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East is East: Socratic classroom communication is linked to higher stress in students from confucian heritage cultures

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ABSTRACT

East Asian students are often educated in a more instructor-led and less interactive manner than their North American and European peers. Therefore, as international students at Western universities, they need to adapt to unfamiliar teaching practices that involve classroom communication emphasising critical thinking, debating, and challenging others' views. We explored the stress from such communication by assessing the relationships between East Asian students' perceived ease of engaging in Socratic communication and stress. 51 students from various majors completed the *Ease of Socratic Communication* scale and the *Conceptions of Learning Inventory*. One week later, students rated on the *Perceived Stress Scale* their levels of helplessness and self-efficacy. East Asian students found it less easy to engage in Socratic communication than their non-Asian peers,. The harder students found Socratic communication, the higher were their stress levels. On the other hand, higher Socratic communication ease was associated with higher self-efficacy. Moreover, the relationship between Socratic communication ease and stress was less pronounced the more students viewed learning as the development of personal competence. Complementing extant qualitative research, our findings suggest that Socratic communication may act as a stressor to East Asian international students. Reducing that stress might help improve international students' learning experience and thus foster their academic integration.

1. Introduction

Research on international students has grown exponentially in the past 15 years [1], fuelled by two decades of steady growth in international student mobility [2,3], which has become a driver of scientific collaboration and technological innovation [4]. Beyond merely growing international student enrolment, universities therefore seek to advance student success [5], even more so as optimising the quality of teaching and learning is considered crucial to counteract the declining numbers of international students in the wake of the COVID-19 pandemic, e.g., Refs. [4,6].

Consistently, international students' academic integration has become one of the primary research topics, i.e., students' adaptation to unfamiliar practices of teaching, learning, and assessment (see Refs. [7,8], which is a predictor of international students' academic performance [9]. Considering the substantial student flow between East Asian and 'Western' (i.e., Anglo-American and European) countries, we focused on East Asian students' academic integration. In 2020, students from China, Japan, Korea, Singapore, and Vietnam were the largest and second largest groups, respectively, from one geographic area in the top three hosting countries U.S. (35.1%), UK (26.1%), and Australia (28.0%) [10]. Importantly, East Asian students are likely to experience at Anglo-American and

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European universities teaching and learning practices that are markedly different from their home universities. At Western universities, engaging in classroom communication is an essential part of learning [11,12]. Students learn by communicating [13], i.e., by interacting with faculty and peer students to understand assignment expectations, assessment requirements and to contribute to discussion in class. Sometimes referred to as *Socratic* (see Refs. [13,14], such communication encompasses, for instance, presenting, debating [15], and challenging peer students' and professors' positions [13]. The prevailing view on communication in the East Asian countries of China, Japan, Korea, Singapore, and Vietnam, however, posits that silence, rather than speech, reflects wisdom and maturity [16–18]. Students from said *Confucian Heritage Cultures* [19] have been claimed to be more silent in class, relative to their Western peers [20–22], to be reluctant to participate in classroom activities, give responses, and to avoid asking questions [23,24]. Culture-specific expectations of student-teacher interaction have been identified, e.g. Refs. [25–27], that appear to reflect cross-cultural differences in behavioural norms and that may account for East Asian students' relative reserve in classroom communication. Moreover, there is experimental evidence that acting contrary to the Confucian silence principle of communication is associated with heightened levels of stress in East Asian, but not Western participants [28].

On this background, based on the general assumption that participation in classroom communication is an essential part of international students' academic integration [29–31], we explored the relationships between East Asian students' perceived ease of engaging in Socratic classroom communication (e.g., displaying critical thinking, challenging in class professors with opposing views on content matters) and stress. Prior research [13] found a positive relationship between Socratic communication ease and both GPA and academic satisfaction, but the sample did not include East Asian students, nor were potential links to stress examined. Virtually all of the direct evidence on the association between classroom communication and stress (e.g., Refs. [32–35]) is from qualitative studies, which limits generalisation. Therefore, to complement extant qualitative research, we included stress as an outcome of Socratic communication ease to gauge if reducing the stress from classroom communication might contribute to optimising international students' learning experience as one way of fostering their academic integration.

2. Socratic classroom communication: a stressor to East Asian students?

Research on the influence of cultural traditions on students' learning has been of long-standing interest (e.g., Refs. [36,37]) and gave rise to the notion that 'Eastern' and 'Western' students belong to distinct learning camps [21,38–42], most notably in terms of their relative preferences for the deep and surface approaches, respectively, to learning, e.g., Ref. [43]. Such differences are thought to reflect the influence of learning traditions, which act as socio-cultural determinants of learning behaviours, and which have attracted growing research interest, particularly regarding classroom communication, e.g., Refs. [20,21,27,44–46]. Labelling those traditions as the Confucian and Socratic ideals of learning, Tweed and Lehman [14] described the Socratic ideal as centred on developing mental skills and critical thinking that are seen as the overarching goals of academic learning. Critical discussion and debates in the classroom are encouraged, and students are supposed to assess if the information they are taught can be verified [47], to generate arguments and counterarguments on any given position [48], and to challenge their professors with different views on content matters in class [27].

The Confucian ideal of learning appears to be the opposite of the Socratic learning culture. Whilst the latter emphasises critical thinking and active verbal expression of one's thoughts, respectful learning is one of the core principles of the Confucian culture [14]. Teachers must be treated respectfully to maintain a harmonious relationship with them. Only after mastering the learning content at hand are students supposed to engage in communication about that content and potentially take a critical stance. Mastery builds on memorisation and repetition that are valued as demonstrating students' learning efforts, which are essential for them to be considered 'good students' [49]. The focus of classroom communication is on professors asking students rhetorical questions to challenge students to reflect on their ideas.

In sum, therefore, students from Confucian Heritage Cultures (hence: CHC students) are likely to gain during their primary and secondary education extensive experience of classroom communication behaviours that differ markedly from behaviours in Western classrooms. Consequently, when they transition to the Socratic learning culture as international students, we expect that.

Hypothesis 1. CHC students report a lower ease of engaging in Socratic classroom communication than Western students.

The Confucian-Socratic learning cultural transition may pose a considerable challenge to CHC students and warrants investigation of its links with acculturative stress [50], i.e., the psychological difficulties and physical discomforts experienced when adapting to new cultural environments, which may involve, amongst other things, role alterations and value conflicts with the host culture [51,52]. Such stress may have severe consequences as it has been shown to cause a range of symptoms such as anxiety, confusion, depression, family conflict, headache, sleep disturbance, or substance abuse [51,53–57], which adversely affect international students' mental health and academic performance. Still, most research has focused on describing acculturative stress itself, rather than on identifying its predictors [58], and evidence on stress-buffering psychological resources is similarly limited.

Findings from qualitative studies suggest Socratic communication might be a stressor to international students. For instance, students reported they found it "culturally unacceptable" to challenge others [59] and that being insecure of what was expected from them in class made their learning experience tense [60]. In Zhou and Zhang's [35] study, Asian international students at a Canadian university noted that they would have to "study from the first day of the semester" and be active in class, whereas in their home countries, only the final exams would really matter. Also, at home, learning theoretical and conceptual knowledge would be valued, whilst the emphasis was on applying knowledge at the Canadian university. As they were not used to being proactive in class, Korean students found it difficult to present their ideas promptly during class discussions [33]. Chinese international students in the U.S. perceived their adjustment to the interactive classroom environment as tough because they found it hard to decide when and how to respond in class discussions [32]. Also, they felt uncomfortable when instructors asked questions, especially when called upon without

having raised their hands [34]. In sum, these findings suggest that Socratic classroom communication may be a stressor to CHC students. Consequently, we expect.

Hypothesis 2. The perceived ease of Socratic communication is negatively related to stress such that students who report lower ease indicate higher levels of stress.

3. Students' conceptions of learning as stress buffers

Concerning psychological resources that mitigate the stress experience, evidence from research with international students is limited. Most studies addressed non-specific resources such as perceived English proficiency [61], social connectedness [62], or self-esteem [63]. Research is needed on resources that are specific to teaching and learning and that might give instructors means of helping reduce stress through course design and instructional interventions. Related to this, resources were usually studied in isolation, although that approach is likely to underestimate their stress-buffering potential. General resource theories such as the Conservation of Resources Theory (COR, e.g., Ref. [64]) have generated ample research showing that resources do not usually exist individually nor in an isolated manner. Instead, resources interact such that, for instance, one resource might reinforce the effect of another resource.

In this context, it is important to note that whilst we portrayed in our second hypothesis a lack of Socratic communication skills as a stressor, their inverse relationship with stress implies that those same skills might also be a resource. Moreover, we posit that in the form of their learning conceptions, international students possess another resource that has hardly ever been studied as such. Students' conceptions of learning determine what learning means to students [36,65] and co-determine the specific learning activities students engage in (e.g., Refs. [66–68]). Those meanings have been shown to range from the more reproduction-oriented view of *learning as memorising and reproducing information* to a more sophisticated and growth-oriented perspective of *learning as personal fulfilment* (e.g., Ref. [69]). Important regarding their stress-buffering potential, students' conceptions of learning (COLs) are influenced both by previous experiences as well as by situational demands of the specific learning context and topic domain [70–73] so that students might come to endorse more than one meaning (see Ref. [74]). That breadth of COLs, i.e., the number of meanings students attribute to learning has been shown to relate positively to academic achievement, [70,75]. Importantly, recent evidence suggests that COLs favourably influence students' engagement in self-regulated learning, which is associated with stronger self-beliefs about their learning abilities and critical thinking skills. For instance, in the domain of science learning, Ho et al. [76] found that the conceptions of learning science as a) constantly practising calculation and solving problems, b) learning to apply knowledge, and c) transferring knowledge and skills to novel problems were all positively related to students' self-regulated learning, which was in turn associated with higher confidence in the ability to use high-order cognitive skills such as problem solving, critical thinking, or scientific enquiry, i.e. conceptions of learning were associated with higher learning-related self-efficacy beliefs (see Ref. [77] for similar results from secondary school students) [76]. showed that the conceptions of learning as applying and as attaining understanding were positively correlated with the levels of motivation for and satisfaction from learning [78]. argued that students with sophisticated conceptions of learning may see cognitive engagement and deep comprehension as necessary for knowledge acquisition and consequently engage in more effective self-regulation, which in turn is likely to enhance self-efficacy beliefs and motivation. In our context, this would imply that students with more sophisticated, i.e., broader COLs – that involve the conception of learning as developing one's personal competence – believe more strongly that engaging in Socratic classroom communication is conducive to effective learning, which might reduce the stress from Socratic communication. In resources terms, the resource of broad learning conceptions would facilitate using the resource of engaging in Socratic communication and thus reduce stress. In sum, therefore, we posit.

Hypothesis 3. Students' conceptions of learning moderate the relationship between Socratic communication ease and stress such that the latter correlation is smaller at higher levels of COLs breadth.

4. Method

4.1. Participants and procedure

We invited via e-mail 315 first-year undergraduate students at Jacobs University Bremen. The study was conducted in compliance with the WMA Declaration of Helsinki, as well as the standards of Constructor University's Internal Ethics Review Board. Participants were informed in writing that the data from this study would be used in a project on teaching quality. Participants learnt that they would be asked to report specific aspects of their learning experience and that it would be studied how their experience was related to motivation-related learning outcomes. Furthermore, participants were informed that their participation was voluntary and that it would in no way affect their course grades if they chose not to participate. Participants could choose to enter a raffle of Amazon® gift vouchers worth 15 € (approx. US$16) and received additional course credit. Before participants could proceed to the questionnaires, we obtained informed consent by asking participants to confirm they had read and understood the above-mentioned information about the study, and to indicate whether they wished to participate.

The study was originally designed as an experience-sampling study with five data-collection waves in consecutive weeks and was intended to also assess the relationships between the weekly partial exam types (e.g., short presentations, quizzes) administered in numerous classes. Therefore, to qualify for participation, students had to be registered to classes that were held across all 14 semester weeks (i.e., no block or lab rotation courses etc.) and in which weekly assessments were administered that counted towards the class grade. Participants self-registered to a database that the weekly questionnaire links were sent from, and they were informed that they could participate anonymously by signing up with an anonymous e-mail address. A given participant's data were matched across

waves by means of an alphanumeric code that we instructed participants to generate from family members' names and birth dates.

The initial sample comprised 126 students. We discarded the data from 75 students who either had not received the links to one or more of the weekly waves due to technical problems, or had failed to either fill in the baseline questionnaire, or to indicate their personal alphanumeric code required for data merging. The final sample consisted of 51 students whose mean age was 19.5 years (range 17–22 years), 54.3% were female. Participants were from a variety of majors like, for instance, Biochemistry, Business Administration, Computer Science, Mathematics, or Psychology.

4.2. Measures

Considering the attrition rate, we decided to use only the data from the baseline questionnaires on classroom communication and on conceptions of learning (T_1) and on stress (T_2). At T_1, participants also indicated their age, gender, geographic region of origin, major, current GPA, and which class they reported their learning experience from. The combined mean length of the T_1 and T_2 questionnaires was 21 min. As English is the language of instruction at Jacobs University, we used all questionnaires in their original English versions.

We assessed the *Ease of Socratic Communication* with four items from Kühnen et al.'s [13] study on classroom communication. Participants rated how easy it was for them to actively participate in class, to display critical thinking abilities, to formulate their own ideas that went beyond reproducing ideas of other scholars, and to challenge their professor in class with opposing views on content matters. In addition, participants indicated with another four items how much those same four behaviours had been valued at their previous secondary education institutions. These items were used as a measure of participants' *Secondary Education Culture*. All ratings were given on 7-point Likert scales from 1 = n*ot at all easy/valued* to 7 = *very easy/valued.*

Students' Conceptions of Learning were assessed with the *Conceptions of Learning Inventory* (COLI, [69]). It consists of 32 statements reflecting the 6 conceptions of learning as (1) gaining information; (2) remembering, using, and understanding information; (3) a duty; (4) personal change; (5) a process not bound by time or place; (6) the development of social competence. Respondents indicated on a 6-point Likert scale their agreement with the statements.

As a measure of *Stress*, students completed the *Perceived Stress Scale* [79]. Six of its ten items refer to *Perceived Helplessness*, a sample item is "In the past week, how often have you been upset because of something that happened unexpectedly?". Another four items assessed *Perceived Self-Efficacy* that we used for additional analyses. A sample item is "In the past week, how often have you felt that you were on top of things?". All ratings were made on five-point Likert scales.

5. Results

We analyzed with hierarchical regression analyses the data from 51 participants using the IBM SPSS® Statistics software (Version 28.0). In an initial data screening, we found no violations of regression assumptions or multicollinearity (all tolerance scores >0.25). Cronbach's α as an indicator of scale reliability was greater than 0.70 for all scales, warranting quantitative analyses. A multivariate analysis of variance with gender as factor and the mean scores on Socratic Communication, Conceptions of Learning, and Stress did not reveal significant differences between participants as a function of gender ($F < 1$, ns.). Also, we included age and major as controls but do not report these data, as neither control yielded significant effects.

5.1. Ease of Socratic Communication

We assigned to the CHC group 24 participants who had reported being born in and having taken their primary and secondary education in an East-Asian country. 27 participants from non-Asian countries of birth and education formed the non-CHC group. In an analysis of covariance with *Region of Origin* (CHC vs. non-CHC) as factor and *Secondary Education Culture* as covariate, we compared the *Ease of Socratic communication* mean scores of CHC students and non-CHC students. Levene's test and normality checks were carried out and the assumptions met. There was a significant difference in Socratic communication ease, with CHC students reporting lower ease than their non-CHC peers. Participants' prior learning experience in terms of the secondary education culture covariate significantly predicted the Ease of Socratic Communication. These findings confirm our first hypothesis. Table 1 lists the analysis of covariance.

5.2. The relationship between the ease of Socratic Communication and stress

Testing our second hypothesis, we regressed the Ease of Socratic Communication score from T_1 onto the Perceived Helplessness score from T_2. Disconfirming Hypothesis 2, communication ease was not a significant negative predictor of helplessness. Given the exploratory nature of our study, we performed additional analyses building on the fact that at 0.80, Cronbach's α of the communication ease scale was at the low end of good scale reliability and bordered "acceptable" quality. Consequently, we inspected the inter-item

Table 1
Difference in the Ease of Socratic Communication between CHC and non-CHC students.

Group	M	*SD*	$M_{adjusted}$	*SE*	*Source of Variance*	*F(1,48)*	*p*	η^2
CHC students	3.32	1.32	3.39	.26	Region of Origin	8.35**	.01	.148
Non-CHC students	4.35	1.33	4.30	.24	Sec. Education Culture	7.99**	.01	.143

correlations and found that item 1 (active participation in class) was most strongly correlated with item 4 (challenging a professor in class with opposing views). At the same time, item 2 (displaying critical thinking abilities) was most highly correlated with item 3 (formulating one's own ideas). This led us to interpret items 1 and 4, and items 2 and 3, respectively, as two 'subscales' of the communication ease measure. As active class participation and challenging one's professor necessarily are 'public' behaviours, we labelled items 1 and 4 the *public* subscale. By contrast, students may view critical thinking and formulating their own ideas as potentially 'private' learning activities that do not invariably require interactions with professors. Consequently, we labelled items 2 and 3 the *private* subscale of the communication ease measure.

We then performed two additional regression analyses with the public and private subscales, respectively, as predictors. The public subscale emerged as a significant negative predictor of stress such that helplessness ratings were higher at lower levels of communication ease in terms of active class participation and challenging one's professor. The private subscale, by contrast, did not significantly predict stress.

Although not originally hypothesised, as an additional analysis, we regressed public and private communication ease onto Perceived Self-Efficacy and found a similar pattern. The public communication subscale positively predicted self-efficacy, with the latter being rated higher at higher levels of communication ease. The private subscale, however, did not predict self-efficacy. Table 2 summarises all regression models, standardised β-coefficients, and their T-values.

5.3. The moderating role of conceptions of learning

To test our third hypothesis, we calculated students' individual COLs breadth score by summing up the number of conceptions a student endorsed. A given conception was counted as endorsed if a student's mean rating of that conception was greater than 3.5 (i.e., the numerical 'midpoint' of the rating scale). Accordingly, COLs breadth scores could range from 1 to 6. We entered those scores as moderators in a regression analysis that regressed public communication ease (i.e., the public subscale from the additional analyses to Hypothesis 2) onto perceived helplessness. Contrary to Hypothesis 3, there was no signification interaction effect from COLs breadth, suggesting that COLs breadth had no moderating effect on the communication ease-stress relationship.

The absence of an overall COLs effect does not preclude the possibility, however, that one or more of the six individual learning conceptions the COLI comprises may act as moderators. Therefore, we performed six additional regression analyses, one with each of the six learning conceptions as moderator. From these analyses, the conception of learning as the development of social competence emerged as a significant moderator. The association of public communication ease with stress was less pronounced at higher levels of endorsing the conception of learning as social competence development. These findings are summarised in Table 3.

6. Discussion

We explored the relationship between students' perceived ease of engaging in Socratic classroom communication and stress. Given its focus on critical thinking, debating, and challenging professors' positions, the Socratic communication that is characteristic of Anglo-American and European university classes might be a stressor to East Asian international students who took their primary and secondary education in the Confucian learning tradition that is instructor-led, emphasising the mastery of learning content through memorisation and repetition. Considering that classroom communication at their host universities is a co-determinant of international students' academic integration, our aim was to gauge if reducing the stress from classroom communication might contribute to optimising international students' learning experience as one way of fostering integration.

Although we had to reject some of our hypotheses, our data draw a plausible picture. As predicted in Hypothesis 1, relative to their non-Asian peers, CHC students found it less easy to engage in Socratic communication. Indicating the long-lasting effects of learning traditions, the extent to which Socratic communication had been valued at students' secondary education institutions predicted the perceived ease of Socratic communication over and above the learning environment at the host institution. Concerning the relationship between communication ease and stress, we had to reject our initial second hypothesis that the perceived ease of Socratic communication as operationalised in the scale by Kühnen et al. [13] predicts students' stress levels. Only after breaking out the total scale into a public and private subscale did we find an association of communication ease with stress. The harder students found it to participate actively in class and to challenge their professors' views, the higher were their stress levels. The ease of critical thinking and of formulating one's own ideas, however, were unrelated to stress. At the same time, higher ease of active class participation was associated with higher self-efficacy. Finally, we had to reject our original hypothesis that the breadth of learning conceptions would moderate the relationship between communication ease and stress. It turned out, however, that said relationship was less pronounced the more students endorsed the conception of learning as the development of personal competence.

Table 2
Relationships between the ease of socratic communication and perceived helplessness.

Predictor	*β*	*SE*	*T*	*p*
Ease of Socratic Communication, full scale	−0.137	0.105	−.902	.362
Ease of Socratic Communication, public subscale	−0.304	0.091	−2.113	.040*
Ease of Socratic Communication, private subscale	0.059	0.095	0.394	.696

Table 3
Conceptions of Learning as moderator of the Socratic Communication-Helplessness relationship.

Variable	*B*	*β*	*SE*	*T*	*p*
(Constant)	3.737		0.833	4.485	.001
Public Communication	−0.267	−0.423	0.206	−1.295	.204
Conceptions of Learning	−0.004	−0.008	0.202	−0.020	.984
Public Communication x Conceptions of Learning	0.019	0.192	0.050	0.372	.712
(Constant)	6.080		1.166	5.213	.001
Public Communication	−0.902	−1.398	0.361	−2.502	.017*
Social Competence	−0.745	−0.716	0.351	−2.121	.041*
Public Communication x Social Competence	0.212	1.569	0.098	2.168	.037*

6.1. Implications

We believe our findings add to an understanding why the same teaching methods and learning tasks that promote learning in students from some cultures may be far less effective for students from other cultures [80,81]. As a well-established explanation, 'Eastern' and 'Western' students have been said to belong to distinct learning camps in terms of their cognitive and metacognitive strategies of processing learning content [21,38–42,82]. Different perceptions of classroom communication may be an additional explanatory factor. For instance, anticipating that Socratic classroom communication will be stressful may curb CHC students' engagement in such communication, which could in turn lead to their benefitting less than Western students from learning activities that involve, for instance, group discussion or debates.

On this background, building students' Socratic communication skills is likely to help improve their learning experience. Complementing prior evidence of positive effects from Socratic communication such as higher GPA and higher satisfaction [13], we found that the ease of Socratic communication was associated with higher levels of self-efficacy and lower levels of stress. On the other hand, consistent with qualitative evidence of the association between classroom communication and stress (e.g., Refs. [32–35]), our study suggests that perceiving Socratic communication to be difficult may not only curb its positive effects, but even 'backfire' in terms of stress. In sum, it seems plausible to assume that building Socratic communication skills would not only equip students with a 'passive buffer' that diminishes stress, but even with an 'active' resource that strengthens self-efficacy, which might in turn increase students' motivation to participate in classroom communication and thus benefit more from the learning opportunities it entails.

6.2. Limitations and further research

Given its exploratory nature and small sample size, this study merely allows for preliminary conclusions, and more research will be needed for more fine-graded analyses. For instance, there might be different emphases on classroom discussion and debating – and consequently in students' stress levels – in, say, the social sciences and natural sciences, respectively, that we cannot test for in our small sample. Also, our study does not reveal differences between students in their first, second, and third years of study, respectively. Future research could investigate if and how students cope with the stress from classroom communication as they 'get used' to it over the course of their studies. Studies in that direction would use additional measures that assess, for instance, students' coping strategies, and could inform the development of specific stress-management interventions. As another obvious extension, the fact that we had to break out the brief *Ease of Socratic Communication* questionnaire in two 'subscales' suggests that there are distinct facets of Socratic communication, which might be associated with different facets of stress.

Research on the relationships between classroom communication and stress could also provide a platform for developing and evaluating course designs and teaching strategies that facilitate students' stress management. It would be interesting to investigate, for instance, if 'fading in' potentially stress-laden class activities (e.g., pro-con debates) over the first few weeks of a class would be associated with lower stress levels than 'being Socratic' from the start. Related to this, it could be tested if instructors could support students in challenging others' views by 'flagging' the controversial aspects of a position and encouraging critique. Also, it could be assessed if more systematic group composition in groupwork tasks can reduce stress by comparing, for instance, groups with equal and unequal numbers of East Asian and non-Asian students, respectively.

7. Conclusion

For East Asian international students at Western universities, adapting to Socratic classroom communication, which emphasises critical thinking, debating, and challenging others' views can be a stressful experience. Our study shows that in addition to reduced stress levels, Socratic communication skills are linked to higher self-efficacy, which can in turn enable students to benefit more from in-class learning opportunities. Whilst further research is clearly needed, our findings suggest that reducing that stress by building Socratic communication skills might contribute to improving international students' improved learning experience and help foster their academic integration, which is a vital ingredient of their academic success.

Author contribution statement

Isabella Langen: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis

tools or data.

Christian Stamov Roßnagel: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

Data will be deposited into publicly available repository by 31/03/2023.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e15748.

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