for future research. We conclude that social
41 identity threat and its social consequences play an important role in higher distance education and
42 should therefore be considered for successful CSCL.

43 **1 Introduction**

44 Underperformance, dropout, and low identification with the university are commonly discussed
45 issues in higher distance education (e.g., Stoessel et al., 2015). Computer-supported collaborative
46 learning (CSCL) is a promising format to address these issues (Kirschner et al., 2004). Collaborative
47 learning formats are associated with positive academic and social outcomes, such as improved
48 performance and class attendance, student familiarity with the faculty, and understanding of diversity
49 (Panitz, 1999; Roberts, 2005). CSCL uses technology to improve learning in the context of reading
50 and writing tasks (Stahl et al., 2006) through collaboration. Research has shown that the key aspect
51 of collaboration, namely social learning (Roschelle & Teasley, 1995), is associated with improved
52 academic achievement (Talan, 2021), more frequent interactions with peers (Shin et al., 2020), and
53 problem-solving skills. CSCL thus has the potential to address the described issues related to
54 academic and social outcomes in higher distance education.

55 The high degree of temporal and spatial flexibility in higher distance education leads to a
56 heterogeneous student body and an overrepresentation of non-traditional students at distance
57 education institutions (i.e., students from sociodemographic groups who have been underrepresented
58 in higher education in the past; e.g., students with disability, students with migration background
59 Schneller & Holmberg, 2014; Stoessel et al., 2015). However, non-traditional students are
60 particularly at risk of underachievement and dropping out of higher education (Stoessel et al., 2015).
61 Therefore, we argue that given the above-mentioned advantages, digital collaborative learning can be
62 beneficial especially for non-traditional students. Moreover, the reduction of performance gaps
63 between traditional and non-traditional students is an important goal especially at higher distance
64 education institutions (Stoessel et al., 2015) and could be motivated by diversity being associated
65 with several advantages for all students, e.g., increased intercultural competencies, understanding,
66 and empathy, better preparation for employment in the global economy, or increased engagement in
67 political issues and participation in democratic processes (Stuart Wells et al., 2016). Furthermore, the
68 financial and reputation-related losses due to student dropout from the universities' perspective
69 (Raisman, 2013) might contribute to the motivation to reduce academic underperformance of specific
70 groups.

71 **1.1 Social Identity Threat as a Potential Risk in Higher Distance Education**

72 Despite the advantages of higher distance education for non-traditional students and the potential
73 benefits of CSCL described above, social-psychological research has identified risks of increased
74 stereotyping and associated negative consequences for non-traditional students during computer-
75 mediated communication. In the current research we investigate CSCL in the form of a collaborative
76 writing task spanning several weeks. This type of CSCL predominantly involves asynchronous
77 computer-mediated communication, where information about individual traits and characteristics of a
78 person (i.e., individuating information) is less frequent than information about social category

79 memberships (e.g., age, gender, ethnicity). Social categories are more salient compared to face-to-
80 face contexts (Postmes et al., 2001; Spears et al., 2002) and we therefore assume that stereotypes
81 associated with social categories are prone to be activated in CSCL as investigated in the current
82 research.

83 The diverse student body in higher distance education includes numerous student groups that are
84 stereotypically associated with low academic competence (e.g., students with chronic illness,
85 students with non-German native language; Bick et al., 2022). These student groups are thus at risk
86 of experiencing detrimental consequences when negative competence-related stereotypes are
87 activated. One prominent consequence of stereotype activation is social identity threat (Schmader et
88 al., 2008; Spencer et al., 2016; Steele & Aronson, 1995). According to social identity theory (Tajfel
89 & Turner, 1979), people strive for a positive social identity (i.e., a positive differentiation or
90 distinction of one's own group from other groups). Negative stereotypes threaten this positive social
91 identity, which leads to impairments in various domains. For example, as second-language learners
92 are often stereotypically associated with low verbal competence, a student with non-native language
93 might worry that their contributions in a collaborative writing task might be negatively evaluated by
94 others in the CSCL group. This worry in turn makes it more difficult for them to show their full
95 intellectual potential and feel like they fit in at university and the CSCL group. A large number of
96 studies has shown performance-related consequences of social identity threat in face-to-face contexts,
97 e.g., for women (Bell et al., 2003; Schmader, 2002), older people (Hess et al., 2003; Lamont et al.,
98 2015), or immigrants (Appel et al., 2015 Steele & Aronson, 1995). However, to our knowledge a
99 systematic investigation of social identity threat in higher distance education is still lacking.
100 Additionally, a first study about widespread stereotypes about student groups in distance education
101 showed that stereotypes about student groups are to some extent specific to the context of higher
102 distance education (e.g., positive evaluation of older students; Bick et al., 2022). Therefore, the first
103 aim of the current research is to investigate the extent of social identity threat experienced by
104 students identifying with different sociodemographic student groups at a large German distance
105 university.

106 **1.2 Consequences of Social Identity Threat for Social Relationships**

107 In addition to the well-investigated performance-related consequences of social identity threat, a
108 growing body of research focuses on social consequences of social identity threat (Froehlich et al.,
109 2022; Good et al., 2012; Martiny & Nikitin, 2019; Rahn et al., 2021). As CSCL is inherently a social
110 activity, the second aim of the current research is therefore to investigate these social consequences
111 of social identity threat in higher distance education. One consequence is that people turn away from
112 the academic field in which the negative stereotype occurs and no longer identify with it (Steele et
113 al., 2002; Woodcock et al., 2012). Accordingly, disidentification from academia is most common
114 among students who face negative stereotypes in higher distance education, i.e., non-traditional
115 students (e.g., Gopalan & Brady, 2020). One aspect of disidentification is the questioning of one's
116 social ties and the feeling of not "fitting in" (i.e., belonging uncertainty; Walton & Cohen, 2007). A
117 lower sense of belonging to academia is in turn associated with academic disadvantage (Good et al.,
118 2012; Mahoney & Cairns, 1997; Walton & Cohen, 2011) as well as lower engagement for studying
119 and lower intention to stay at university, particularly for ethnic minority students (Just, 1999; Wolf et
120 al., 2021; Zea et al., 1997). Non-traditional students might therefore be disadvantaged due to a lack of
121 social connectedness (Yildirim et al., 2021).

122 Most research on sense of belonging in the educational domain focuses on students' sense of
123 belonging to academia in general or to their academic institution (e.g., Abdollahi & Noltemeyer,

124 2018; Martiny & Nikitin, 2019; Meeuwisse et al., 2010). Differentiating specific domains to which
125 students report they belong led to a more accurate understanding of which domain is relevant to
126 students in different contexts (e.g., Good et al., 2012). In higher distance education, students might
127 only weakly identify with the university as they rarely visit the campus. When students collaborate in
128 virtual study groups, their sense of belonging to the study group might in fact be more important than
129 their sense of belonging to the university. Research with high-school students in face-to-face
130 education has shown different findings with regard to sense of belonging to the class or school
131 (Froehlich et al., 2023). Therefore, in the present research we assess sense of belonging to the CSCL
132 group and to the university. We expect sense of belonging to the CSCL group to be closer to social
133 identity threat and our outcome variables related to social relationships. We also investigate whether
134 the results with sense of belonging to the university are comparable to the results with sense of
135 belonging to the CSCL group.

136 The main outcome variables in the current research are students' motivation and behavioral
137 tendencies to form peer relationships and their collaboration behavior during the CSCL task. We base
138 our predictions for these outcome variables on previous research conducted in face-to-face learning
139 contexts, extend the research focus to computer-mediated communication, and use learning analytics
140 to shed light on the potential social consequences of social identity threat in CSCL. In studies with
141 immigrant students in Norway and Germany, students who reported higher social identity threat also
142 reported lower sense of belonging (Froehlich et al., 2022, 2023). In addition, these studies examined
143 sense of belonging as a mediator between social identity threat and social approach motivation, as
144 well as behavioral intentions for contact as outcome measures for social connectedness. Social
145 approach motivation (i.e., the motivation to initiate and maintain social relationships; Elliot et al.,
146 2006) is associated with less loneliness and more satisfaction with social ties (Gable, 2006), which in
147 turn is associated with physical health and subjective well-being (Hawkey & Cacioppo, 2010;
148 Nikitin et al., 2012). Especially for non-traditional students who are struggling with family
149 obligations or chronic illness, or who have difficulties in accessing information due to language
150 difficulties, social approach motivation in educational contexts might play a crucial role, as social
151 relationships at university bring study-related advantages (e.g., Ma & Yuen, 2011; Raaper et al.,
152 2022).

153 **1.3 Methodological Advancements when Investigating Social Identity Threat in Distance** 154 **Education: Longitudinal Analysis and Learning Analytics**

155 Previous research has found that sense of belonging mediates the relationship between social identity
156 threat and social approach motivation among participants with different social identities, of different
157 age, and in different European countries (Froehlich et al., 2022, 2023; Martiny & Nikitin, 2019; Rahn
158 et al., 2021). The present study aims to replicate these findings with heterogeneous student groups in
159 higher distance education and thus to corroborate the generalizability of the effect. Moreover, the
160 social consequences of social identity threat have so far mainly been investigated in cross-sectional
161 studies which provide only limited evidence on the directionality of the effects. The third aim of the
162 present research is therefore to investigate the mediation of social identity threat and social approach
163 motivation by sense of belonging in a longitudinal design to test the proposed directionality of
164 effects. CSCL tasks often involve collaboration over several weeks during the semester so that
165 multiple measurement occasions can be integrated into the online learning environment. A
166 longitudinal design allows us to test whether associations can be replicated at the level of individual
167 students (within-person effects), while the between-person effects are statistically accounted for in a
168 Random Intercept Cross-Lagged Panel Model (RI-CLPM; Hamaker et al., 2015). Thus, within- and
169 between-person effects that have been confounded in previous cross-sectional studies can be

170 disentangled to investigate whether the hypothesized associations of social identity threat, sense of
171 belonging, and social outcomes are between-person (i.e., reflecting a stable rank order between
172 students in classrooms or distance education courses) or within-person (i.e., reflecting psychological
173 processes that unfold over time at the intraindividual level).

174 The fourth and final aim of the present research is to expand the outcome variables concerning the
175 social consequences of social identity threat and make use of behavioral data available through
176 learning analytics in the context of distance education. To complement previous research in face-to-
177 face contexts (Froehlich et al., 2022), we assessed the same self-report outcome variables of social
178 approach motivation and behavioral intentions for contact with other students. The assessment of
179 behavioral intentions is common in social psychology because the measurement of actual behavior is
180 difficult and resource-intensive in many traditional study designs. However, there is usually a gap
181 between intentions and actual behavior (Webb & Sheeran, 2006). The mainly asynchronous CSCL
182 context of the present study, in which students' behavior is stored in databases and logfiles, provided
183 a unique opportunity to combine established self-report measures with measures of student behavior
184 in virtual groups using collaborative distance learning tools. To this end, we used data from students'
185 interactions around a collaborative writing task to conduct social network analysis directly reflecting
186 the social relationships between students. This data refers to the group communication and
187 coordination in a course-related Moodle forum and the actual shared writing process in a real-time
188 collaborative text editor.

189 **1.4 The Present Research and Hypotheses**

190 Based on the considerations outlined above, we argue that low social identity threat, high sense of
191 belonging, and high social approach motivation are important prerequisites to successful CSCL.
192 Furthermore, we are convinced that collaboration can be especially beneficial for non-traditional
193 students who are overrepresented in higher distance education. Thus, the higher distance education
194 context is very suitable for the investigation of the role of social identity threat and sense of
195 belonging for social approach motivation and peer relationships. Accordingly, the aims of the present
196 study are threefold. First, we aim to descriptively investigate perceived social identity threat for
197 different student groups to identify groups who are particularly at risk for social identity threat in
198 higher distance education. Second, we expect to replicate the cross-sectional findings on the
199 relationship between social identity threat and social approach motivation via sense of belonging,
200 previously shown in face-to-face contexts (e.g., Froehlich et al., 2022, 2023; Martiny & Nikitin,
201 2019), in the context of higher distance education. Third, we apply data-driven methods in a
202 longitudinal field study to validate self-report findings with data from actual learner interactions over
203 time. We apply a learning analytics approach combining self-report data and behavioral data. During
204 a CSCL task spanning several weeks, we collected self-report data at multiple occasions. In addition,
205 we collected fine-grained process data (e.g., Moodle forum activity, writing/ deleting/ copying/
206 pasting/ formatting text) of learning activities taking place within the online learning environment. At
207 the beginning of the semester, students participated in a demographic survey (T0). After being
208 assigned to the CSCL groups and a phase of getting to know each other, students participated in the
209 first survey (T1). This was followed by two working phases of the CSCL task with an interim survey
210 (T2) and a final survey (T3).

211 We investigated the following pre-registered research question (RQ) and Hypotheses (H;
212 https://osf.io/rymzb/?view_only=be9aae0da8fa41028d13f68a0da6d3e3): We descriptively
213 investigated perceived social identity threat for different student groups at different measurement
214 occasions (RQ). We hypothesize a simple cross-sectional mediation with higher social identity threat

215 negatively predicting self-reported social approach motivation via a lower sense of belonging at T1
216 (H1). Further, we hypothesize a serial cross-sectional mediation with social identity threat as the
217 predictor, sense of belonging and social approach motivation as mediators, and self-reported
218 behavioral intentions as outcome at T1 (H2). Third, in a simple longitudinal mediation model, we
219 expect higher social identity threat at T1 to negatively predict social approach motivation at T3 via
220 lower sense of belonging at T2 (H3). Furthermore, in another longitudinal mediation model, we
221 expect that higher social identity threat at T1 negatively predicts the behavioral measure of the
222 individuals' integration in the CSCL group during the final cooperation phase (between T2 and T3)
223 via a lower sense of belonging at T2 (H4).

224 **2 Materials and Methods**

225 The study was conducted in accordance with open science principles (pre-registration of Hypotheses,
226 open materials, open data). The pre-registration, materials, data, and script can be found on the OSF:
227 (https://osf.io/axq7k/?view_only=4493ac1e1358486baa61457cc4305007).

228 **2.1 Participants and Data Collection**

229 Data collection for this study was embedded in a superordinate project implemented in a mandatory
230 course of the introductory module of the Bachelor's degree program in psychology at a large distance
231 university. The beginning of the Bachelor's degree is an important academic transition to higher
232 distance education. In addition, it provides the best opportunity to investigate social identity threat
233 and its consequences, as the dropout rate is highest in the first two semesters when the introductory
234 module takes place (Neugebauer et al., 2019). During the course, students interacted in a course-
235 related Moodle forum. The longitudinal design consisted of three voluntary measurement occasions
236 with self-report questionnaires in Unipark¹ with two- or three-week intervals. At the beginning of the
237 semester, students completed a demographic survey (T0). They were then assigned to CSCL groups
238 of eight and had two weeks to get to know each other. The first main measurement (T1) was
239 conducted before the first CSCL phase started. The first CSCL phase consisted of three weeks in
240 which students collaborated to summarize the introduction and the methods sections of a peer-
241 reviewed journal article. The second measurement (T2) was conducted afterwards. The subsequent
242 second CSCL phase again consisted of three weeks in which the results and discussion sections of the
243 same article were summarized, followed by the final measurement (T3). Both CSCL tasks were
244 completed online in individual Etherpad Lite instances² for each CSCL group which were provided
245 by a Collaborative Learning Platform to support collaborative writing in large-scale distance
246 education (Burchart & Haake, 2023). Each CSCL group was provided with an individual Etherpad
247 Lite instance containing only the Etherpad documents (Pads) of the particular group. Therefore, the
248 actual collaboration took place during the working phases in the shared text documents of the group,
249 whereas the Moodle forum served as a communication platform during all three phases. The self-
250 report measures (i.e., social identity threat, sense of belonging, social approach motivation,
251 behavioral intentions for contact) were presented in the final section of the superordinate project's
252 survey at three measurement occasions (T1-T3). Students were informed about data protection, the
253 content and duration of the survey, and provided written consent for participation according to EU
254 General Data Protection Regulations and research ethics guidelines by the American Psychological
255 Association (APA), the German Psychological Association (DGPs), and the Declaration of Helsinki

¹ <https://www.unipark.com/>

² <https://github.com/ether/etherpad-lite>, <https://etherpad.org/>

256 (World Medical Association Declaration of Helsinki, 2013). First, the students were asked to indicate
257 which student group(s) they identified with. Then, social identity threat items were answered for each
258 group with which the students had previously identified. Next, items on sense of belonging to the
259 university and the CSCL group, social approach motivation, and behavioral intentions for contact
260 were completed. Finally, the students provided written consent to the scientific use of their data. To
261 match data from the surveys, students generated an individual pseudonymized code. Survey data
262 were matched with behavioral data from Moodle and Etherpad Lite by an independent data trustee.
263 Since data were collected using three different systems (Unipark, Moodle, Etherpad Lite) students
264 were assigned to individual identifiers in each system. It was ensured that none of the researchers
265 involved had technical access to more than one of these three systems. The data trustee replaced the
266 respective identifiers of the individual systems with a unique key for each student. The unique key
267 consisting of a 41-digit hexadecimal code was generated using a hash function including a secret salt.
268 For ensuring data privacy requirements, this unique key can only be related to the identifiers of the
269 three systems by the data trustee but not by the involved researchers, administrators, or teachers.

270 Data were collected from October to December 2022. Survey participation was compensated with
271 course credit. We applied the following pre-registered exclusion criteria: After excluding participants
272 who did not answer any of our main items ($n = 631$), did not consent to the scientific use of their data
273 ($n = 22$), or did not identify with at least one of the student groups ($n = 57$), $N = 1,210$ undergraduate
274 psychology students were included in the sample. Of those who completed the demographic survey
275 at T0 ($n = 694$), 52.7% were under the age of 30 and 46.8% were 30 years or older. Furthermore,
276 69.8% indicated a female and 28.7% a male gender. Around a quarter (25.5%) stated that they have a
277 migration background and 14.0% reported that their native language is not German. More than a
278 third (35.3%) reported to be in full-time employment. Due to dropout during the course, the CSCL
279 groups differed regarding their number of active students. On average, 4 to 5 of the 8 students
280 assigned to each group actively contributed to the CSCL task, $M_{T1} = 4.4$, $SD_{T1} = 1.3$; $M_{T2} = 4.8$, SD_{T2}
281 $= 1.5$; $M_{T3} = 4.3$ $SD_{T3} = 1.3$.

282 Sample size was determined by the number of students in the introductory module of the Bachelor's
283 degree program in psychology who voluntarily participated in the survey. We therefore relied on pre-
284 registered rules of thumb to determine the statistical power for testing our Hypotheses. According to
285 Pan et al. (2018, tbl. 5), our sample was sufficiently large (i.e., $N > 544$) for a longitudinal mediation
286 analysis based on Bootstrap estimation with three measurement points, high intra-class correlation
287 ($ICC = .90$), and small effects (i.e., $b = .14$) for the a and the b path. Note that we incorrectly referred
288 to Table 4 (medium intra-class correlation; $ICC = .60$) instead of Table 5 (Pan et al., 2018) in the pre-
289 registration, resulting in a smaller pre-registered sample size ($N = 385$). However, the achieved
290 sample of $N = 1210$ was larger than the required minimum sample sizes in both tables so the
291 statistical power was sufficiently large to test the pre-registered Hypotheses.

292 **2.2 Measures**

293 **2.2.1 Self-report Measures**

294 As a measure of *group identification*, students indicated which sociodemographic student group(s)
295 they identified with at university over the course of the semester. Ten student groups were presented
296 based on previous research on stereotypes about student groups in higher distance education (Bick et
297 al., 2022): female students (students who identify with the female gender), male students (students
298 who identify with the male gender), students with chronic illness (students who have a chronic-
299 somatic or mental illness), students with disability (students with a self-reported disability or a
300 health-related impairment), students with children (who raise at least one [own] child under the age

301 of 18), full-time employed students (students who are employed for at least 30 hours per week), older
302 students (students who are older than 30 years of age), younger students (students who are up to 30
303 years of age), students with migration background (students who have at least one parent who was
304 born in another country or who were born in another country themselves), and students with non-
305 German native language (students who have a native language other than German). When
306 participants indicated that they did not identify with any of the ten groups, the option to choose other
307 responses as well was deactivated.

308 All further self-report measures were assessed on a five-point Likert scale from “does not apply at
309 all” to “fully applies”. *Social identity threat* was measured separately for each group the students
310 indicated with four items based on Martiny & Nikitin (2019): “I am concerned that I will confirm
311 stereotypes about the abilities of #Group# at university”, “I am concerned that stereotypes about
312 #Group# might hinder my performance at university”, “I am concerned that the stereotypes about
313 #Group# are true”, “I am concerned that the stereotypes about #Group# might influence how others
314 judge my performance at university”.

315 *Sense of belonging to university* was measured with an eight-item scale based on Good et al. (2012):
316 “At the FernUniversität, I feel accepted”, “At the FernUniversität, I feel respected”, “At the
317 FernUniversität, I feel valued”, “At the FernUniversität, I feel appreciated”, “I feel like I belong at
318 the FernUniversität”, “I feel like a member of the group of students at the FernUniversität”, “I feel
319 connected to other students at the FernUniversität”, “I feel like I am a part of the students at the
320 FernUniversität”. The same eight items were applied for sense of belonging to the CSCL group by
321 only replacing “university” by “study group”.

322 *Social approach motivation* was measured with four items based on Gable (2006) which were
323 already applied in the context of higher education by Froehlich et al. (2022): “I try to get a deeper
324 relationship with other students”, “I try to get relationships with other students that develop
325 positively”, “I try to strengthen bonds and intimacy in my relations to other students”, “I try to share
326 many fun and meaningful experiences with other students”.

327 *Behavioral intentions for contact* were assessed with three items based on Froehlich et al. (2022): “I
328 plan to join an organization to meet other students in the near future”, “I will contact other students to
329 start/join a study group in the near future”, and “I will volunteer at various events that the university
330 holds in the near future”.

331 *Off-system behavior*, a control variable, was measured with three self-generated items: “In our group,
332 we have used other media than Moodle for task-related exchange”, “In our group, we have used other
333 media than Moodle for content-related collaboration on the task”, “In our group, we have used other
334 media than Moodle for personal exchange”. Further measures collected for the superordinate project
335 are available on request.

336 **2.2.2 Behavioral Measures**

337 During each phase of the collaboration (getting to know each other, CSCL phase 1, CSCL phase 2),
338 forum activity in the course-related Moodle discussion boards was collected. Applying social
339 network analysis, we computed *discussion outdegree* (i.e., number of replies to other students’
340 threads in the course-related Moodle forum) as our main behavioral measure for student interaction.

341 Access to the data on student activity in the Etherpad Lite was not available at the time of the pre-
342 registration of the present study. We only received access to this measure after the end of the

343 semester and included exploratory analyses with the Etherpad Lite data as a measure of actual task
344 collaboration. With another social network analysis, we computed *Etherpad outdegree* (i.e., edits
345 made by a student in a text that has been written by another student). Additionally, *Etherpad text*
346 *edits* (i.e., sum of all operations of a student in the text, e.g., writing/ deleting/ copying/ pasting/
347 formatting) was investigated for the exploratory analyses since these measures best represented
348 behavior aligned with social approach motivation in the CSCL context. Furthermore, key-strokes,
349 clickstreams, and scroll data in the Etherpads were collected for analyses in the scope of another
350 project.

351 2.3 Data Analysis

352 All multi-item measures had sufficient reliability ($\alpha s > .82$) and were aggregated into scales. Social
353 identity threat was additionally aggregated across all groups to which each student had responded.
354 For cross-sectional and longitudinal mediation analyses, all predictor variables were z-standardized.
355 Because of the large differences in range and variances between self-report and behavioral data, we
356 z-standardized all predictor and outcome variables before computing bivariate correlations. Since RI-
357 CLPMs consider only one level of nested data in the exploratory analyses (i.e., measurements nested
358 within individuals), we accounted for the second level (i.e., students nested in CSCL groups) by
359 conducting robustness checks including clustering for the CSCL group level for all pre-registered
360 Hypotheses. Detailed results of robustness checks are reported in Supplement 1. We applied robust
361 Maximum Likelihood estimation to consider the outcome variable of discussion outdegree which
362 violated the assumption of normality as it was left-skewed. Additionally, we implemented Full-
363 Information Maximum Likelihood estimation to take missing data into account.

364 The forum interaction data was represented as a social network graph $G = (S, L)$, where S is a set of
365 nodes representing forum participants s and L is a set of directed edges of which the included
366 elements are called *links* representing forum posts of respondents answering forum posts of original
367 posters. Social network centrality measures were computed to analyze interactions within Moodle
368 forum discussions. Each response to a forum post was interpreted as establishing a directed *link* $l \{s_x,$
369 $s_y\}$ between two participants, where the respondent s_x is connected to the original poster s_y .
370 *Discussion outdegree* was calculated as the number of outgoing links (answers to different original
371 posters) from each student, reflecting their social connection in the forum discussions. This approach
372 allowed for a comprehensive analysis of the social dynamics within the Moodle forums, identifying
373 key actors and understanding the flow of interactions.

374 Etherpad Lite stores individual text edits of the collaborative text editor using the Easysync Protocol
375 which encodes the affected characters, their position in the text, and the applied formatting
376 operations. The edits collected from Etherpad Lite were used to determine the overall number of edits
377 per students and time period. For each edit, the authors of the character on the left and right side of
378 the inserted or removed character were identified at the respective time and document status. Thus,
379 we counted how often a student had changed the document at a specific position in the text given that
380 the neighboring characters were previously contributed by themselves or another student in the same
381 group. Furthermore, it was counted whose text has been added to or deleted by another student. In
382 this way, it was possible to quantify students' task-related collaboration in the text. For social
383 network analysis, a graph $G = (S, L)$ was constructed, where S is a set of *nodes* representing students
384 s in the group, and L is a set of paired and directed vertices of which the included elements are called
385 *links*. Each *link* $l \{s_x, s_y\}$ represents an editing operation of student s_x directly next to the text that was
386 formerly added by s_y . We calculated *Etherpad outdegree* as the outdegree of a node which indicates
387 the number of times a student s made changes (adding, removing, formatting) to a text that was

388 previously contributed by another student in the same group. Although it is most closely aligned with
389 self-reported social approach motivation and *discussion outdegree*, it reflects only a limited range of
390 all potential collaborative writing activities. Therefore, we also computed *Etherpad text edits* to get a
391 more encompassing measure of what each student contributed to the CSCL assignment.

392 Hypothesis testing was conducted with R version 4.2.2 and RStudio version 2023.06.0+421 (Posit
393 team, 2023; R Core Team, 2022). To investigate Research Question 1, we computed analysis of
394 variance (ANOVA) with Bonferroni-corrected post-hoc tests with stats (R Core Team, 2022). Cross-
395 sectional Hypotheses (H1 and H2) were tested with path analyses using lavaan (Rosseel, 2012).
396 Longitudinal Hypotheses (H3 and H4) were tested with RI-CLPMs (Hamaker et al., 2015) using
397 lavaan (Rosseel, 2012).

398 **3 Results**

399 Descriptive statistics and bivariate correlations of all variables included in the analyses are presented
400 in Table 1. Social identity threat was negatively associated with sense of belonging but not with
401 social approach motivation. Sense of belonging was positively associated with social approach
402 motivation and behavioral intentions for contact with peers. Social approach motivation was
403 positively associated with behavioral intentions. Discussion outdegree was not associated with any
404 other measure.

405 We report the results for sense of belonging to the CSCL group as the main mediator throughout the
406 manuscript. The results of additional analyses with sense of belonging to the university as an
407 alternative mediator were similar to the results for sense of belonging to the CSCL group except for
408 one path that is highlighted in Table S2e. Detailed results with sense of belonging to the university as
409 a mediator are reported in Supplement 2.

410 **3.1 Levels of Social Identity Threat in Different Student Groups**

411 To investigate Research Question 1, we compared perceived social identity threat for different
412 student groups at all measurement occasions. As depicted in Figure 1, students with chronic illness,
413 students with disability, students with children, full-time employed students, and students with non-
414 German native language reported higher levels of social identity threat across all measurement
415 occasions, whereas female students, male students, older students, younger students, and students
416 with migration background reported lower levels of social identity threat.

417 **3.2 Cross-Sectional Analyses**

418 Path models to test Hypotheses 1 and 2 are depicted in Figure 2. To investigate Hypothesis 1, we
419 computed a manifest cross-sectional simple mediation model with social identity threat as the
420 predictor, sense of belonging to the CSCL group as the mediator, and social approach motivation as
421 the outcome. All variables were assessed at T1. The model was fully identified (i.e., included all
422 possible paths). Results revealed that social identity threat negatively predicted sense of belonging, β
423 = $-.22$, 95% CI [$-.29$, $-.15$], $SE = .03$, $p < .001$, and positively predicted social approach motivation, β
424 = $.09$, 95% CI [$.02$, $.16$], $SE = .03$, $p = .008$. In turn, sense of belonging positively predicted social
425 approach motivation, $\beta = .35$, 95% CI [$.28$, $.42$], $SE = .03$, $p < .001$. As expected, the indirect effect
426 was negative and significant, $\beta = -.08$, 95% CI [$-.11$, $-.05$], $SE = .01$, $p < .001$, reflecting that social
427 identity threat was associated with a reduced feeling of fitting in and in turn a reduced motivation to
428 approach others.
429

430 To investigate Hypothesis 2, we computed a cross-sectional serial mediation model with social
431 identity threat as the predictor, sense of belonging to the CSCL group as the first mediator, social
432 approach motivation as the second mediator, and behavioral intentions for contact as the outcome.
433 Again, the model was fully identified and all variables were assessed at T1. Results showed that
434 social identity threat negatively predicted sense of belonging and positively predicted social approach
435 motivation (see Table 2). Sense of belonging positively predicted social approach motivation. Social
436 approach motivation positively predicted behavioral intentions for contact. Again, as expected the
437 indirect effect was negative and significant. Results for cross-sectional Hypotheses did not differ in
438 additional models including robustness checks (see Supplement).

439 3.3 Longitudinal Analyses

440 To investigate Hypothesis 3, we conducted a RI-CLPM with social identity threat, sense of belonging
441 to the CSCL group, and social approach motivation at the three measurement occasions (T1-T3). The
442 models included autoregressive paths and the hypothesized within-person effects: social identity
443 threat at earlier measurement occasions predicted sense of belonging to the CSCL group and social
444 approach motivation at later occasions. Additionally, sense of belonging to the CSCL group at earlier
445 occasions predicted social approach motivation at later occasions (see Figure 3). According to
446 Hamaker et al. (2015) and our Hypotheses, we only allowed first-order autoregressive effects and
447 cross-lagged paths from one measurement occasion to the next. The only path across two
448 measurement occasions included in the model was the direct effect from social identity threat at T1
449 on social approach motivation at T3, since it was necessary for testing the longitudinal mediation
450 Hypothesis. Random intercepts and residual variances were allowed to correlate. The model showed
451 good fit, $\chi^2(8) = 11.73$, RMSEA = .02, CFI = 1.00, TLI = .99, SRMR = 0.01. Social identity threat at
452 T2 positively predicted sense of belonging at T3, $\beta = .17$, $SE = .06$, $p = .008$. However, there were no
453 further significant direct effects of social identity threat on sense of belonging and social approach
454 motivation or of sense of belonging on social approach motivation (see Supplement 3). Furthermore,
455 the expected within-person indirect effect of social identity threat at T1 on social approach
456 motivation at T3 via sense of belonging to the CSCL group at T2 was not significant, $\beta = .002$, $SE =$
457 0.01 , $p = .651$. Results were similar when taking the clustering for the CSCL group into account as an
458 additional robustness check. Interestingly, the random intercept for social identity threat was
459 negatively correlated with the random intercept for sense of belonging to the CSCL group, $r = -.20$,
460 $SE = 0.03$, $p < .001$, which in turn was positively correlated with the random intercept for social
461 approach motivation, $r = .26$, $SE = 0.04$, $p < .001$. In other words, stable across measurement
462 occasions, students with social identity threat above the sample average reported sense of belonging
463 to the CSCL group below the average. In turn, students with sense of belonging below the average
464 had lower-than-average motivation for contact with other students.

465 To investigate Hypothesis 4, we computed an analogous RI-CLPM with discussion outdegree as the
466 behavioral outcome measure (see Figure 4). The RI-CLPM showed good fit, $\chi^2(8) = 5.82$, RMSEA
467 $< .001$, CFI = 1.00, TLI = 1.01, SRMR = 0.01. Again, social identity threat at T2 positively predicted
468 sense of belonging at T3, $\beta = .15$, $SE = .06$, $p = .009$. Sense of belonging at T1 negatively predicted
469 outdegree at T2, $\beta = -.35$, $SE = .16$, $p = .030$. No further significant direct effects from social identity
470 threat on sense of belonging and discussion outdegree or from sense of belonging on discussion
471 outdegree were found. In contrast to our expectations, there was no significant indirect effect of
472 social identity threat on discussion outdegree via sense of belonging to the CSCL group on the
473 within-person-level, $\beta = -.002$, $SE = 0.01$, $p = .802$. Results were similar when taking the clustering
474 for the CSCL group into account as an additional robustness check. On the between-person-level, the
475 random intercept for social identity threat was negatively correlated with the random intercept for

476 sense of belonging to the CSCL group, $r = -.20$, $SE = 0.03$, $p < .001$. However, the random intercept
477 for discussion outdegree was not significantly correlated with the random intercepts for social
478 identity threat or sense of belonging to the CSCL group. Detailed results of H4 are reported in
479 Supplement 4.

480 **3.4 Exploratory Analyses**

481 Since Etherpad Lite data were available only for the two CSCL phases, RI-CLPMs could not be
482 computed. As analyses with the Etherpad Lite data were exploratory, we report bivariate correlations
483 of social identity threat, sense of belonging, discussion outdegree, Etherpad outdegree, and Etherpad
484 text edits (see Table 1). Similar to the outcomes of the main analyses, neither Etherpad outdegree nor
485 Etherpad text edits were significantly related to social identity threat. Etherpad outdegree was also
486 not significantly related to sense of belonging to the CSCL group. However, Etherpad text edits in
487 working phase 1 were negatively related to sense of belonging to the CSCL group at all measurement
488 occasions. Etherpad text edits in working phase 2 were negatively related to sense of belonging to the
489 CSCL group at T2.

490 Since the number of active students in the CSCL groups might have influenced sense of belonging to
491 the CSCL group and activity in the group (in the forum as well as in the Etherpads), we repeated all
492 cross-sectional analyses controlling for group size. Results did not change when controlling for group
493 size (see Supplement 5). In longitudinal analyses, the models did not converge when group size was
494 added as control variable due to insufficient model identification. Correlations revealed that group
495 size at T2 was positively related to social identity threat at T3, $r = .09$, 95% CI = [.01, .17] and to
496 sense of belonging to the CSCL group at T3, $r = .11$, 95% CI = [.03, .18]. Group size at T3 was
497 positively related to sense of belonging to the CSCL group at T1, $r = .09$, 95% CI = [.01, .18], T2, $r =$
498 $.10$, 95% CI = [.03, .18], and T3, $r = .08$, 95% CI = [.02, .15].

499 **4 Discussion**

500 This study contributes to understanding the social consequences of perceived social identity threat in
501 distance learning when there is no face-to-face contact between students. First, we showed that
502 perceived social identity threat varies between different student groups in higher distance education.
503 Second, we replicated the cross-sectional findings from face-to-face contexts in higher distance
504 education, namely, the mediation of social identity threat on social approach motivation via lower
505 sense of belonging. Third, the current study has shown that within- and between-person effects need
506 to be separated. Fourth, based on research showing an intention-behavior gap, we included self-
507 reported and behavioral outcome measures collected via Learning Analytics in the same study.

508 **4.1 (Some) Non-traditional Student Groups are Particularly at Risk of Experiencing Social** 509 **Identity Threat in CSCL**

510 In line with research on stereotypes about non-traditional students in higher distance education (Bick
511 et al., 2022), we found that social identity threat differed between student groups insofar that some
512 non-traditional student groups (i.e., students with chronic illness, students with disability, students
513 with children, full-time employed students, students with non-German native language) reported
514 higher levels of social identity threat than traditional student groups (i.e., male students, younger
515 students). Thus, we substantiated earlier findings reporting higher vulnerability of non-traditional
516 student groups in the context of higher distance education (e.g., Stoessel et al., 2015).

517 On the other hand, female students and students with migration background reported comparably low
518 levels of social identity threat in the current study, although both groups meet the definition of non-
519 traditional students and were found to be negatively affected by social identity threat in face-to-face
520 contexts in previous studies (Froehlich et al., 2022; Spencer et al., 1999). In the case of female
521 students, the large proportion of female students in psychology (usually around 70 %) might lead to
522 lower social identity threat since females represent the majority group in this specific context.
523 However, it remains an open question whether this result is generalized or domain-specific. In
524 contrast to the current research which investigated CSCL in the domain of scientific reading and
525 writing, future research should investigate whether female students report higher social identity threat
526 in psychology courses that reflect more traditional gender stereotypes about women's mathematical
527 competence (e.g., research methods and statistics).

528 In the case of students with migration background, the following reasons might explain the
529 comparably low levels of social identity threat. When asking which groups students identified with,
530 both students with migration background and students with a non-German native language were
531 presented. Only half of the students who identified as students with migration background also
532 identified as having a non-German native language. Students who identified as students with
533 migration background but perceive German to be their first language might be second- or third-
534 generation immigrants and therefore might have developed dual social identities (i.e., simultaneously
535 identifying with their ethnic group of origin and the national group of the residence country), which
536 acts as a buffer against the social consequences of social identity threat (Froehlich et al., 2023).
537 Students identifying with both student groups might have contrasted stereotypes about the two
538 groups and attributed negative stereotypes and associated social identity threat to the group of
539 students with non-German native language, resulting in lower levels of reported social identity threat
540 regarding the identification with students with migration background. Future research is needed to
541 verify this post-hoc explanation.

542 Interestingly, we found the highest levels of social identity threat among students with chronic
543 illness. This result is surprising because based on the social identity model of deindividuation effects
544 (SIDE; Postmes et al., 2001; Spears et al., 2002), we had expected social categories that are easily
545 recognizable in online interactions such as gender, ethnicity/ native language, or age to be most
546 salient in higher distance education. In contrast, it is often not immediately apparent in online
547 contexts whether peers have a chronic illness or not. Nevertheless, students who identified as
548 members of the group of students with chronic illness that they were relatively worried about being
549 negatively stereotyped because of their group membership. In line with Clair et al. (2005), students
550 with chronic illness may be repeatedly confronted with the need to disclose their chronic illness to
551 their peers, as in collaborative contexts “those with an invisible chronic illness must find ways to
552 explain or hide symptoms from others” (Clair et al., 2005, p. 91). Therefore, belonging to the group
553 of students with chronic illness might be similarly relevant or, in line with our data, even more
554 relevant than belonging to visible groups as social identity threat is intensified by the conflict of
555 whether or not to disclose the chronic illness to peers.

556 The current research aggregated self-reported social identity threat across all students in the data set.
557 In the present study, sample sizes for subgroups of non-traditional students were too small to
558 examine whether the associations between social identity threat and the outcome variables differed
559 between the traditional and non-traditional student subgroups. Furthermore, students were clustered
560 in CSCL groups, so that not only membership of individual students to sociodemographic groups was
561 important, but also the multi-attributional diversity at the CSCL group level. Research at group level
562 has shown that in groups with high sociodemographic diversity, task-related prior knowledge and

563 skills cannot be optimally utilized for group performance (Voltmer et al., 2022a, 2022b, 2023).
564 Future research should therefore simultaneously consider the membership of individual students in
565 sociodemographic groups targeted by negative stereotypes and the impact of the demographic
566 composition of the CSCL groups. It was beyond the scope of the current manuscript to investigate
567 these complex interrelations.

568 **4.2 Self-reported Consequences of Social Identity Threat in CSCL**

569 The present study aimed to replicate and better understand the social consequences of social identity
570 threat shown in face-to-face contexts in the emerging and important context of higher distance
571 education. We replicated previous results on the mediating role of sense of belonging for the
572 association between social identity threat, social approach motivation, and behavioral intentions for
573 peer contact in cross-sectional analyses. This result indicates that findings from traditional
574 educational contexts with face-to-face classrooms can be generalized to digital educational contexts
575 with mostly asynchronous computer-mediated communication.

576 In contrast, the longitudinal investigation of social identity threat, sense of belonging, and social
577 approach motivation revealed unexpected findings. Due to the repeated measurements implemented
578 during a CSCL task over several weeks, we were able to conduct state-of-the-art analyses including
579 RI-CLPM. As Hamaker et al. (2015) emphasize, the main advantage of the RI-CLPM is its ability to
580 disentangle within- and between-persons components of variance in longitudinal data. Consequently,
581 the application of the RI-CLPM allowed us to investigate whether the hypothesized mediation model
582 reflects psychological intraindividual processes that unfold over time. The results of the current study
583 do not support this. Interestingly, the correlations of the random intercepts, which represent a stable
584 between-person variance, indicated that the mediation might be a between-person effect. Students
585 with a higher average social identity threat over time also had lower average levels of sense of
586 belonging to the CSCL group and in turn a lower average social approach motivation over time. Such
587 an association of the random intercepts would argue for more stable rank-order effects in a given
588 classroom or course, rather than psychological processes unfolding in individuals over time.
589 However, these findings should be interpreted with caution. The longitudinal analyses were
590 conducted over a total of eight weeks with intervals of two to three weeks, which might not have
591 been enough time for the intraindividual effects to unfold (Cook et al., 2012). In addition,
592 longitudinal studies with the goal of investigating cross-lagged associations should ideally be
593 conducted under stable conditions. In contrast, in our study, the changing CSCL tasks in the different
594 phases (getting to know each other, working phases 1 and 2) and the transition to a new academic
595 institution (measurement during the first weeks of the first semester in the Bachelor's program) were
596 a source of high variability. This lack of stability over time is also reflected in the often weak or
597 insignificant autoregressive paths in the longitudinal analyses. Future research should therefore
598 replicate the results under more stable conditions.

599 **4.3 Behavioral Consequences of Social Identity Threat in CSCL**

600 In addition to self-reported social approach motivation and behavioral intentions, the current study
601 used learning analytics to compute social network analysis based on data generated during the actual
602 CSCL collaboration. The main behavioral outcome variable was discussion outdegree, reflecting a
603 student's responses to postings of their peers in course-related Moodle forums. Contrary to our
604 expectations, discussion outdegree was unrelated to our main predictor variables of social identity
605 threat and sense of belonging. One possible explanation for the diverging results for the self-report
606 and the behavioral data is that there is a gap between intention and behavior as actual collaborative
607 behavior might be influenced by additional factors beyond social approach motivation and behavioral

608 intentions to interact with peers. For example, students might have wanted to interact more with
609 peers but did not have time, e.g., due to family commitments. An alternative explanation is that
610 discussion outdegree encompasses merely students' discussion about the CSCL task, but not actual
611 collaborative writing activities. Our data on this task-related discussion are probably also incomplete,
612 as students might have used not only the designated Moodle forums, but also other communication
613 channels outside of the learning environment. In fact, students indicated that they used other media
614 than the course-related Moodle forum for communication about the course (i.e., off-system
615 behavior). However, statistically controlling for off-system behavior did not change the results of
616 cross-sectional analyses (see Supplement 6).

617 In exploratory analyses, we investigated correlations between social identity threat and sense of
618 belonging with further behavioral outcomes collected via Etherpad Lite instances for each CSCL
619 group. Etherpad outdegree and Etherpad text edits reflect the closest measures of actual collaborative
620 behavior in the current study. Similar to the results for discussion outdegree, Etherpad outdegree was
621 also unrelated to social identity threat and sense of belonging. It should be noted that Etherpad
622 outdegree reflects only the edits a student made in the text written by another student, but no initial
623 writing of the text or edits made in the text that was initially written by themselves. Etherpad text
624 edits was unrelated to social identity threat but negatively related to sense of belonging to the CSCL
625 group. Research about frustration in CSCL at a Spanish distance learning university revealed that the
626 main source of frustration in CSCL was imbalance of commitment in group tasks which was further
627 described as “sometimes I run into someone whose contribution was almost nothing. When that
628 happens, I tend to do more than I can, to compensate, and this makes me feel nervous, causes some
629 discomfort and feeling of injustice” (Capdeferro & Romero, 2012). In line with these findings, it
630 could be argued that also in the present sample, students were frustrated of being forced to invest
631 more because other students invested less, independent of the size of the CSCL groups. As
632 Capdeferro and Romero (2012) recommend, instructions on effective collaboration and the
633 communication of realistic expectations for the course might help online learners to overcome
634 frustration and to enhance belonging to the CSCL group in collaborative courses at distance learning
635 universities.

636 **4.4 Conclusion**

637 “To close achievement gaps, it is necessary both to eradicate psychological threats embedded in
638 academic environments and to remove other barriers to achievement including objective biases, the
639 effects of poverty, and so forth” (Walton & Spencer, 2009, p. 1137). The present study is a first step
640 towards eliminating psychological threats in online learning environments, as it found that most non-
641 traditional student groups in higher distance education are at risk of experiencing social identity
642 threat. The present study thus underpins earlier research that points to problems faced by non-
643 traditional student groups at university (e.g., Yildirim et al., 2021). Furthermore, we substantiated the
644 mediation of social identity threat on social approach motivation by reduced sense of belonging by
645 replicating it in the novel context of higher distance education. Finally, this study has taken a first
646 step towards integrating learning analytics into research on social identity threat and belongingness in
647 CSCL and found interesting effects that can be subject of future research aimed at improving the
648 prerequisites of successful CSCL.

649 **5 Conflict of Interest**

650 The authors declare that the research was conducted in the absence of any commercial or financial
651 relationships that could be construed as a potential conflict of interest.

652 **6 Author Contributions**

653 All authors were involved in the design and the conceptualization of the study. NB and LF
654 implemented the items in the superordinate project of SS, JBV, JR, and NRS. JR was in charge of the
655 module in which data were collected. JBV prepared the self-report data of the superordinate project
656 including the items relevant for the present study. MB created the Collaborative Learning Platform to
657 support collaborative writing in large-scale distance education. MB and NS prepared the Etherpad
658 Lite data. NB conducted the main data analyses with comments and contributions of LF and JBV.
659 NB wrote the manuscript with contributions and revisions from LF, NS, JN, JBV, JR, NRS, MB,
660 SEM, SS, and AM.

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857 **10 Supplementary Material**

858 **10.1 Figures**

859 **Figure 1.** Means and standard errors of social identity threat for all student groups over all
860 measurement occasions. Please note that values of social identity threat at T0 for younger students
861 were not available due to a programming issue.

862 **Figure 2.** Path model for cross-sectional analyses. Black arrows depict paths and results for H1
863 whereas grey arrows depict paths and results for H2. * indicates $p < .05$, ** indicates $p < .01$, and ***
864 indicates $p < .001$.

865 **Figure 3.** RI-CLPM for Hypothesis 3. Social identity threat is abbreviated with SIT, sense of
866 belonging to the CSCL group is abbreviated with SOB, and social approach motivations is abbreviated
867 with SAM. Between-subject-variation is represented in RIs whereas within-subject variation is
868 represented in Ws. * indicates $p < .05$, ** indicates $p < .01$, and *** indicates $p < .001$.

869 **Figure 4.** RI-CLPM for Hypothesis 4. Social identity threat is abbreviated with SIT, sense of
870 belonging to the CSCL group is abbreviated with SOB, and discussion outdegree is abbreviated with
871 OUT. Between-subject-variation is represented in RIs whereas within-subject variation is represented
872 in Ws. * indicates $p < .05$, ** indicates $p < .01$, and *** indicates $p < .001$.

873 **10.2 Supplementary Material:**

874 Supplement 1: Results of robustness analyses clustering for CSCL group level

875 Supplement 2: Results of analyses with sense of belonging to university as mediator

876 Supplement 3: Results of analyses regarding H3

877 Supplement 4: Results of analyses regarding H4

878 Supplement 5: Results of analyses controlling for CSCL group size

879 Supplement 6: Results of analyses controlling for off-system behavior

880 **11 Data Availability Statement**

881 The prepared datasets, materials, analysis script, and pre-registration for this study can be found on
882 the OSF: https://osf.io/axq7k/?view_only=4493ac1e1358486baa61457cc4305007.

883 **Table 1**

884 *Means, standard deviations, and correlations of all variables*

Variable	<i>M</i>	<i>SD</i>	Social Identity Threat T1	Social Identity Threat T2	Social Identity Threat T3	Sense of Belonging T1	Sense of Belonging T2	Sense of Belonging T3	Social Approach Motivation T1	Social Approach Motivation T2	Social Approach Motivation T3	Behavioral Intentions T1
Social Identity Threat T1	1.7	0.7										
Social Identity Threat T2	1.6	0.7	.70** [.66, .74]									
Social Identity Threat T3	1.7	0.8	.69** [.64, .73]	.73** [.69, .77]								
Sense of Belonging T1	3.8	0.8	-.21** [-.27, -.14]	-.17** [-.24, -.09]	-.19** [-.27, -.11]							
Sense of Belonging T2	3.7	1.0	-.13** [-.21, -.05]	-.17** [-.23, -.11]	-.19** [-.26, -.11]	.47** [.41, .53]						
Sense of Belonging T3	3.7	1.0	-.15** [-.23, -.07]	-.12** [-.19, -.04]	-.14** [-.21, -.07]	.40** [.33, .47]	.68** [.64, .72]					
Social Approach Motivation T1	2.8	1.0	.03 [-.04, .10]	.03 [-.05, .11]	.06 [-.03, .14]	.32** [.26, .38]	.26** [.19, .33]	.18** [.10, .26]				
Social Approach Motivation T2	2.5	1.1	.00 [-.08, .08]	.02 [-.05, .08]	-.04 [-.11, .04]	.21** [.14, .29]	.33** [.27, .38]	.30** [.27, .37]	.69* [.65, .73]			
Social Approach Motivation T3	2.5	1.1	-.02 [-.10, .06]	.02 [-.05, .10]	.01 [-.06, .08]	.18** [.10, .26]	.26** [.18, .33]	.33** [.26, .39]	.67** [.62, .71]	.75** [.71, .78]		
Behavioral Intentions T1	2.5	0.9	.05 [-.02, .12]	.02 [-.06, .10]	.08 [-.00, .16]	.22** [.15, .29]	.23** [.15, .30]	.21** [.13, .29]	.64** [.59, .68]	.54** [.48, .60]	.52** [.45, .57]	
Behavioral Intentions T2	2.4	1.0	.03 [-.05, .11]	.09** [.02, .15]	.06 [-.01, .14]	.16** [.08, .24]	.23** [.16, .29]	.27** [.20, .34]	.60** [.55, .65]	.61** [.57, .65]	.60** [.54, .64]	.73** [.69, .77]
Behavioral Intentions T3	2.1	1.0	.08 [-.00, .16]	.10** [.03, .18]	.12** [.05, .19]	.24** [.16, .31]	.20** [.13, .28]	.26** [.20, .33]	.48** [.42, .54]	.45** [.39, .51]	.58** [.54, .63]	.64** [.59, .69]
Discussion Outdegree T1	1.48	1.19	.01 [-.06, .09]	.02 [-.05, .09]	-.00 [-.08, .07]	-.03 [-.11, .04]	.03 [-.04, .10]	-.03 [-.11, .04]	-.03 [-.10, .05]	.04 [-.03, .11]	.01 [-.06, .08]	-.08* [-.15, -.00]

885

Variable	<i>M</i>	<i>SD</i>	Social Identity Threat T1	Social Identity Threat T2	Social Identity Threat T2	Sense of Belonging T1	Sense of Belonging T2	Sense of Belonging T3	Social Approach Motivation T1	Social Approach Motivation T2	Social Approach Motivation T3	Behavioral Intentions T1
Discussion Outdegree T2	2.59	2.96	.05 [-.03, .13]	-.00 [-.08, .07]	-.02 [-.10, .07]	-.10* [-.18, -.02]	-.02 [-.09, .06]	-.01 [-.09, .07]	-.04 [-.12, .04]	-.06 [-.13, .02]	-.04 [-.12, .04]	-.06 [-.14, .02]
Discussion Outdegree T3	1.45	1.48	.07 [-.03, .17]	.05 [-.05, .14]	.04 [-.06, .14]	.00 [-.10, .10]	.00 [-.09, .10]	-.06 [-.16, .03]	-.03 [-.13, .07]	-.03 [-.12, .07]	-.05 [-.15, .05]	-.12* [-.22, -.02]
Groupsize T1	4.4	1.4	.01 [-.06, .08]	.06 [-.02, .14]	.04 [-.04, .12]	.02 [-.05, .09]	.04 [-.04, .12]	.04 [-.05, .12]	-.05 [-.12, .02]	.03 [-.05, .11]	-.01 [-.10, .07]	-.06 [-.13, .01]
Groupsize T2	4.8	1.5	.06 [-.02, .14]	.05 [-.02, .11]	.09* [.01, .17]	-.01 [-.09, .07]	.05 [-.02, .11]	.11** [.03, .18]	-.04 [-.12, .04]	-.01 [-.07, .06]	.00 [-.07, .08]	-.03 [-.11, .05]
Groupsize T3	4.3	1.3	.05 [-.03, .13]	-.00 [-.08, .08]	.04 [-.02, .11]	.09* [.01, .18]	.10** [.03, .18]	.08* [.02, .15]	-.02 [-.10, .06]	.02 [-.05, .10]	.03 [-.04, .10]	-.03 [-.11, .05]
Off-System Behavior T1	3.3	1.1	-.03 [-.10, .04]	-.03 [-.11, .05]	.00 [-.08, .08]	.16** [.09, .22]	.06 [-.02, .14]	-.01 [-.09, .07]	.16** [.09, .23]	.11** [.03, .18]	.11** [.03, .19]	.12** [.05, .18]
Off-System Behavior T2	3.2	1.0	-.03 [-.11, .05]	-.01 [-.07, .06]	-.01 [-.08, .07]	.15** [.07, .23]	.17** [.10, .23]	.12** [.05, .20]	.11** [.03, .19]	.14** [.07, .20]	.08 [-.00, .15]	.08 [-.00, .15]
Off-System Behavior T3	3.3	1.0	.05 [-.03, .13]	-.07 [-.15, .01]	.00 [-.06, .07]	.12** [.04, .20]	.20** [.13, .28]	.18** [.11, .24]	.07 [-.01, .16]	.12** [.04, .19]	.07* [.00, .14]	.05 [-.03, .14]
Etherpad Outdegree T2	148.24	195.14	.05 [-.02, .12]	.01 [-.06, .07]	-.00 [-.07, .07]	-.06 [-.13, .01]	-.06 [-.13, .00]	-.01 [-.08, .06]	-.03 [-.10, .04]	.02 [-.05, .08]	.00 [-.07, .07]	-.04 [-.11, .03]
Etherpad Outdegree T3	119.68	186.00	.02 [-.05, .09]	-.02 [-.09, .05]	-.04 [-.11, .03]	-.01 [-.08, .07]	-.02 [-.08, .05]	.06 [-.01, .13]	-.02 [-.09, .05]	.05 [-.01, .12]	.06 [-.01, .13]	-.06 [-.13, .01]
Etherpad Text Edits T2	936.2	1121.1	.06 [-.01, .13]	.04 [-.02, .11]	.02 [-.05, .09]	-.09* [-.16, -.02]	-.15** [-.21, -.08]	-.12** [-.19, -.05]	-.03 [-.10, .04]	-.02 [-.09, .04]	-.04 [-.10, .03]	-.06 [-.13, .01]
Etherpad Text Edits T3	694.8	876.8	.01 [-.07, .08]	-.02 [-.09, .05]	-.02 [-.09, .06]	-.01 [-.09, .06]	-.08* [-.14, -.01]	-.04 [-.11, .03]	-.06 [-.13, .01]	-.01 [-.08, .06]	-.02 [-.09, .05]	-.11** [-.18, -.03]

Variable	Behavioral Intentions T2	Behavioral Intentions T3	Discussion Outdegree T1	Discussion Outdegree T2	Discussion Outdegree T3	Groupsize T1	Groupsize T2	Groupsize T3	Off-System Behavior T1	Off-System Behavior T2
Behavioral Intentions T3	.71** [.67, .74]									
Discussion Outdegree T1	-.08* [-.15, -.01]	-.07 [-.14, .01]								
Discussion Outdegree T2	-.09* [-.16, -.01]	-.06 [-.14, .02]	.32** [.25, .38]							
Discussion Outdegree T3	-.07 [-.16, .02]	-.02 [-.12, .08]	.41** [.33, .48]	.56** [.50, .62]						
Groupsize T1	-.02 [-.10, .06]	-.03 [-.12, .05]	.14** [.07, .21]	.01 [-.07, .10]	.00 [-.10, .10]					
Groupsize T2	-.01 [-.08, .05]	-.01 [-.08, .07]	.07 [-.00, .14]	-.03 [-.10, .05]	-.08 [-.17, .01]	.47** [.41, .53]				
Groupsize T3	-.01 [-.09, .06]	.00 [-.07, .07]	.08* [.00, .15]	-.07 [-.15, .01]	-.04 [-.14, .05]	.46** [.39, .52]	.48** [.41, .53]			
Off-System Behavior T1	.08* [.00, .16]	.08 [-.00, .16]	-.16** [-.23, -.08]	-.28** [-.35, -.20]	-.20** [-.29, -.10]	.03 [-.04, .10]	.07 [-.01, .15]	.06 [-.02, .14]		
Off-System Behavior T2	.11** [.04, .17]	.05 [-.02, .13]	-.10** [-.17, -.03]	-.39** [-.46, -.33]	-.25** [-.33, -.16]	.12** [.04, .19]	.06 [-.00, .13]	.15** [.08, .23]	.37** [.30, .44]	
Off-System Behavior T3	.08 [-.00, .15]	.02 [-.05, .09]	-.12** [-.19, -.05]	-.38** [-.44, -.31]	-.30** [-.39, -.21]	.08 [-.01, .16]	.07 [-.00, .15]	.13** [.06, .19]	.27** [.20, .35]	.74** [.71, .78]
Etherpad Outdegree T2	-.02 [-.08, .05]	-.03 [-.10, .04]	.10** [.04, .16]	.18** [.12, .25]	.14** [.06, .22]	.01 [-.06, .08]	.01 [-.06, .07]	.06 [-.01, .13]	-.08* [-.15, -.01]	-.08* [-.14, -.01]
Etherpad Outdegree T3	.02 [-.05, .08]	-.00 [-.07, .07]	.06 [-.01, .12]	.08* [.01, .15]	.12** [.03, .20]	-.03 [-.10, .05]	.02 [-.05, .09]	.04 [-.03, .11]	-.04 [-.11, .03]	-.01 [-.08, .05]
Etherpad Text Edits T2	-.04 [-.11, .02]	-.03 [-.10, .04]	.05 [-.02, .11]	.09* [.02, .16]	.06 [-.02, .14]	-.03 [-.10, .04]	-.03 [-.09, .04]	-.00 [-.07, .07]	-.03 [-.10, .04]	-.10** [-.16, -.03]
Etherpad Text Edits T3	-.02 [-.08, .05]	-.02 [-.09, .05]	.03 [-.04, .09]	.10** [.03, .17]	.09* [.00, .17]	-.03 [-.10, .04]	-.05 [-.11, .02]	-.02 [-.09, .05]	-.04 [-.11, .04]	-.07* [-.14, -.01]

887

Variable	Off-System Behavior T3	Etherpad Outdegree T2	Etherpad Outdegree T3	Etherpad Text Edits T2
Etherpad Outdegree T2	-.11** [-.18, -.04]			
Etherpad Outdegree T3	.00 [-.07, .07]	.24** [.18, .29]		

Etherpad Text Edits T2	-.12**	.57**	.23**	
	[-.19, -.05]	[.53, .61]	[.17, .29]	
Etherpad Text Edits T3	-.08*	.26**	.61**	.47**
	[-.15, -.01]	[.20, .31]	[.57, .65]	[.42, .51]

888 *Note.* Confidence intervals are depicted in square brackets at the 95% level. * indicates $p < .05$. ** indicates $p < .01$.

889 **Table 2**

890 *Results of the path model testing H2*

891

<i>Direct Effects</i>													
		Consequent											
		Sense of Belonging			Social Approach Motivation			Behavioral Intentions					
Antecedent		<i>b</i> [95% CI]	<i>SE</i>	<i>p</i>		<i>b</i> [95% CI]	<i>SE</i>	<i>p</i>		<i>b</i> [95% CI]	<i>SE</i>	<i>p</i>	
Social Identity Threat	a ₁	-.22 [-.29; -.15]	.03	<.001	a ₂	.09 [.02; .16]	.03	.008	c _p	.04 [-.01; .09]	.03	.043	
Sense of Belonging		-	-	-	d ₂₁	.34 [.28; .42]	.03	<.001	b ₁	.03 [-.02; .09]	.03	.268	
Social Approach Motivation		-	-	-		-	-	-	b ₂	.57 [.52; .62]	.03	<.001	
<i>Indirect Effect</i>													
Social Identity Threat → Social Approach Motivation → Sense of Belonging → Behavioral Intentions										a ₁ d ₂₁ b ₂	<i>b</i> [95% CI]	<i>SE</i>	<i>p</i>
											-.04 [-.06; -.03]	.01	<.001

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