I Need Your Encouragement! Requesting Supportive Comments on Social Media Reduces Test Anxiety

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ABSTRACT
Many students underperform on exams due to experiencing high test anxiety. We report on a study comparing a novel intervention of seeking support from one's social network to the more common approaches of expressive writing and studying task-relevant materials for simulated open-ended test questions. We measured in-the-moment (state) anxiety before and after each intervention, and correctness of the solutions. We also surveyed students to learn about their perceptions of the interventions. Our results showed that social support decreased the anxiety of high test-anxious students by 21% with the reduction in anxiety correlating with the number of messages received. Social support also allowed high test-anxious students to score at the level of low test-anxious students. Expressive writing showed a similar effect, but increased the anxiety of low test-anxious students by 61%. Studying task materials had no effect on anxiety and high test-anxious students performed worse than low test-anxious students. Despite benefiting from social support, we found that students were uncomfortable soliciting support from their online social network. Realizing the benefits of this approach may therefore require different formulations of social support in practice.

Author Keywords
Anxiety; social support; expressive writing; programming.

ACM Classification Keywords
H.5.3 [Information Interface and Presentation]: Group and Organization Interfaces--Collaborative computing.

INTRODUCTION
Students who experience high levels of test anxiety perform worse on exams [37], and struggle with absent-mindedness, feelings of sickness, and irrelevant thinking [10, 34]. High test anxiety can also have adverse long-term effects on grade history, general anxiety, and classroom behavior [1].

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Test anxiety may be particularly acute for students taking exams with open-ended problems. These types of problems introduce more uncertainty over how to approach solutions, the constraints must be quickly understood, mistakes made early can inhibit later choices, and it is more difficult to guess a correct solution [41]. Open-ended problems are often encountered on exams in computing, among other disciplines. Here students must not only address the challenges of solving open-ended problems, but must also manage the uncertainty related to the use of the programming tools required to construct the solution (e.g. compilation or runtime errors).

HCI and related research offer several possible approaches to reduce test anxiety during exams. One approach is to provide test anxious students with social support. For instance, prior work has shown that facilitating group discussions before an anagram task increased the number of correct solutions for students with high test anxiety [37]. A second approach is the use of expressive writing. Expressive writing is a form of therapy where people write about a past incident by recording their thoughts and feelings [32]. Ramirez and Beilock showed that expressive writing increased exam scores for high text anxious students for a multiple choice test [34]. However, these approaches have never been empirically compared, and neither has been tested for open-ended exam questions.

We report on a study investigating a novel application of social media for reducing test anxiety. Students posted a request for encouragement to their online social network (Facebook) and read the responses prior to solving open-ended programming problems. We compared this approach to the widely studied anxiety intervention of expressive writing and a control condition (N=88). In the expressive writing condition, students wrote about their thoughts and feelings regarding the tasks they were about to perform. In the control condition, students read task-relevant material to simulate common student behavior of reviewing course notes before an exam. An incentive scheme was applied to further simulate the stress of an authentic exam situation. We measured in-the-moment (state) anxiety before and after each intervention, and the correctness of the programming solutions. The Cognitive Test Anxiety scale was used to categorize high and low test anxiety students.

Students were also surveyed to learn about their perceptions of the interventions used.

Our study produced three main findings. First, our results showed that reading supportive messages decreased the in-the-moment (state) anxiety of high test-anxious students by 21%. Supportive messages also allowed the high test-anxious students to achieve scores on the programming tasks that were similar to that of low test-anxious students. Second, we found that the number of messages received was positively correlated (r^2=0.30, p=0.002) with the reduction in anxiety, while less substantive interactions, such as 'likes', had a non-significant correlation (r^2=0.10). However, our qualitative results showed that students were reluctant to solicit supportive messages from their own social network. Therefore, realizing the benefits of this approach may require exploring different formulations of social support in practice. Third, we found that expressive writing also allowed high test-anxious students to perform similarly to low test-anxious students. However, this intervention increased the state anxiety of low test-anxious students by 61%. Taken together, our results advocate for the use of a social support intervention for those students who generally experience high text anxiety.

Our work makes three contributions to the CHI community. First, our results provide empirical understanding for using a social media intervention to lower anxiety and increase performance on a simulated exam. Second, we report how the appropriation of social media for anxiety reduction compares to the more widely studied approach of expressive writing. Third, we extend prior work on test anxiety interventions to open-ended programming problems. We believe these contributions can be applied to help students perform better in evaluative situations.

RELATED WORK

We describe test anxiety and situate the choice of measures in our study. We also describe how social support and expressive writing have been used to reduce anxiety for various tasks, and situate these methods in the context of other possible anxiety interventions. Last, we describe the unique characteristics of open-ended questions on exams.

Measures and Studies of Test Anxiety

Test anxiety is a combination of physiological and emotional responses that occur while preparing for and during testing situations [1]. It has been found to negatively correlate with scores on achievement tests, problem-solving and memory tasks, course grades, and cumulative GPA [18]. When test anxiety is reduced, increases in aptitude and standardized tests, as well as GPA have been observed [18].

Previous studies have found that between 25-41% of students experience test anxiety, with higher numbers reported in women and students of color [1, 27, 33]. Another recent study found 22% of high test-anxious students have no method of coping with it [15]. High test-anxious students display strong fears of negative evaluation and lower levels of self-esteem [18]. They also show an increase in the number of distracting thoughts and test-irrelevant thinking when in a testing situation [5, 20, 37].

In our study, we chose two methods to measure anxiety. We used the Cognitive Test Anxiety scale (CTA) to measure test anxiety. CTA has a rich history of being used to measure the cognitive aspects of test anxiety including task-irrelevant thinking and lapses in attention [10]. We also used the State Trait Anxiety Inventory (STAI) form. The state portion of the STAI is used to measure anxiety in the moment while the trait portion is used to measure anxiety of the person [43]. Many other measures of anxiety and test anxiety exist [6, 11, 36, 38, 39]. However, we chose the CTA and STAI because they have been validated and are relatively straightforward to administer.

Social Support

Social support is defined as an "interpersonal transaction in which one can rely on others for information, help, and advice" [30]. It consists of several categories, including emotional support (e.g. encouragement, sympathy, love), instrumental aid (e.g. providing material aid or behavior assistance), companionship (e.g. spending time with others during leisure time), and informational support (e.g. guidance) [40]. CHI researchers have examined the effects of social support in education. For example, Saerbeck et. al. showed that a socially supportive robot helped children score higher on a language test and report higher intrinsic and task motivation than children in a neutral condition [35]. Kao and Harrell showed that an encouraging message, such as "You're doing well," shown while participants were playing a STEM learning game improved the experience of the game for players [22]. Other researchers in the HCI community have examined how social media is leveraged for support when experiencing life events, such as gender transition or job loss [9, 16]. Online health communities have also been investigated as a source of social support [26, 29, 46]. For example, Newman et al. studied how seeking social support in online health communities and social networks can provide emotional support, accountability, and motivation [29]. Wang et al. found that members of online health communities who receive emotional support participate longer than members receiving only informational support [46].

Researchers in the behavioral sciences have begun to study the impact of social support on test anxiety. For example, Sarason showed that students who participated in either a group discussion or overheard a supportive message directed toward another student before completing an anagram task, scored higher than students that did not participate in the discussion or overhear the message [37]. These effects were even more favorable for high test-anxious students. Additionally, Kimbler showed that a single emotionally supportive message before completing the Everyday Problem Solving Test reduced the number of distracting thoughts participants experienced and increased

task performance [23]. The buffering hypothesis offers one explanation for how these beneficial effects are realized; social support reduces the negative emotions that occur when appraising an evaluative situation [12].

In our study, we synthesize and extend these threads of prior work by developing a novel intervention for test anxiety reduction where students request social support by leveraging their online social network. Our work is also original in that it compares this and two other interventions for anxiety reduction for open-ended programming tasks.

Expressive Writing

Expressive writing has been widely studied as an anxiety reduction technique. McKeachie, Pollie, and Speisman conducted early research on reducing anxiety during classroom exams. By studying student performance on a multiple-choice psychology exam, they found that student scores increased when the problems contained sections for writing comments about the exam. They attributed this performance increase to a decrease in anxiety [28].

Other researchers showed that writing about one's thoughts and feelings before arithmetic problems or an exam increased math accuracy and exam scores, respectively, for students when compared to students who were asked to think about task-irrelevant topics before the same evaluation. The expressive writing task was shown to be especially beneficial for students with high test anxiety or high math anxiety [31, 34]. Lang used a writing exercise to heighten student self-perceptions of their knowledge. The writing exercise increased the scores of high test-anxious high school students on an intelligence test, while lowering the scores of low test-anxious students [25]. A proposed theory for this effect is that writing about worries before the task unburdens working memory during the task, making it available to focus on the evaluative task [31].

This prior work shows that expressive writing can reduce student test anxiety. However, the research on expressive writing as a test anxiety intervention focuses on its use in forced-choice problems. Our research extends the study of an expressive writing intervention to open-ended problems where there is more uncertainty related to solution generation [41]. We also compare expressive writing to social support and reading task-related materials for anxiety reduction, and analyze student perceptions of these interventions.

Other Anxiety Interventions

There are approaches for anxiety reduction beyond social support and expressive writing. One approach is to work with a trained professional on relaxation and desensitization procedures [14, 49]. Hembree's meta-analytic study found that this approach reduces anxiety but found mixed results for increasing cognitive performance [18]. Another approach, cognitive behavioral therapy, can also be effective for decreasing test anxiety and raising test performance [18]. These two approaches are helpful for those experiencing severe anxiety, but the drawback is that they require working with a trained professional. A third approach is to modify the exams, such as adjusting item difficulty order or integrating humor into exam questions [6, 13, 49]. The generalizability of this approach is unclear, however, since it relies on individual interpretations of difficulty or humor.

Of the possible approaches for anxiety reduction, we chose to compare social support and expressive writing, in addition to a control condition, in the current study. We chose these approaches because they have been shown to be effective for anxiety reduction in other task situations, can be widely applied through technology, and can be implemented without training or a trained therapist.

Anxiety and Open-ended Questions

Prior work on test anxiety interventions focused on forced-choice questions. Though often used, the limitations of this format include the inability to effectively assess problem solving and creativity [4, 17]. In contrast, open-ended questions are considered to better measure these attributes but students perceive increased anxiety and uncertainty when solving them [42, 48]. For example, Zeidner showed that students found open-ended essay exams more difficult, complex, and anxiety provoking than multiple-choice exams [48]. Additionally, Schmidt and Crocker showed that low test-anxious students performed better on open-ended exams and high test-anxious students performed better on multiple-choice exams [42]. Lastly, Deloatch et al. showed that students report moderate to high levels of anxiety when solving open-ended programming problems on exams and 21% of students reported having no method of coping [15]. Our motivation for using open-ended programming problems was due to our interest in computer science assessment and the paucity of literature on the effectiveness of anxiety reduction techniques to help students solve open-ended problems.

RESEARCH QUESTIONS

The goal of our study was to answer the following research questions:

1. How do social support and expressive writing affect the anxiety experienced by students prior to an exam situation?
2. How does the level of student anxiety relate to the correctness of programming solutions on an exam?
3. How do students feel about seeking social support or expressive writing to reduce anxiety prior to an exam?

With these questions, we want to produce empirical knowledge for how to reduce student anxiety and increase performance for exams with open-ended problems.

Please take the next 7 minutes to write as openly as possible about your thoughts and feelings regarding the programming problems you are about to perform. In your writing, I want you to really let yourself go and explore your emotions and thoughts, as you are getting ready to start the problems. You might relate your current thoughts to the way you have felt during other similar situations at school or in other situations in your life. Please try to be as open as possible as you write about your thoughts at this time. The text you write will only be viewed in aggregate and your response will not be evaluated. When the timer at the bottom expires you will move to the next page. Please start writing.

Figure 1. Prompt for the expressive writing condition.

METHOD

To answer these research questions, we performed a single factor between-subjects controlled experiment. The factor was Anxiety Intervention (social support vs. expressive writing vs. control). Participants were randomly split into groups representing each condition. Next, we describe the participants, programming tasks, interventions, and measures.

Participants

Participants were recruited via an email sent to all undergraduate students in the computer science department (1,235) at a large mid-western university. Additionally, an instructor sent an email to all students currently enrolled in a Spring 2016 Data Structures course (600). Participants enrolled in the course received extra credit whereas other participants received $10. Additionally, participants were entered into a multi-winner lottery for $100. In total we had 88 participants complete all parts of the experiment.

Our participants were 78% men, 20% women, with 2% not responding. Most participants (94%) were enrolled in the Spring 2016 Data Structures course. Participants were mostly engineering students majoring in computer science (52%), computer engineering (16%), and electrical engineering (7%). Just over half (51%) of participants were in their first year, 30% in their second year, 14% in their third year, and 5% in their fourth year. About one-third (31%) of participants reported having previously used Facebook to request encouragement from their social network.

Programming Tasks

The two programming problems chosen for this study included a binary tree task and linked list manipulation and were to be completed in C++. For the first problem, participants were asked to write a function that returns the number of nodes in a binary tree that have exactly one child. This problem was selected because it used concepts of recursion and data structures that students in our curriculum were expected to be familiar with. The second problem was a modification of a question from a prior midterm in the course. It required participants to write a function that removed nodes from a singly linked list if the node's string data element was longer than a given threshold. The function had to return the number of nodes removed and the resulting changed linked list. These two problems had many viable solutions in terms of memory efficiency, complexity, and choice of language constructs. No two participants produced identical solutions to either problem. Participants were provided with a source code text editor with the ability to compile and run their code. We estimated that students were expected to complete each problem within 20 minutes, so we provided participants with 40 minutes to complete the two problems. A pilot study revealed participants believed the problems were appropriate for their level of knowledge and that the amount of time provided was adequate.

Hi friends, I need your encouragement. I will be competing in a computer programming challenge on Monday. I will have the opportunity to view comments and likes you put on this post during the challenge. I will also be able to see private messages. I won't be able to respond to any of your messages at that time, but I will be able to read them. Any supportive comments would be great to see.

Figure 2. The template text participants in the social support condition adapted and posted to Facebook.

Anxiety Interventions

Our study compared two interventions, expressive writing and social support, and a control condition of reading task-relevant information. The interventions were administered prior to participants performing the programming tasks. For expressive writing, following the procedures described in prior work [31, 34], participants were given the prompt shown in Figure 1 and wrote their response into an online form. Participants in the social support condition adapted a template message and posted it to their Facebook timeline the day before the experiment (see Figure 2). They were informed that just prior to the experiment, they could view the likes, comments, and private messages associated with their post. Participants were instructed to refrain from viewing the responses until they arrived for the study. We chose to implement social support using a social media platform because the approach is scalable, accessible, and fast; features which we believe would increase the likelihood that students would use this approach in practice and receive timely responses. We chose Facebook since it's network is based on social relationships. In the control condition, participants read general information regarding computer programming data structures before completing the programming tasks. The control condition was intended to simulate common student behavior of reviewing course material immediately before an exam.

Procedure

After informed consent, participants completed an online form asking about their years of programming experience, C++ experience, and gender. In addition, participants

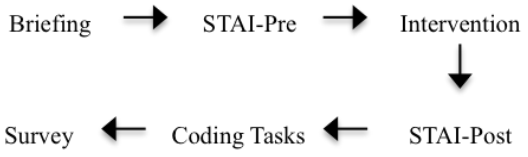

Figure 3. A summary of the experimental procedure. Participants were briefed and completed the state anxiety form. Participants then performed the assigned intervention and completed the state anxiety form again. The coding tasks were then performed, followed by a survey.

completed the Cognitive Test Anxiety instrument and the *trait* portion of the State-Trait Anxiety Inventory (STAI).

Participants were also asked about their willingness to post a message to Facebook as part of the study and if they have ever used Facebook to solicit social support. Finally, participants completed a five-question multiple choice pre-test without any outside assistance. The pre-test focused on basic data structures, runtime complexity, and C++ syntax. The pre-test was used to ensure participants had a basic understanding of programming.

Participants assigned to the social support condition were asked to adapt a template message and post it to their Facebook timeline (Figure 2). They were informed that they could modify the text to fit their style, but any modification should still convey the message of when the programming task occurs, that they will have the opportunity to read the responses, and that supportive comments would be valued.

Upon arriving at the study location, our experiment followed the process shown in Figure 3. An experimenter instructed participants that they would have forty minutes to complete two programming problems and described the remuneration. The experimenter then presented a scenario designed to induce increased anxiety. Participants were informed that they would receive an additional $100 for earning a perfect score on the programming problems and $10 if each member of their assigned group, determined by arrival order, scored at least a 75% score on the problems. We believe this created an increased anxiety scenario due to previous work on simulating exam situations by using monetary incentives along with pressure to perform well relative to peers [34]. A pilot study also revealed that participants reported feeling increased anxiety if they could see the members of their group working and if they thought that they should be able to complete the problems. Thus, groups were assigned in view of participants and they were told that the programming problems were based on their expertise as measured by the pre-test problems.

After hearing this information, participants logged on to a lab computer and worked in view of other participants. This design was also employed to mimic authentic exam situations where students can see each other when working. In the lab, students first completed the *state* portion of the STAI to obtain a pre-condition state anxiety measurement.

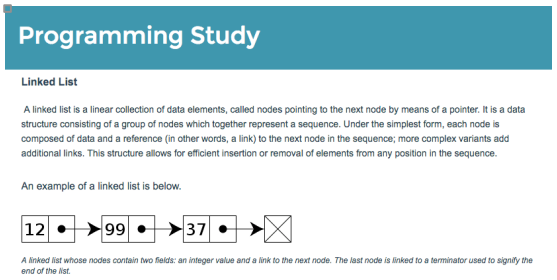

Figure 4. The task relevant information read by participants in the control condition.

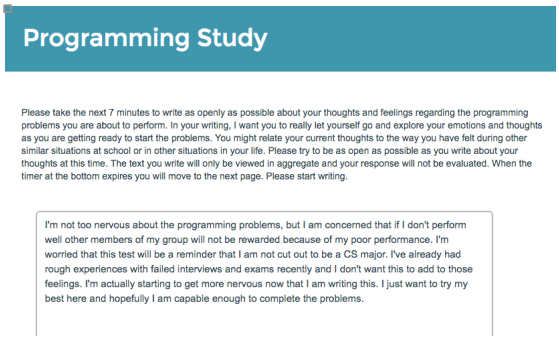

Figure 5. The user interface and prompt for the expressive writing condition. Participants read the prompt and entered their response.

Figure 6. An example Facebook Timeline post made by a participant in the social support condition. The post was made to Facebook to elicit encouraging responses from friends. Names were redacted for anonymity.

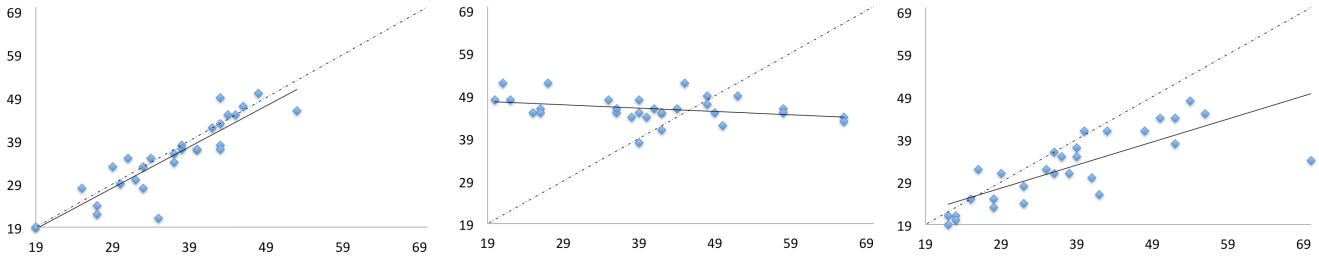

Figure 7. State anxieties before (X-axis) and after (Y-axis) the assigned anxiety interventions. The graphs show results for the control (left), expressive writing (middle), and social support (right) conditions. The dotted line indicates perfect correlation and the solid line is the regression line for the data (R^2=0.8; 0.1; 0.61, respectively).

Participants then performed a seven-minute intervention based on the assigned condition. Control group participants read relevant material on data structures and answered three questions about the text (Figure 4). Participants in the expressive writing condition were presented with the interface in Figure 5 and typed their response. Participants in the social support condition viewed the comments, likes, and private messages they received from their prior post. They were asked to report the number of responses received and which response made them feel most supported. An example post with responses is shown in Figure 6. As a manipulation check, participants reported their perception of how supportive the responses to the post were.

After completing the intervention, all participants completed the *state* portion of the STAI again to obtain a post-intervention measurement. Participants were then presented with two programming tasks and had 40 minutes to complete them. Afterward, participants completed a survey that focused on their perceptions of how the control, expressive writing, or social support activity affected their anxiety and if they would perform a similar activity before a course exam.

Measures

The Cognitive Test Anxiety scale (CTA) and the State Trait Anxiety Inventory (STAI) were used to measure participant cognitive test, state, and trait anxieties. The CTA is a 27-item questionnaire that focuses on behaviors before and during testing, including task-irrelevant thinking, making comparisons to others, and lapses in attention. It ranges from 27 (lowest anxiety) to 108 (highest anxiety). Previous studies classify a sample of participants as low or high test-anxious based on scoring in higher or lower percentiles [10, 34]. The STAI measures state (of the moment) and trait (of the person) anxiety with two twenty-item questionnaires. Each questionnaire ranges in score from 20 (lowest anxiety) to 80 (highest anxiety). Due to experimenter oversight, the state portion of the STAI was measured using nineteen of the twenty items, adjusting the range from 19 to 76. We believe the effects of this omission on our data to be inconsequential.

The final survey consisted of two five-point Likert scale questions: "[Intervention] helped reduce my stress or anxiety" and "I would [intervention] before a course exam," where [intervention] reflected the condition. The questions ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). We asked participants to explain their rating. Our goal was to gauge student perceptions of the assigned anxiety intervention. The open-ended responses were partitioned into idea units. Thematic codes were assigned to each unit on an initial pass, and subsequent passes were made to group similar themes into more abstract categories until they were reasonably exclusive. The programming problems were scored using input test cases and ranged from 0-100, with both problems weighted equally. Evaluations were performed blind to condition.

	CTA	Trait	State
CTA	1	--	--
Trait Anxiety	0.64**	1	--
Initial State Anxiety	0.73**	0.60**	1

Table 1. The correlations between the anxiety metrics. The CTA, trait anxiety, and initial state anxiety had moderate positive correlations. ** Indicates significance at the p < .001 level.

RESULTS

ANOVAs confirmed that participants in each condition did not differ for their initial state anxiety, C++ experience, cognitive test anxiety, trait anxiety, and pre-test scores. Additionally, we found that the CTA, state, and trait anxiety metrics had moderately positive correlations, as expected, and are reported in Table 1.

A Wilcoxon signed rank test revealed that participants in the social support condition found the responses they received to be supportive, (μ=4.62, σ=0.82, $p < .001$, d=2.80), confirming our manipulation and corroborating prior work [7]. The average number of likes, comments, and private messages per post were 41.8, 12.5, and 1.38, respectively.

Figure 7 shows the state anxiety of participants before and after the assigned anxiety intervention. From the plots, we saw that participants in the control group were largely unaffected by the task relevant reading activity. They also show that participants in the social support and expressive

	Low CTA	High CTA	All
Control	32 (7.9)	39.3 (8.8)	36.3 (8.4)
	29.2 (7.1)	38.1 (8.9)	35.1 (8.9)
	12	8	29
Writing	28.7 (7.2)	47.7 (10.0)	40.6 (12.3)
	47 (2.9)	44.4 (2.5)	46 (3.1)
	11	15	30
Social	28.7 (7.0)	46.6 (10.4)	37.9 (11.9)
	26.2 (6.7)	36.8 (6.4)	32.3 (8.3)
	11	12	29

Table 2. The pre / post state anxiety scores grouped by condition and CTA cluster. For each condition, the initial state anxiety (SD) is on the top row, the post state anxiety (SD) is on the second row, and the number of participants is on the third.

writing conditions were affected differently and we discuss these differences below.

Effects on Anxiety

Table 2 shows the means for the initial state anxiety and the post state anxiety for each condition. We computed the difference between the two state anxiety measurements for each participant. We conducted a one-way ANCOVA with the difference scores as the dependent variable and anxiety intervention as the factor. The Cognitive Test Anxiety score was included as a covariate. Results showed a main effect ($F(2,82)=21.59$, $p < 0.001$). Post hoc comparisons showed that the social support condition ($\mu=5.67$) had a larger decrease in anxiety than the control condition ($\mu=1.28$). Also, the control condition had a larger decrease in anxiety than the expressive writing condition ($\mu=-5.3$).

We performed a correlational analysis between the social media interactions (likes, comments, and private messages) and anxiety difference scores. The more substantive responses (comments and private messages), which we collectively refer to as *messages*, were compared to less substantive "likes". We found a moderately positive relationship between the number of messages received and anxiety difference scores ($r=0.55$, $p=0.002$, n=29), whereas the relationship between likes and anxiety difference scores was not significant ($r=0.32$, $p=0.09$, n=29).

Based on our main result and prior work we classified participants as "Low anxiety" if they scored in the bottom 40th percentile on the CTA and as "High anxiety" if they scored in the upper 40th percentile [10]. Table 2 shows the mean state anxiety before and after the intervention for each classification.

We performed an ANOVA with anxiety difference as the dependent variable and the CTA cluster and intervention as factors. For the control condition, we found no difference between the two CTA clusters on the difference scores, $F(1,18)=0.79$, $p=0.39$. For the social support condition, the analysis showed that the "High Anxiety" participants experienced a larger decrease in anxiety ($\mu=9.8$) than the "Low Anxiety" participants ($\mu=2.5$; $F(1, 21)=5.76$, $p=0.03$). For the expressive writing condition, the "Low Anxiety" participants experienced a larger increase in anxiety ($\mu=-18.3$) than the "High Anxiety" participants ($\mu=3.3$; $F(1,24)=30.13$, $p < 0.001$). These results indicate that social support decreased anxiety, especially for the "High Anxiety" participants, whereas expressive writing increased the anxiety for "Low Anxiety" participants.

	Low CTA	High CTA	All
Control	77.4 (29.8)	38.3 (24.9)	63.2 (30.9)
Writing	74.1 (25.6)	54.4 (28.2)	61.2 (31.3)
Social	62.7 (20.5)	67.4 (38.1)	67.6 (31.8)

Table 3. Means and (SD) of the programming task scores grouped by condition and CTA cluster.

Effects on Performance

To examine how the anxiety intervention affected the correctness of the programming solutions, we conducted a one-way ANCOVA using Cognitive Test Anxiety score as a covariate. Results showed an interaction between factors ($F(2,82)=3.24$, $p = 0.04$). To examine it we performed an ANOVA with correctness of solutions as the dependent variable and the CTA classification and anxiety intervention as factors. The results can be seen in Table 3.

For the social support condition, the "High Anxiety" ($\mu=67.4$, $\sigma=38.1$) and "Low Anxiety" ($\mu=62.7$, $\sigma=20.5$) participants showed no difference in the correctness of programming solutions ($F(1,21)=0.13$, $p=0.724$, $d=0.15$). Additionally, a correlational analysis between the social media interactions and performance scores revealed no significant relationships. In the expressive writing condition, our analysis showed a large noticeable difference between the means of the "High Anxiety" ($\mu=54.4$,$\sigma=28.2$) and "Low Anxiety" ($\mu=74.1$, $\sigma=25.6$) participants, but the analysis showed only a marginal effect ($F(1,24)=3.32$, $p=0.08$, $d=0.70$). Consistent with prior work, in the control condition the "High Anxiety" participants scored significantly worse on the programming solutions ($\mu=38.3$, $\sigma=24.9$) than the "Low Anxiety" participants ($\mu=77.4$, $\sigma=29.8$; $F(1,18)=9.35$, $p=0.007$, $d=1.16$). Together, these results indicate that both social support and expressive writing allowed the high test anxiety participants to perform as well as the low anxiety participants.

Participant Perceptions

We asked participants in the social support condition to explain which post made them feel most supported. We found that the authors of the posts participants identified included close friends, family members, people they admired, and friends who the participant had not recently communicated with. For example, one participant stated,

"*One of my friends privately reached out to me to express her support. She is one of my smartest friends, and it felt comforting to have her support going into this challenge*. (P62)" We also found various reasons for why the particular post made them feel supported, including it increased their confidence, put them at ease, made them laugh, or was unexpected. Some participants stated the effort others made by writing personal responses, finding supportive quotes from noteworthy people, or praying on behalf of the participant encouraged them. For example, one participant stated that their family member said, "*You do your best work with the word 'challenge' in it. Prayers are starting as of now." This participant said it was "encouraging to know that she was taking time out of her day to pray for me*. (P71)"

To evaluate responses about how participants perceived the effects of the assigned intervention on their anxiety, we conducted Wilcoxon signed rank tests on responses to the question "[Intervention] helped reduce my stress or anxiety." [Intervention] was replaced by the assigned condition. We used a Bonferroni adjustment on our significance threshold to be p=0.05/3=0.016. We found that the control and writing conditions had moderate effect sizes on perceived anxiety compared to a Neutral response, but were not significant: (μ=3.45, σ=1.05, p=0.04, d=0.60) and (μ=3.3, σ=0.92, p=0.09, d=0.46) respectively. In the social support condition, participants reported the responses significantly decreased their perceived anxiety (μ=3.59, σ=0.63, $p < 0.001$, d=1.33) when compared to a Neutral response. These results are consistent with our findings using the STAI measure.

From the open-ended responses explaining their rating, the main theme from the social support condition was "Emotionally Beneficial" (n=31). The "n=" indicates how many occurrences of this theme were in the data based on our previously mentioned coding scheme. This theme focused on liking the encouragement received and its ability to help them relax and increase their confidence. One participant stated, "*They restored my self-confidence*," (P77) when referring to the Facebook friends that left responses on their post. In the expressive writing condition, the two largest themes were "Emotionally Beneficial" and "Not Useful." The "Emotionally Beneficial" theme (n=13) stated that the activity helped them feel better, and reduced their anxiety. For example, one participant stated, "*After I write down the feeling I can calm down easier. (P45)*" The other theme was "Not useful" (n=8). Participants in this theme stated that the activity did not affect them. For example, one participant stated, "*I don't think it really helped that much with reducing any anxiety that I had*. (P34)" Finally, in the control condition, three themes emerged: "Mentally Beneficial," "Emotionally Beneficial," and "Not Useful." The "Mentally Beneficial" theme (n=11) contained responses that stated the reading helped refresh their memory or gave them an idea of what to expect. For example, one participant stated that it "*helped me gather my thoughts*" and was a "*valuable refresher that helped me to remember the general ideas which made it easier to think of the finer details later on. (P15)*" The "Emotionally Beneficial" theme (n=10) contained responses about increases in confidence and decreases in anxiety or stress. For example, one participant stated that the reading "*helped boost my confidence*, (P16)" and another stated that it "*put me at ease*. (P25)" Participants in the "Not Useful" theme (n=11) made statements such as "*It did nothing for me (P29)*" or "*I knew nearly everything that was written. (P2)*"

For the second question, "I would like to use [intervention] before a course exam," we conducted one-sample Wilcoxon signed rank tests on the responses, and adjusted our significance threshold using a Bonferroni adjustment (p=0.05/3=0.016). Our results showed that participants in the writing condition showed no difference from a Neutral response in how they answered the question (μ=2.77, σ=1.14, p=0.25, d=0.29). Participants in the control condition strongly favored referring to notes before an exam over a Neutral option (μ=4.0, σ=0.86, $p < 0.001$, d=1.67). Additionally, participants in the social support condition reported they would not elicit support of their Facebook friends before a course exam (μ=2.34, σ=1.14, p=0.005, d=0.81).

The open-ended responses explaining the rating revealed two themes in the control condition: "Reinforcement" and "Information Dependent." For "Reinforcement" (n=15), participants stated that they would prefer to read course notes before an exam because it boosted their confidence, provided a refresher, and calmed them. One participant stated, "*I would like to read before exam. Because it helps me to review the topic in class and gives me more confidence. (P7)*" For "Information Dependent" (n=5), participants stated that they would like to review course notes before an exam only if they did not know the material. One participant stated, "*If I wasn't well versed in a topic, it would be extremely helpful to read general information before taking an exam*. (P8)"

In the writing condition, there were two major themes: "Alternative" and "Positive Experience." For "Alternative" (n=19), participants stated that they found the writing exercise ineffective and in some cases felt it increased their anxiety. Participants also stated they would rather engage in other activities, such as reviewing course notes. For example, one participant stated, "*I am just too nervous to think of doing so before taking exams. I would rather read more review materials, maybe. Lol*. (P44)" For "Positive Experience" (n=7) participants stated that expressive writing calmed them or helped them organize their thoughts. For example, one participant stated, "*I think that I may benefit from writing about thoughts before an exam*. (P55)"

The most common theme in the social support condition was "Uncomfortable" (n=29). In this theme, participants stated that they would not like to rely on others or felt it

was uncharacteristic for them to broadcast messages for encouragement. For example, one participant stated, "*While I would like reading encouraging responses before an exam, I would not like posting to Facebook because this behavior seems attention seeking and slightly annoying in my opinion. (P88)*" Another participant stated, "I *would not post to Facebook like this again. It's not something that people do, and such a post is definitely out of place. I would, however, consider using a more passive and ephemeral media like Snapchat or Yik Yak. That has the benefits of not breaking social norms on FB*. (P74)"

DISCUSSION

Our study investigated how social support and expressive writing impact the state anxiety and solution correctness of open-ended programming problems for students. The results showed that supportive messages from a student's social network decreased the state anxiety of high test-anxious students by 21% before performing a mentally stressful activity. Further, the results showed that the number of messages (comments and private messages) received correlated with the reduction in anxiety, whereas the number of 'likes' did not correlate. They also showed that when completing programming tasks under pressure, supportive messages and expressive writing allowed high test-anxious students to perform similarly to low test-anxious students. However, expressive writing increased the anxiety of low test-anxious students by 61%, whereas the social support condition did not. Additionally, studying task-relevant materials had no effect on anxiety and high test-anxious students scored lower than low test-anxious students. Though the quantitative data favored the social support intervention, all of the students reported through the surveys that they were uncomfortable leveraging their online social network to elicit support. The discomfort stemmed from the public nature of the posts and concerns about being perceived as attention seeking.

Information disclosure research has shown that disclosing private information is perceived to be inappropriate for public posts on Facebook [3]. Participants may therefore have felt that asking for encouragement was too private to post on Facebook in our study. Additionally, previous work has shown that people perceive risks of being vulnerable when disclosing private information such as negative outcomes [50]. As a majority of the participants in our study were computer science students, the competitive environment of the curriculum may also have led to concerns about how others would perceive them [2]. They may have felt that such statuses could harm relations in group project settings. Further research is needed to understand if participants were uncomfortable with the specific formulation of seeking social support in our study or with seeking social support online generally.

Different formulations of seeking social support online, such as giving users more control over the audience, ephemerality, anonymity of the requests, and rhetorical strategies should be considered. Lists with only certain members of a user's social circle could be used to better control disclosure while still reaching a wide audience. For example, Haimson found that people undergoing gender transition used lists to manage their disclosure [16]. Reducing the length of time messages are visible to a social network by controlling ephemerality could also increase comfort. For example, Xu et al. found that participants had fewer concerns over self-presentation when using Snapchat (which allows ephemeral messages) compared to other communication tools [47]. Anonymity, such as on Yik Yak or Facebook Confessions Boards, has been shown to increase comfort as people are more willing to disclose to strangers [21]. Additionally, different rhetorical strategies have been shown to effect response rates in online communities [8]. In the context of this study, different strategies could include the phrasing of the requests and how much information is revealed pertaining to the request. Future work is needed to test how these formulations would affect students' comfort levels when seeking social support online, balanced against the speed, volume, and quality of the messages received.

Instructors who prefer not to use any social media platform could write and share supportive messages with students. For instance, students could be reminded of previous assignments where their performance was commendable. Instructors could also organize course-restricted online discussions where students could exchange supportive thoughts prior to exams.

Our results also contribute to understanding how expressive writing affects the anxiety and programming correctness of students. Previous work has suggested that expressive writing increases the performance of higher test anxious participants on exams, modular arithmetic tasks, and anagram tasks [31, 34]. Our results support this and extend this finding to open-ended tasks, such as programming. We also extend prior work by showing expressive writing negatively impacts the state anxiety of lower test anxious students. By expanding the scope of measures considered in prior work to also include student perceptions, we were able to learn that students with lower test anxiety felt the expressive writing "made them aware of their own anxiety," and "amplified their nervousness."

Social association with other participants and experimenter empathy has previously been found to aid in performance on anagram tasks [37]. Our work focuses on social support from members of a student's social network. Our findings show that supportive messages from Facebook friends help high test-anxious students score similarly to low test-anxious students on programming tasks. Additionally, our findings extend the literature by showing that reading supportive messages before performing open-ended tasks under pressure decreases the state anxiety of students.

Limitations

One limitation of this study is that all participants attended the same university and the majority were peers in the same course. Future work is needed to generalize our findings to other courses, exam formats, and university environments. It would also be interesting to test the generalizability of our findings in other evaluative situations, such as in job interviews and programming competitions. Prior work showed that women reported increased anxiety for computer-based tests, whereas men reported decreased anxiety [15]. In our present study, we were unable to examine effects of gender or race due to insufficient sample sizes in our participant pool. Further research is needed to examine how these anxiety interventions affect different demographics.

Our study design allowed participants in the social support condition to view their supportive messages before they arrived at the experiment. We asked participants to refrain from viewing these messages, but we could not be sure that the first time participants viewed the responses was in the laboratory. This could have been controlled by constructing a more artificial study, but this may have limited the ecological validity of our experimental design. Further research is needed to understand if viewing messages more than a few minutes before a testing situation affects student test anxiety and performance.

Future Work

We see at least three additional directions of work for reducing anxiety during programming exams. One direction is investigating how anxiety affects the coding behavior of programmers at a more granular level. For example, prior work has shown the feasibility of detecting stress by analyzing mouse and keyboard interaction [19, 24, 44, 45]. Expanding this work to understand how anxiety relates to edit, compilation, and execution behavior could lead to possible targeting of anxiety reduction methods within the programming interface. A second direction for future work focuses on how sharing the benefit that supportive messages had on anxiety and solution correctness could encourage others to adopt the strategy. Tracing how student perceptions change as they view peers seeking support may lead to less reservation around using broadcast messages for support. A third direction is studying how regularly seeking social support from one's social network affects anxiety and performance, and how it affects the response rate.

CONCLUSION

Test anxiety is pervasive and particularly acute for open-ended questions on exams. The contribution of this work was to compare how a novel intervention implemented using social media affects student anxiety and solution quality relative to expressive writing for exams with open-ended programming questions. We found that an expressive writing intervention allowed high test-anxious students to perform as well as low test-anxious students, but increased the anxiety of low test-anxious students by 61%. We also found that supportive messages from a student's own social network decreased the anxiety of high test-anxious students by 21% and allowed them to perform similarly to low test-anxious students on programming tasks. Though the effects of this intervention are promising, our results show that many students are uncomfortable requesting social support from their online social network. Realizing the benefits of this approach may therefore require different formulations of social support in practice. It is our hope that this work will inspire instructors, researchers, and practitioners to explore methods of reducing anxiety in evaluative situations, allowing each person to perform at their best.

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REFERENCES

1. Arezou Asghari, Rusnani Abdul Kadir, Habibah Elias, and Maznah Baba. 2012. Test Anxiety and It's Related Concepts: A Brief Review. *GESJ: Education Science and Psychology* 22, 3: 3-8.
2. Lecia Jane Barker, Kathy Garvin-Doxas, and Michael Jackson. 2002. Defensive Climate in the Computer Science Classroom. In *Proceedings of the 33rd ACM Technical Symposium on Computer Science Education,* 43-47. http://dx.doi.org/10.1145/563517.563354.
3. Natalya N. Bazarova. 2012. Contents and Contexts: Disclosure Perceptions on Facebook. In *Proceedings of the 15th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 369-372. http://dx.doi.org/10.1145/2145204.2145262.
4. William E. Becker and Carol Johnston. 1999. The Relationship Between Multiple Choice and Essay Response Questions in Assessing Economics Understanding. *The Economic Record* 75, 231: 348-357. http://dx.doi.org/10.1111/j.1475-4932.1999.tb02571.x.
5. Jeri Benson and Nabil El-Zahhar. 1994. Further Refinement and Validation of the Revised Test Anxiety Scale. *Structural Equation Modeling: A Multidisciplinary Journal* 1, 3: 203-221. http://dx.doi.org/10.1080/10705519409539975.
6. Ronald A. Berk and Joy Nanda. 2006. A randomized trial of humor effects on test anxiety and test performance. *Humor: International Journal of Humor Research* 19, 4: 425-454. http://dx.doi.org/10.1515/humor.2006.021.
7. Moira Burke and Mike Develin. 2016. Once More with Feeling: Supportive Responses to Social Sharing on Facebook. In *Proceedings of the 19th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 1460-1472. http://dx.doi.org/10.1145/2818048.2835199.
8. Moira Burke, Elisabeth Joyce, Tackjin Kim, Vivek Anand, and Robert Kraut. 2007. Introductions and Requests: Rhetorical Strategies That Elicit Response in Online Communities. *Communities and Technologies*:

21-39. http://dx.doi.org/10.1007/978-1-84628-905-7_2.
9. Moira Burke and Robert Kraut. 2013. Using Facebook after Losing a Job: Differential Benefits of Strong and Weak Ties. In *Proceedings of the 16th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 1419-1429. http://dx.doi.org/10.1145/2441776.2441936.
10. Jerrell C. Cassady and Ronald E. Johnson. 2002. Cognitive Test Anxiety and Academic Performance. *Contemporary Educational Psychology* 27, 2: 270-295. http://dx.doi.org/10.1006/ceps.2001.1094.
11. Beth G. Chung, Mark G. Ehrhart, Karen Holcombe Ehrhart, Keith Hattrup, and Jerry Solamon. 2009. Stereotype Threat, State Anxiety, and Specific Self-Efficacy as Predictors of Promotion Exam Performance. *Group & Organization Management* 35, 1: 77-107. http://dx.doi.org/10.1177/1059601109354839.
12. Sheldon Cohen and Thomas Ashby Wills. 1985. Stress, Social Support, and the Buffering Hypothesis. *Psychological Bulletin* 98, 2: 310-356. http://dx.doi.org/10.1037/0033-2909.98.2.310.
13. Jerry L. Deffenbacher, Sheila R. Deitz, and Susan L. Hazaleus. 1981. Effects of Humor and Test Anxiety on Performance, Worry, and Emotionality in Naturally Occuring Exams. *Cognitive Therapy and Research* 5, 2: 225-228. http://dx.doi.org/10.2466/pr0.1999.84.3c.1203.
14. Jerry L. Deffenbacher and Richard M. Suinn. 1988. Systematic Desensitization and the Reduction of Anxiety. *The Counseling Psychologist* 16, 1: 9-30. http://dx.doi.org/10.1177/0011000088161002.
15. Robert Deloatch, Brian P. Bailey, and Alex Kirlik. 2016. Measuring Effects of Modality on Perceived Test Anxiety for Computer Programming Exams. In *Proceedings of the 47th ACM Technical Symposium on Computing Science Education,* 291-296. http://dx.doi.org/10.1145/2839509.2844604.
16. Oliver L. Haimson, Jed R. Brubaker, Lynn Dombrowski, and Gillian R. Hayes. 2015. Disclosure, Stress, and Support During Gender Transition on Facebook. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 1176-1190. http://dx.doi.org/10.1145/2675133.2675152.
17. Gregory R. Hancock. 1994. Cognitive Complexity and the Comparability of Multiple-Choice and Constructed Response Test Formats. *Journal of Experimental Education* 62, 2: 143-157. http://dx.doi.org/http://dx.doi.org/10.1080/00220973.1994.9943836.
18. Ray Hembree. 1988. Correlates, Causes, Effects, and Treatment of Test Anxiety. *Review of Educational Research* 58, 1: 47-77. http://dx.doi.org/10.3102/00346543058001047.
19. Javier Hernandez, Pablo Paredes, Asta Roseway, and Mary Czerwinski. 2014. Under pressure: Sensing Stress of Computer Users. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* 51-60. http://dx.doi.org/10.1145/2556288.2557165.
20. James G. Hollandsworth Jr., Robert C. Glazeski, Karl Kirkland, Gary E. Jones, and Laura R. Van Norman. 1979. An Analysis of the Nature and Effects of Test Anxiety: Cognitive, Behavioral, and Physiological Components. *Cognitive Therapy and Research* 3, 2: 165-180. http://dx.doi.org/10.1007/BF01172603.
21. Ruogu Kang, Laura A. Dabbish, and Katherine Sutton. 2016. Strangers on Your Phone: Why People Use Anonymous Communication Applications. In *Proceedings of the 19th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 358-369. http://dx.doi.org/10.1145/2818048.2820081.
22. Dominic Kao and D. Fox Harrell. 2016. Exploring the Effects of Encouragement in Educational Games. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Extended Abstracts,* 1906-1914. http://dx.doi.org/10.1145/2851581.2892335.
23. Kristopher J. Kimbler, Jennifer A. Margrett, and Tara L. Johnson. 2012. The role of supportive messages and distracting thoughts on everyday problem-solving performance. *Experimental Aging Research* 38, 5: 537-558. http://dx.doi.org/10.1080/0361073X.2012.726158.
24. Artie Konrad, Victoria Bellotti, Nicole Crenshaw, Simon Tucker, Les Nelson, Honglu Du, Peter Pirolli, and Steve Whittaker. 2015. Finding the Adaptive Sweet Spot: Balancing Compliance and Achievement in Automated Stress Reduction. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems,* 3829-3838. http://dx.doi.org/10.1145/2702123.2702512.
25. Jonas W.B. Lang and Jessica Lang. 2010. Priming competence diminishes the link between cognitive test anxiety and test performance. Implications for the interpretation of test scores. *Psychological Science* 21, 6: 811-819. http://dx.doi.org/10.1177/0956797610369492.
26. Michael Massimi, Jackie L. Bender, Holly O. Witteman, and Osman H. Ahmed. 2014. Life transitions and online health communities. In *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 1491-1501. http://dx.doi.org/10.1145/2531602.2531622.
27. Angus S. Mcdonald. 2001. The Prevalence and Effects of Test Anxiety in School Children. *Educational Psychology* 21, 1: 89-101. http://dx.doi.org/10.1080/01443410020019867.
28. W.J. Mckeachie, Donald Pollie, and Joseph Speisman. 1955. Relieving Anxiety in Classroom Examinations.

The Journal of Abnormal and Social Psychology 50, 1: 93-98. http://dx.doi.org/http://dx.doi.org/10.1037/h0046560.

29. Mark W. Newman, Debra Lauterbach, Sean A. Munsun, Paul Resnick, and Margaret E. Morris. 2011. "It's not that I don't have problems, I'm just not putting them on Facebook": Challenges and Opportunities in Using Online Social Networks for Health. In *Proceedings of the 14th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 341-350. http://dx.doi.org/10.1145/1958824.1958876.
30. Deborah A. Olson, Jeanny Liu, and Kenneth S. Shultz. 2012. The Influence of Facebook Usage on Perceptions of Social Support, Personal Efficacy, and Life Satisfaction. *Journal of Organizational Psychology* 12, 3/4: 133-144.
31. D. Park, G. Ramirez, and S. L. Beilock. 2014. The role of expressive writing in math anxiety. *Journal of Experimental Psychology: Applied* 20, 2: 103-111. http://dx.doi.org/10.1037/xap0000013.
32. James W. Pennebaker and Sandra Klihr Beall. 1986. Confronting a Traumatic Even: Toward an Understanding of Inhibition Disease. *Journal of Abnormal Psychology* 95, 3: 274-281. http://dx.doi.org/10.1037//0021-843X.95.3.274.
33. Dave Putwain and Anthony L. Daly. 2014. Test anxiety prevalence and gender differences in a sample of English secondary school students. *Educational Studies* 40, 5: 554-570. http://dx.doi.org/10.1080/03055698.2014.953914.
34. G. Ramirez and S. L. Beilock. 2011. Writing about testing worries boosts exam performance in the classroom. *Science* 331, 211: 211-213. http://dx.doi.org/10.1126/science.1199427.
35. Martin Saerbeck, Tom Schut, Christoph Bartneck, and Maddy D. Janse. 2010. Expressive Robots in Education Varying the Degree of Social Supportive Behavior of a Robotic Tutor. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* 1613-1622. http://dx.doi.org/10.1145/1753326.1753567.
36. Irwin G. Sarason. 1978. The Test Anxiety Scale: Concept and Research. *in C. D. Spielberger & I. G. Sarason, (Eds.) Stress and Anxiety* 5: 193-216.
37. Irwin G. Sarason. 1981. Test Anxiety, stress, and social support. *Journal of Personality* 49, 1: 101-114. http://dx.doi.org/10.1111/j.1467-6494.1981.tb00849.x.
38. Irwin G. Sarason. 1984. Stress, Anxiety, and Cognitive Interference: Reactions to Tests. *Journal of Personality and Social Psychology* 46, 4: 929-938. http://dx.doi.org/10.1037/0022-3514.46.4.929.
39. Irwin G. Sarason, Barbara R. Sarason, Dennis E. Keefe, Bob E. Hayes, and Edward N. Shearin. 1986. Cognitive Interference: Situational Determinants and Traitlike Characteristics. *Journal of Personality and Social Psychology* 51, 1: 215-226. http://dx.doi.org/http://dx.doi.org/10.1037/0022-3514.51.1.215.
40. Cathy Donald Sherbourne and Anita L. Stewart. 1991. The MOS Social Support Survey. *Social Science and Medicine* 32, 6: 705-714. http://dx.doi.org/10.1016/0277-9536(91)90150-B.
41. Mark G. Simkin and William L. Kuechler. 2005. Multiple-Choice Tests and Student Understanding: What Is the Connection? *Decision Sciences Journal of Innovative Education* 3, 1: 73-97. http://dx.doi.org/10.1111/j.1540-4609.2005.00053.x.
42. Richard E. Snow. Construct validity and constructed-response tests. In *Construction versus choice in cognitive measurement*, W.C. Ward and R.E. Bennett Eds. Routledge,1993, Hillsdale, NJ, 45-60|.
43. Charlers D. Speilberger, Lushene R. Gorsuch, P.R. Vagg, and G.A. Jacobs. 1983. Manual for the State-Trait Anxiety Inventory. *Consulting Psychologists Press*.
44. David Sun, Pablo Paredes, and John Canny. 2014. MouStress: Detecting Stress from Mouse Motion. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* 61-70. http://dx.doi.org/10.1145/2556288.2557243.
45. Lisa M. Vizer. 2009. Detecting Cognitive and Physical Stress Through Typing Behavior. In *Proceedings of the Extended Abstracts on Human Factors in Computing Systems,* 3113-3116. http://dx.doi.org/10.1145/1520340.1520440.
46. Yi-Chia Wang, Robert Kraut, and John M. Levine. 2012. To Stay or Leave? The Relationship of Emotional and Informational Support to Commitment in Online Health Support Groups. In *Proceedings of the 15th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 833-842. http://dx.doi.org/10.1145/2145204.2145329.
47. Bin Xu, Pamara Chang, Christopher L. Welker, Natalya N. Bazarova, and Dan Cosley. 2016. Automatic Archiving versus Default Deletion: What Snapchat Tells Us About Ephemerality in Design. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing,* 1660-1673. http://dx.doi.org/10.1145/2818048.2819948.
48. Moshe Zeidner. 1987. Essay versus Multiple-Choice Type Classroom Exams: The Student's Perspective. *The Journal of Educational Research* 80, 6: 352-358.
49. Moshe Zeidner. 1998. *Test Anxiety: The State of the Art*. Plenum Press.
50. Chen Zhao, Pamela Hinds, and Ge Gao. 2012. How and To Whom People Share: The Role of Culture in Self-Disclosure in Online Communities. In *Proceedings of the 15th ACM Conference on Computer Supported Cooperative Work & Social Computing,* 67-76. http://dx.doi.org/10.1145/2145204.2145219.