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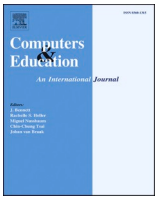

Supporting students' intrinsic motivation for online learning tasks: The effect of *need-supportive* task instructions on motivation, self-assessment, and task performance

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ABSTRACT

Self-determination theory argues that students' intrinsic motivation is cultivated when teachers teach in ways that meet students' basic psychological needs for autonomy, competence, and relatedness (i.e., need-supportive teaching). However, the suspension of in-person teaching and learning due to the COVID-19 pandemic has urged teachers to search for strategies to practice need-supportive teaching online. This study tested the effect of *need-supportive* task instruction on students' situational intrinsic motivation in an online language learning task. We also examined whether the ensuing intrinsic motivation on the task would positively predict task performance directly or indirectly through self-assessment practice. Controlling for pre-test situational intrinsic motivation, secondary school students randomly assigned to the need-supportive task instruction ($n = 56$) showed significantly higher situational intrinsic motivation than those in the control group ($n = 50$). The need-supportive task instructions had a medium effect size on intrinsic motivation. Although such intrinsic motivation had no direct effect on task performance, it yielded significant indirect effects via self-assessment practice. Post-hoc moderated mediation analysis demonstrated that the indirect effect of intrinsic motivation on task performance was specific to students in the need-supportive task instruction group. Overall, need-supportive statements embedded in task instructions generated increased intrinsic motivation on an online task. As schools transition to the new normal of education, this study presents a unique opportunity for educators to implement theoretically informed, brief, and sustainable interventions to support students' motivation and learning online.

1. Introduction

Schools in over 138 countries have closed and have been compelled to conduct all teaching and learning activities online due to the COVID-19 pandemic (UNESCO, 2021; Van Lancker & Parolin, 2020). Such school closures led to students' learning loss (e.g., Engzell et al., 2021), and the abrupt shift to online learning presented a myriad of challenges in teaching and learning (see Chiu et al., 2021; Dhawan, 2020). Student motivation, among other adaptive school outcomes, was heavily impacted during the pandemic (Daniels et al., 2021), exacerbating the pre-existing concerns about students' low school motivation, particularly in secondary school (see Cai

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et al., 2022; Gnambs & Hanfstingl, 2016; Gottfried et al., 2007). Given how crucial intrinsic motivation is in developing and maintaining learning and achievement online (see Hartnett, 2016), effective and sustainable interventions are urgently needed to ameliorate low motivation and recover students' learning losses.

To increase students' intrinsic motivation in class, teachers relied on need-supportive teaching (NST), which creates a learning environment that supports students' basic psychological needs for relatedness, competence, and autonomy (Leenknecht et al., 2017; Reeve, 2006; Ryan & Deci, 2000, 2017; Vansteenkiste et al., 2012). Teachers practice NST by being more involved and caring, setting actionable and clear goals, communicating flexibility in students' learning strategies, and explaining the rationale for learning tasks (Haerens et al., 2015; Pelletier & Rocchi, 2016; see also Taylor & Ntoumanis, 2007). Evidence suggests that students' perception of a need-supportive learning context optimizes various students' learning outcomes (e.g., achievement, motivation, engagement, well-being; Baeten et al., 2013; Mouratidis et al., 2011; Olivier et al., 2021; Pelikan et al., 2021; Reeve, 2012; Reeve & Jang, 2006; Wang et al., 2021; see Stroet et al., 2013 for a review). However, much of the research on NST has been conducted in in-person learning contexts. Hence, given the shift to online learning due to the COVID-19 pandemic, it is necessary to explore how teachers can support students' basic psychological needs in online contexts and what implications this might have for their intrinsic motivation, self-assessment practice, and achievement.

This study aims to explore how task instructions framed with need-supportive statements can support motivation and the mechanisms that could explain the potential effect of such motivation on task performance. More specifically, we aim to examine whether need-supportive task instructions can increase the situational intrinsic motivation of secondary school students on an online language learning task. Situational intrinsic motivation is an appropriate outcome given the study's experimental design (see Grouzet et al., 2004). We regarded the situational specificity of intrinsic motivation as a relevant contextualization since the examined intrinsic motivation is for a specific learning task (Guay et al., 2000; Lonsdale et al., 2011; Ryan, 1995) and not for a generalor global learning domain.

Subsequently, we aim to test how the intrinsic motivation derived from need-supportive task instructions can directly improve task performance or indirectly through self-assessment practice as a mediator. Self-assessment practice is posed as a mediator due to the crucial role of self-directed learning in online contexts (Kim & Frick, 2011). Previous findings have also demonstrated self-assessment practice as a behavioural mechanism that can link motivation to achievement scores (Mendoza et al., 2022). This study also aims to yield several implications for teaching and learning in online contexts. First, the current study intends to generate evidence highlighting potential actionable pathways to foster intrinsic motivation in students' online learning tasks by testing the motivational implications of need-supportive statements embedded in the instructions of a language learning task (cf. Chiu et al., 2021; McEown & Oga-Baldwin, 2019). Second, by directly or indirectly testing the influence of situational intrinsic motivation on task performance, we can examine and identify behavioural mechanisms that can explain how motivation impacts task performance. Finally, it is hoped that the findings from this study can inform innovative ways to support student motivation in online learning. Such innovation is necessary to foster and maintain intrinsic motivation for online learning tasks and overcome the pervasive challenges driven by online learning during the pandemic and beyond.

2. Theoretical background and research hypotheses

In this intervention study, the self-determination theory (Deci, Deci, & Ryan, 1985; Ryan & Deci, 2000) and its mini-theory (i.e., basic psychological needs theory; Ryan & Deci, 2017; Vansteenkiste et al., 2010; Vansteenkiste et al., 2020) was integrated with wise interventions (Walton & Wilson, 2018; Walton & Yeager, 2020) to develop a brief intervention administered within an online learning task. The aim of the intervention is to foster intrinsic motivation for students' online tasks. Furthermore, self-assessment practice (Yan, 2020; Yan & Brown, 2017) is included as a behavioural mechanism that can potentially link the ensuing intrinsic motivation to task performance. The theoretical integration of these theories is vital for developing a brief intervention that can generate students' intrinsic motivation for an online learning task. We further discuss these in the subsections below.

2.1. Satisfying students' basic psychological needs through need-supportive instructions

Self-determination theory (SDT) rests on the fundamental assumption that individuals, by nature, are inherently driven by curiosity and desire for learning (Deci & Ryan, 2000; Ryan & Deci, 2000, 2017; Vansteenkiste et al., 2010). In essence, people are inherently intrinsically motivated. However, there are circumstances when students do not present an intrinsic desire for learning and instead display a lack of motivation. According to the Basic Psychological Needs mini-theory of SDT (see Vansteenkiste et al., 2010; Vansteenkiste et al., 2020 for reviews), individuals' basic psychological needs for *autonomy*, *competence*, and *relatedness* must be satisfied to sustain their intrinsic motivation (Ryan & Deci, 2017; Vansteenkiste et al., 2010, 2020). *Autonomy* refers to the need to have self-endorsed behaviours or having a clear task rationale, *competence* is the need for a sense of ability to engage effectively with desired tasks, and *relatedness* covers the need to have a caring and close connection with others (Vansteenkiste et al., 2020). In school, these needs are satisfied by teachers' need-supportive teaching practices (Reeve, 2006; Ryan & Deci, 2000, 2017; Vansteenkiste et al., 2012, Nalipay et al., 2020).

Teachers use several instructional practices to satisfy students' basic psychological needs inside the classroom. For instance, a teacher can explain the rationale behind school tasks to satisfy autonomy needs, promote the importance of effort over results to satisfy competence needs, or encourage and cheer on students to evoke a sense of confidence and trust that satisfies students' relatedness needs (see Ahmadi et al., 2022; Reeve, 2006, 2016; Ryan & Deci, 2017). These teaching practices can target specific needs (e.g., autonomy-supportive teaching to satisfy autonomy needs; Reeve, 2016; Reeve et al., 1999), although one need-supportive teaching

(NST) practice can also satisfy multiple needs (see Leenknecht et al., 2017; Olivier et al., 2021; Reeve, 2012; Vansteenkiste et al., 2020 for the non-orthogonal effects of need-supportive teaching). As such, NST practices are actionable pathways toward fostering intrinsic motivation among students. However, many of these findings are based on cross-sectional or longitudinal data limiting causal interpretations. Moreover, these practices are naturally impeded by the sudden shift to online learning due to the COVID-19 pandemic. Furthermore, although teachers can still teach in a manner that is responsive to students' basic psychological needs in online contexts (see Oga-Baldwin, 2015; Turk et al., 2022), such strategies and pedagogies remain limited.

Still, NST practices remain relevant online and can influence adaptive student outcomes (e.g., engagement, achievement; Chen & Jang, 2010, Chiu, 2022). A recent study involving students from 17 countries also emphasized the value of the satisfaction of basic psychological needs on students' intrinsic motivation in distance learning during the pandemic (Pelikan et al., 2021). Longitudinal and empirical evidence also highlights the importance of basic psychological needs satisfaction in online learning during the COVID-19 pandemic (see Chiu, 2022; Holzer et al., 2021). Despite these, the asynchronous nature of online learning—which offers limited real-time interaction between teachers and students—continues to pose an inherent barrier to meeting students' basic psychological needs. How can teachers effectively and sustainably support students' basic psychological needs online?

2.2. The effectiveness of brief online interventions to support basic psychological needs

Brief interventions can have potent and lasting effects if they tap into how people see themselves in a specific context or task (e.g., wise interventions; Walton & Wilson, 2018; Walton & Yeager, 2020). For example, brief randomized experiments show that tweaking a question from "*How important is it to you to vote* [verb] *in tomorrow's election?*" to "*How important is it to you to be a voter* [noun] *in tomorrow's election?*" significantly increased voter turnouts in the US (see Bryan et al., 2011; Walton, 2014 for a list of wise interventions across domains). Walton (2014) argued that noun wording (i.e., "*to be a voter*") places value on taking an identity of value as a voter, whereas verb wording (i.e., "*to vote*") may present voting as a mere errand. This suggests that how statements are communicated can have psychological and behavioural effects.

Relatedly, meta-analytic evidence highlights the effectiveness of online interventions designed to enhance student motivation (see Lazowski & Hulleman, 2016). Specifically, brief task-based interventions informed by the self-determination theory (Deci et al., 1985; Ryan & Deci, 2000, 2017) have been shown to impact positive student outcomes significantly (e.g., intrinsic motivation, prosocial behaviours; Jeno et al., 2020; Kanat-Maymon et al., 2015; Pavey et al., 2011; Sheldon & Filak, 2008; Vaughn, 2017). When students' basic psychological needs are supported in digital learning environments, this helps learners persist and stay motivated in their learning tasks (Chiu, 2022; see also Oga-Baldwin, 2015). The interventions are implemented by framing statements to be worded in a way that supports students' basic psychological needs for relatedness, competence, and autonomy (Kanat-Maymon et al., 2015; Pavey et al., 2011). Among other need-supportive statements, statements such as "*One thing to keep in mind is that these tasks are quite challenging, and beginners find that they do not meet the time pressures. Just do the best you can, and you will improve quickly.*" to support competence needs have been shown to increase autonomous motivation (see Kanat-Maymon et al., 2015). These interventions can impact outcomes such as prosocial motivation (Pavey et al., 2011), self-regulatory focus (Vaughn, 2017), mood (Sheldon & Filak, 2008), and even decrease cheating behaviour (Kanat-Maymon et al., 2015).

In such studies, experimenters use brief priming interventions by reading instructions phrased to manipulate basic psychological needs (see Sheldon & Filak, 2008). For example, an experimenter verbalizing autonomy-supportive statements such as "*In this experiment, you will be given two tasks. In the first task, I just want you to play around with the puzzles, learning to do them your own way. You can choose which puzzle to start with. Just try to get into it and see where it goes*" can satisfy autonomy needs (Kanat-Maymon et al., 2015). However, very little research has incorporated these experiments on specific learning tasks, that is, phrasing the instructions of school tasks to be need-supportive. Furthermore, while efforts have been made to integrate such statements online (e.g., learning apps; Jeno et al., 2020), brief interventions focused on satisfying basic psychological needs on online school tasks remain in their early stages. The literature on theoretically informed online interventions holds the foundation of the conditions of this experimental study.

2.3. Self-assessment practice as a behavioural mechanism linking intrinsic motivation to task performance

Intrinsic motivation provides a self-directed drive behind a behaviour. It correlates with increased mastery (Turner et al., 2002), higher achievement (Lepper et al., 2005; Taylor et al., 2014), greater persistence (Abuhamdeh & Csikszentmihalyi, 2009), and better psychological health (see Froiland et al., 2012). However, research continues to call for studies that examine the mechanisms that can explain how intrinsic motivation improves school performance. Not because intrinsic motivation alone cannot lead to improved performance, but rather because there could be behaviours that can account for such an effect. Identifying such behaviours holds practical implications for interventions. Research has shown that self-regulated learning (SRL) strategies can act as mediators linking motivation to achievement (see Feraco et al., 2022; Leenknecht et al., 2020; see also Mendoza et al., 2022). A fundamental strategy in the SRL process is self-assessment practice (Yan & Brown, 2017).

Self-assessment practice is considered a 21st-century learning skill (see Dweck, 2009) and a vital behavioural component of SRL (Yan, 2020; Yan & Brown, 2017). It refers to a process through which learners "reflect on the quality of their work, judge the degree to which it reflects explicitly stated goals or criteria, and revise accordingly" (Andrade & Valtcheva, 2009, p. 13). This self-directed behaviour is enacted by determining the assessment criteria, seeking feedback information from various sources, and self-reflecting on ways to improve (McMillan & Hearn, 2008; Yan & Brown, 2017; Yan & Carless, 2021). Meta-analytic (see Panadero et al., 2017; Sitzmann et al., 2010; Yan et al., 2021) and empirical findings (Leenknecht et al., 2020; Panadero et al., 2012; Yan, 2018b, 2020) have shown that students' self-assessment practice can act as a key lever that can improve achievement in English language learning

(see Mendoza et al., 2022 for reference on how self-assessment practice is embedded within the self-system model of motivational development). Given the importance of self-directed learning in online contexts (Kim & Frick, 2011), it is theoretically and practically relevant to examine self-assessment practice as a mediator linking motivation to performance. Examining the causal link between intrinsic motivation on task performance via behavioural mechanisms such as self-assessment practice within an experimental design has been deemed necessary (see Mendoza et al., 2022).

2.4. The present study

This study was a randomized experiment that recruited secondary school students for an online learning task. We compared the effect of a need-supportive task instruction and a default task instruction on students' situational intrinsic motivation, task-specific self-assessment practice, and task performance in an online language learning task. We hypothesized that need-supportive task instructions would help generate increased intrinsic motivation resulting in higher self-assessment practice which, in turn, improves task performance. The specific hypotheses of this study are as follows:

H1. Participants in the need-supportive task instructions group would have higher intrinsic motivation than the control group while controlling for their pre-test motivation

H2. Intrinsic motivation will directly influence task performance (H2.1) or indirectly via self-assessment practice (H2.2)

3. Methods

3.1. Participants

We used G* Power (Faul et al., 2009) to compute the required sample size a priori. Specifically, we used F tests analysis of covariance (ANCOVA), where the entered effect size, alpha error probability, and power as 0.40, 0.05, and 0.95, respectively. The number of groups was two, the numerator degree of freedom was two, and the number of covariates was one. The output parameters indicate that the total sample size required is 100, with a critical F of 3.09. For the experiment, we recruited 123 secondary school students attending a public science high school in a highly urbanized city in Central Luzon, Philippines. This school is specifically chosen as it is among the few schools that implemented online learning during the COVID-19 pandemic. Seven students opted out of the study halfway through the experiment. Five observations were excluded due to spurious responses, and five students failed to answer the items for the attention check[1]. The final sample size was 106 ($n = 56$ for intervention group; $n = 50$ for the control group). This sample size was within the required sample size calculation and is considered adequate similar to previous related experiments (e.g., Chung et al., 2020; Kanat-Maymon et al., 2015; Radel et al., 2015). The average age of the participants was 15.77 years old (SD = 0.58). As a proxy for socioeconomic status, 73 (68.22%) of the participants reported that their mother's highest educational attainment was graduating college. This suggests that the students are from the lower middle class in terms of their socioeconomic status.

3.2. Instruments

3.2.1. Situational intrinsic motivation

The 4-item intrinsic motivation subscale of the situational motivation scale (SIMS; Guay et al., 2000; see also Standage et al., 2005) was used to assess intrinsic motivation for a specific task. A stem of "Why are you currently doing this task" is followed by statements on intrinsic motivation, such as "Because I think that this task is interesting". The response options ranged from 1 (*not at all*) to 7 (*exactly*). The Cronbach's alpha of this scale was 0.94 and.93 for the pre-test and post-test, respectively. The scale's construct validity had excellent fit to the data, $SB\chi^2(6) = 230.587$, CFI = 1.000, TLI = 1.000, RMSEA = 0.000 (95% C.I. = 0.000–0.142), SRMR = 0.005.

3.2.2. Self-assessment practice

A 5-item task-specific self-assessment practice was devised based on the Self-assessment Practice Scale (SaPS; Mendoza & Yan, 2021b; Yan, 2018a) by targeting the five key practices of self-assessment practice on a specific task. The five core processes and their respective task-specific adaptations are as follows: determining criteria ("I know what I need[ed] to do in order to do the task correctly"), seeking feedback via monitoring (I reviewed the instructions and double-checked my answers to check if I'm doing the task correctly), seeking feedback via inquiry ("I asked a question or sought feedback in the Zoom chat regarding the task"), seeking internal feedback ("I evaluated how well or poorly I did on the tasks based on how I generally felt"), and self-reflection ("I reflected on what I can do to perform better for the next time I do the task"). The items are responded to on a 5-point scale from 1 (*not at all*) to 5 (*always*). The third item, focused on inquiry, was not included in the analyses since most students did not ask a question due to the nature of the task being administered online. The Cronbach's alpha of this scale was 0.75, and the scale's construct validity had adequate fit to the data, $SB\chi^2(6) = 67.913$, CFI = 0.968, TLI = 0.903, RMSEA = 0.119 (95% C.I. = 0.000–0.241), SRMR = 0.040.

[1] We asked two dichotomous questions to check for attention: (1) "Were you able to read and understand the instructions?" which is answerable with "yes" or "no", and (2) "This is a question to check if you are reading attentively, please click "No" as your answer below."

3.2.3. Basic psychological needs

We devised a 4-item scale to assess students' satisfaction of basic psychological needs on a specific task (BPN-ST). This was used as an instrument for the manipulation check or to determine whether the manipulated task instructions were perceived. The items were based on the conceptual tenets of basic psychological needs theory (Ryan & Deci, 2017; Vansteenkiste et al., 2020) and from the items of the adolescent basic psychological needs scale (Tian et al., 2014). Two items evaluated the satisfaction of the need for autonomy ("I understand the reason behind doing this task", "I feel free to engage on this task in a way that suits me"), one item for the satisfaction of needs for relatedness ("I feel comfortable and supported in doing this task"), and one item for competence need satisfaction ("I feel confident in my ability to do this task well"). The global contribution of each basic psychological needs satisfaction (i.e., the merging of items under one global needs support or satisfaction; Olivier et al., 2021) has been found to accurately approximate basic psychological needs satisfaction (see Haw et al., 2021; Haw & King, 2022). Students responded to these statements with a 1 (*strongly disagree*) to 5 (*strongly agree*). The Cronbach's alpha of this scale was 0.85, and the scale's construct validity had adequate fit to the data, $SB\chi^2(6) = 157.954$, CFI = 0.974, TLI = 0.922, RMSEA = 0.139 (95% C.I. = 0.000–0.318), SRMR = 0.037.

3.2.4. Task performance

The online learning task to assess task performance was a C-test (Eckes & Grotjahn, 2006; Norris, 2018). C-tests are brief assessment instruments that measure global foreign language proficiency in written form (see Klein-Braley, 1997; Norris, 2018). It is a language learning task where participants are instructed to complete mutilated words to make meaningful sentences. This task was chosen because it is straightforward to answer with sufficient novelty. The number of correctly filled words on the C-test had 25 mutilated words. The mean score was 23.72.

3.3. Procedures

Before implementing the procedures detailed below, a pilot test with ten secondary school students was conducted. The students in the pilot went through both the intervention condition and the control condition. We sought comments on the procedures from the students. We found parts of the online task that can be improved to make the task less tedious (e.g., reducing the page breaks on the online platform), and the readability of the font type and size was optimized for laptop use. Notably, the pilot test also helped refine the experiment's logistics and procedures.

The experimental procedures (see Fig. 1) are based on previous studies that manipulated task instructions (see Chung et al., 2020). First, students joined an online call via Zoom using their laptops. The first author discussed Informed Consent. All participants are aware that they are participating in a language learning task (i.e., C-test) that will take approximately 10 min. Consequently, participants are provided with a Qualtrics link that contains all parts of the experiment and will randomly assign them to either the control or the intervention group. The randomization was automated to have an equal number of samples for each condition, but due to the exclusion of random responders and those who opted out, the intervention group ($n = 56$; 36 girls) ended up having six more participants than the control group ($n = 50$; 32 girls).

Within the Qualtrics link, demographic details were sought, and the 4-item situational intrinsic motivation scale (SIMS) was administered as a pre-test. Next, the students were presented with the task instructions. The following is task instruction for the control condition: "*This task is called a C-test. A C-test is a task where you fill in the blanks to make a meaningful sentence. In a given text, parts of some words have missing letters.* [A blank C-test is shown here as an example] *Your task is to complete the words to make the words and the sentences meaningful, as below:* [a completed C-test example]." The need-supportive task instruction for the intervention condition includes the following before the default instructions: "*About this task: (1) This task can assess and can also help improve your language proficiency in English. (2) You are more likely to do well by reading carefully and putting effort into the task. (3) You may find some parts of the task to be more challenging than others, and that is normal. What's important is that you do your best.*" After the default task instructions, the following is also added: "*You can consider re-reading the words, taking down notes, or using other strategies that you find suitable for you. I trust you can do this task well. If you find some parts of the tasks confusing or if you want to clarify something, please do not hesitate to message me in Zoom.*"

The need-supportive statements embedded within the task instructions were anchored on the existing literature for need-supportive teaching (Connell & Wellborn, 1991; Reeve, 2012; Ryan & Deci, 2000) and from a study that classified and consolidated teachers' motivational behaviours for self-determination theory interventions (Ahmadi et al., 2022), based on the recommendations of an international panel of experts in the field of motivation. Specifically, the statements in the need-supportive task instructions were designed to support *autonomy* (via providing rationale and using invitational language), *competence* (via praising effort and giving encouragement and optimism), and *relatedness* (via understanding the students' perspective, showing unconditional positive regard, and asking students about their progress and/or feeling)[2]. Immediately after the manipulated task instructions were presented, we implemented a manipulation check by administering the BPN-ST. Afterwards, the students responded to the SIMS again.

[2] The need-supportive task instructions were pilot-tested on five secondary school students and five English language teachers through a think-aloud protocol. We asked the students and teachers about their general thoughts on the instructions and their perception of the objective of the instruction. Finally, we asked them how the instructions could be improved to communicate a sense of autonomy, competence, and relatedness to the task taker. This procedure was critical to increasing the instruction's applicability, fidelity, and effectivity to the task (see Sekhon et al., 2017). Along with semantic suggestions, the teachers suggested that the need-supportive instructions be bulleted, and the students recommended the addition of emojis for the statements designed to communicate relatedness.

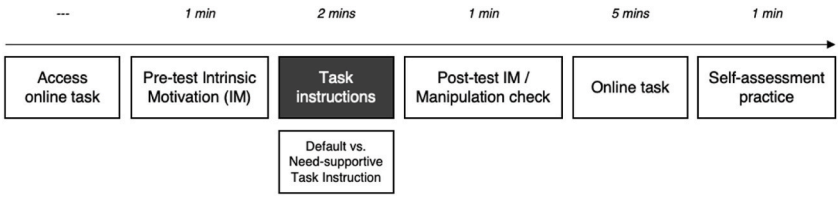

Fig. 1. Experimental procedures.

The post-test measurement of the SIMS was administered prior to the actual C-test to isolate the effect of the manipulated task instruction from the task itself. The C-test task was then presented (see Fig. 2; Arndt, 2019). This specific C-test was chosen after consulting with five teachers at the secondary school. It was chosen out of five other C-tests to adjust to the students' language proficiency. After completing the C-test, the 5-item task-specific self-assessment practice was administered. After the survey, all the participants were debriefed, thanked, and remunerated with 250 Philippine Pesos (equivalent to US$5) for their participation.

3.4. Data analysis

No missing items were observed from the data. Descriptive statistics and bivariate correlations are presented in Table 1. For the manipulation check, an independent samples *t*-test was conducted to compare the mean scores of BPN-ST between the control and intervention groups. ANCOVA was conducted for constructs with pre-test and post-test measures (i.e., situational intrinsic motivation) to examine the difference between the intervention and control groups while controlling for pre-test scores. Assumptions of linearity, homogeneity, and normality were tested before the ANCOVA. We also used the Shapiro-Wilk test and Levene's test to evaluate the normality of residuals and the equivalence of residuals for both the control and intervention groups, respectively. ANCOVA was conducted with a Bonferroni adjustment. Using the *ggplot2* package (Wickham, 2016), the estimated marginal means from the ANCOVA were plotted in line plots.

Structural equation modelling was used to test the direct effect of situational intrinsic motivation on task performance and its indirect effect via self-assessment practice. We used the *lavaan* package (Rosseel, 2012). The following goodness-of-fit indices were used to evaluate and compare the models: Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Following the Hu and Bentler (1995) recommendation, a good model fit would include model CFI and TLI of greater than 0.90 and an RMSEA of less than 0.08. An SRMR value of less than 0.08 is considered a good fit (Hu & Bentler, 1999). Standardized estimates falling within the lower and upper 95% confidence interval for the indirect effects should indicate significant effects. All statistical analyses and plotting procedures were conducted in R (R Core Team, 2016).

4. Results

4.1. Manipulation check

To evaluate whether the respective groups detected the manipulated task instructions, we compared the means on the BPN-ST using a *t*-test. The Shapiro-Wilk test was significant for both the control ($W = 0.940$, $p < .05$) and intervention group ($W = 0.932$, $p < .01$), indicating evidence for the non-normality of residuals between the two groups. Levene's test was computed and was not significant, $F(1,104) = 0.351$, $p = .55$, suggesting the equivalence of the residual variances for both groups. The *t*-test result, $t(102) = -3.99$, $p < .001$, shows that the mean scores for BPN-ST of the intervention group ($n = 56$, mean = 17.34, $SD = 2.09$) were significantly higher than that of the control group ($n = 50$, mean = 15.70, $SD = 2.13$; see Fig. 3). This result suggests that, at the group level, the experimental manipulation was effective.

4.2. Differential effect of need-supportive task instruction on situational intrinsic motivation

The visual scatter plot (see Fig. 4) shows the direct linear relationship between pre-test and post-test intrinsic motivation scores for the control and intervention groups. Testing for the homogeneity of regression slopes, the interaction term between the two conditions and the pre-test intrinsic motivation was not statistically significant, $F(1, 102) = 3.50$, $p > .05$. The Shapiro-Wilk test was not significant ($W = 0.986$, $p = .35$); thus, no evidence for the non-normality of residuals was detected. Levene's test was computed and was not significant, $F(1,104) = 1.54$, $p = .22$, so the residual variances could be assumed to be equal for both the control and the intervention group.

$$\text{PostTestMotivation} = \alpha + \beta_1 \text{PreTestMotivation} + \beta_2 \text{Condition} + \varepsilon \quad (1)$$

An ANCOVA with the model Equation (1) was conducted to determine the effect of the intervention on the situational intrinsic motivation of the participants after controlling for their intrinsic motivation pre-test scores. After adjustment of pre-test intrinsic motivation, there was a statistically significant difference in post-test intrinsic motivation between the intervention group and the

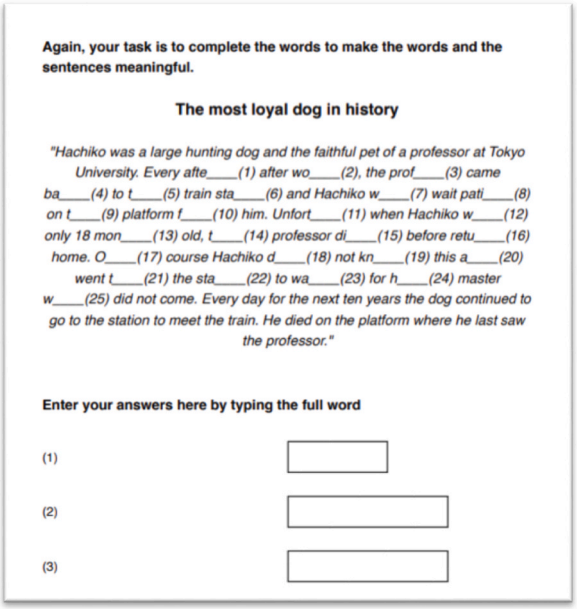

Fig. 2. The C-Test language task.

Table 1
Descriptive statistics and bivariate correlations.

	1	2	3	4	5
1. Pre-test motivation	(0.94)				
2. Post-test motivation	0.84**	(0.93)			
3. Basic psychological needs	0.57**	0.64**	(0.81)		
4. Self-assessment practice	0.45**	0.39**	0.53**	(0.75)	
5. Task performance	0.04	0.10	0.16	0.25*	–
Overall ($n = 106$)					
Mean	19.76	21.26	16.57	17.38	23.72
SD	5.16	4.75	2.56	2.48	1.34
Control group ($n = 50$)					
Mean	18.56	19.64	15.70	17.12	23.48
SD	5.69	5.39	2.13	2.87	1.42
Intervention group ($n = 56$)					
Mean	20.84	22.71	17.34	17.61	23.95
SD	4.43	3.56	2.09	2.08	1.24

Notes. $^{**}p < .001$, $^{*}p < .01$, parentheses in diagonal are the internal consistency ratings of the instruments.

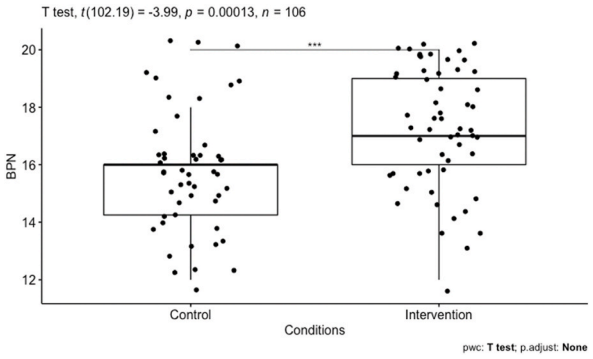

Fig. 3. Boxplots for basic psychological needs between groups as a manipulation check.

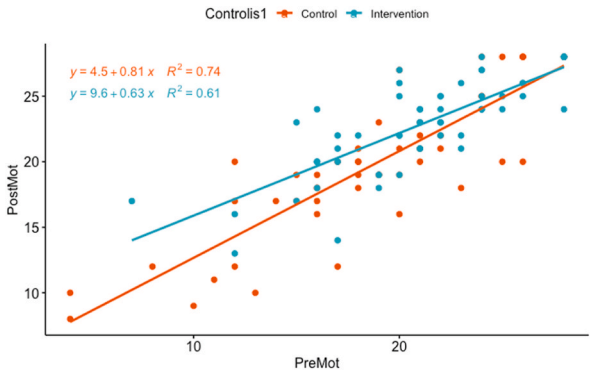

Fig. 4. Scatterplot for intrinsic motivation. PreMot = Pre-test intrinsic motivation, PostMot = Post = test intrinsic motivation.

control group, $F(1,103) = 7.56$, $p < .01$ ($\eta^2 = 0.07$). The effect of the intervention on intrinsic motivation, $\eta^2 = 0.07$ (or Cohen's $d = 0.55$), is considered a medium effect size (Cohen, 1988) and within the desired effect size in the educational contexts (Hattie, 2011; see also Lenhard & Lenhard, 2016). With a Cohen's d of 0.55, 70.9% of the intervention group will be above the mean of the control group (Cohen's U_3), 78.3% of the two groups will overlap, and there is a 65.1% chance that a person picked at random from the intervention group will have a higher score than a person picked at random from the control group. Further, the Bonferroni adjusted estimated marginal means (emmeans) of post-test situational intrinsic motivation was significantly higher for the intervention group (emmeans = 21.9, $SD = 0.36$) than that of the control group (emmeans = 20.6, $SD = 0.34$). The emmeans are illustrated in a line plot in Fig. 5.

4.3. Indirect effects of situational intrinsic motivation on task performance via self-assessment practice

A structural equation model (SEM; see Fig. 6) was conducted where the dependent variable task performance was regressed to the independent variable situational intrinsic motivation (path *c*) and to the mediator self-assessment practice (path *b*). The mediator self-assessment practice was also regressed to situational intrinsic motivation (path *a*). The mediation model ran normally after 37 iterations. The model was estimated using the Satorra-Bentler correction and had good model fit to the data, $SB\chi^2(36) = 381.974$, CFI = 0.979, TLI = 0.970, RMSEA = 0.063 (95% C.I. = 0.000–0.107), SRMR = 0.054. Results show that intrinsic motivation did not significantly predict task performance ($\beta = -0.01$, $p = .91$) while self-assessment practice did ($\beta = 0.28$, $p < .05$). Results also show that intrinsic motivation had a significant direct effect on self-assessment practice ($\beta = 0.45$, $p < .05$). After implementing 5000 bootstraps to test for indirect effects, we found that intrinsic motivation had significant indirect effects to task performance via self-assessment practice ($\beta = 0.12$ [95% C.I. = 0.011, 0.508],). The total effect in the link between intrinsic motivation to task performance mediated by self-assessment practice was not significant ($\beta = 0.11$ [95% C.I. = −0.136, 0.389],); thus, a full mediation is demonstrated. The model accounts for 20% of the variance of self-assessment practice and 7% of the variance of task performance.

4.3.1. Post-hoc analysis of indirect effects within the context of the intervention

As with previous experimental methods (Leander & Shah, 2013; Thrash et al., 2017), we ran a moderated mediation to further examine whether the mediation model linking situational intrinsic motivation to task performance via self-assessment practice was contingent upon the intervention and control conditions[3]. The moderated mediation model (see Fig. 7) with a bootstrap of 1000 had good fit to the data, $\chi^2(2) = 2.889$, CFI = 0.988, TLI = 0.960, RMSEA = 0.065. Similar to the results of the mediation model in Fig. 6, self-assessment practice had a significant direct effect on task performance ($B = 1.11$, SE = 0.54, $p < .05$) but situational intrinsic motivation did not ($B = -0.01$, SE = 0.14, $p = .92$). The moderated mediation shows that the direct effect of intrinsic motivation to self-assessment practice was significant ($B = 0.10$, SE = 0.03, $p < .01$) and this effect is significantly moderated by the condition variable ($B = 0.85$, SE = 0.07, $p < .001$).

To illustrate the moderated mediation effects, we mean-centred task performance scores and plotted mediated simple slopes. Fig. 8a shows the indirect effect of intrinsic motivation on task performance through self-assessment practice (i.e., index of moderated mediation) for the intervention and the control group. Since the line plot of the intervention group is larger that of the control group, this indicates that the positive effect of intrinsic motivation on task performance via self-assessment practice is more pronounced in the intervention group. Moreover, the mediated simple slopes with 95% C.I. (see Fig. 8b) show a positive association between intrinsic motivation, self-assessment practice, and task performance for the intervention group, while a non-linear direction was observed for the control group. Overall, the moderated mediation demonstrates that the role of self-assessment practice in mediating the influence

[3] Instead of using the latent factors used in the previous SEM, we used factor scores for intrinsic motivation (independent variable) and self-assessment practice (mediator) since moderated mediation analyses require observed and not latent variables. Using factor scores instead of aggregate or sum scores also accounts for item-level errors. Consequently, we mean-centred these factor scores. Then, we included the dichotomous condition variable as a moderator in the link between intrinsic motivation and self-assessment practice. We used the gemm command in the rosetta package (Garbulowski et al., 2021).

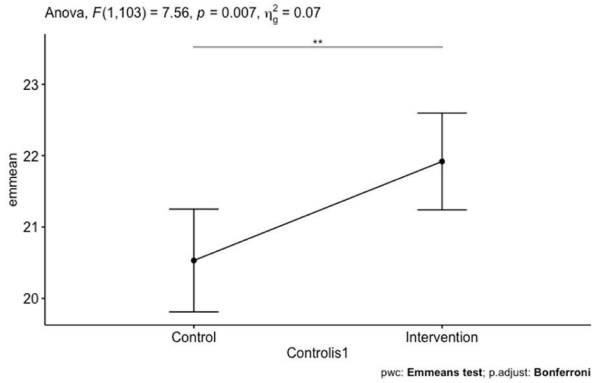

Fig. 5. Line plots of the estimated marginal means (emmeans) comparing post-test intrinsic motivation across both groups, controlling for pre-test motivation.

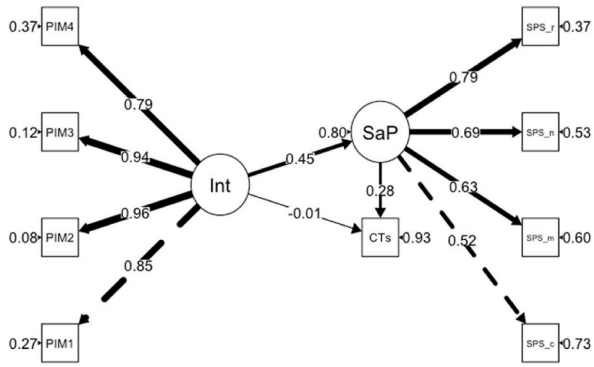

Fig. 6. Mediation model testing the (in)direct effect of intrinsic motivation to task performance via self-assessment practice (INT = intrinsic motivation; SaP = self-assessment practice; CTs = c-test scores/task performance scores).

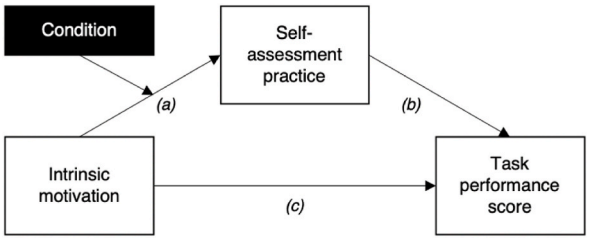

Fig. 7. Moderated mediation model to test the indirect effect of intrinsic motivation on task performance via self-assessment practice depending on the study condition (i.e., need-supportive task instructions and default task instructions).

of intrinsic motivation on task performance was specific to the intervention group.

5. Discussion

This study aimed to develop and test a theoretically informed intervention that can foster students' intrinsic motivation for an online learning task. This aim is pursued in two related ways: (a) by examining whether including need-supportive statements within the instructions of an online learning task could increase students' situational intrinsic motivation, and (b) by testing whether the increase in situational intrinsic motivation can improve task performance directly, or indirectly through self-assessment practice.

The results of this study demonstrated that students who engaged in an online learning task which included need-supportive task instructions had significantly higher intrinsic motivation than those presented with a default task instruction (supports H1). The need-supportive task instructions had a medium effect size on instrinsic motivation, while accounting for pre-test intrinsic motivation. Although the ensuing intrinsic motivation did not directly affect task performance (rejects H2.1), we found evidence supporting the indirect effects of intrinsic motivation via self-assessment practice (supports H2.2). Specifically, the results suggest that greater

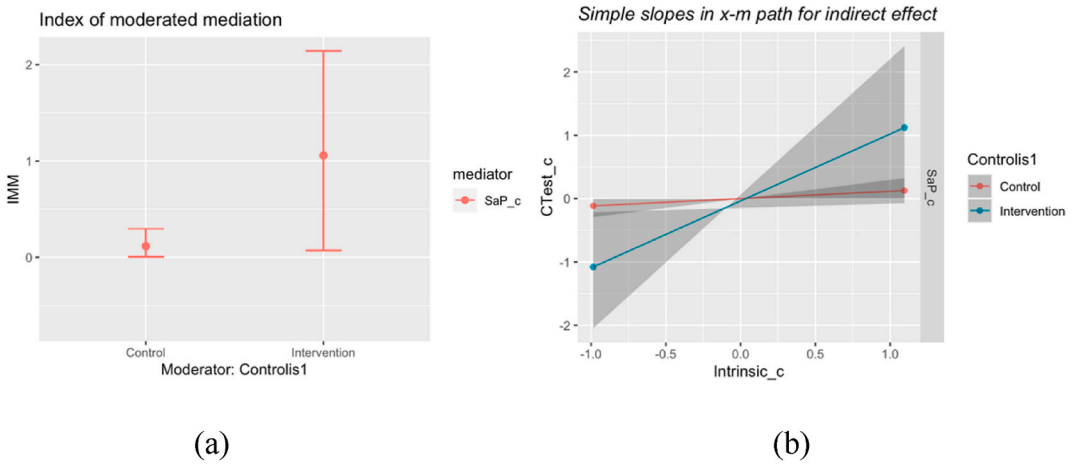

Fig. 8. Mediated simple slopes plots testing the moderated mediation model.

situational intrinsic motivation is associated with increased self-assessment practice which, in turn, yielded increased task performance. This suggests that the ensuing intrinsic motivation for the task does not necessarily lead to increased task performance, but through self-assessment practice as a behavioural learning strategy, intrinsic motivation can indirectly boost online task performance. In general, our findings demonstrated experimental evidence that need-supportive task instructions have a positive impact on students' intrinsic motivation for online learning tasks. These results extend the current theorizing on the integration of self-determination theory, wise interventions, and self-assessment practice, and offers a way forward to supporting student's motivation in online learning. Before going into greater detail about the interpretations and implications of these findings, some important study limitations need to be noted.

5.1. Study limitations and future research directions

First, given that the intervention is brief and minimal scale, its effectiveness in increasing students' intrinsic motivation can be put into question. It could be argued that merely adding phrases designed to communicate support for autonomy, competence, and relatedness needs may not consistently and sustainably impact intrinsic motivation. However, as we've introduced, the strength of wise interventions lies in their conciseness (Bryan et al., 2011; Walton, 2014; Walton & Wilson, 2018; Walton & Yeager, 2020). As demonstrated in this study, when integrated with self-determination theory and embedded within online tasks (e.g., Kanat-Maymon et al., 2015; Lazowski & Hulleman, 2016), such a brief intervention can be used to increase situational intrinsic motivation. As we are yet to test the intervention's external validity (i.e., whether need-supportive task instructions may generate situational intrinsic motivation in the actual classroom context) or its temporal validity (i.e., increase in motivation throughout a learning semester), research efforts to establish the ecological validity of the findings in actual learning contexts and domains are needed. Such efforts can strengthen the experimental findings of this work. Specifically, future research can implement a longitudinal design that can scale the intervention to examine whether need-supportive statements embedded within task instructions consistently foster student motivation over time.

Second, similar to previous research (e.g., Kanat-Maymon et al., 2015; Pavey et al., 2011), we have manipulated and assessed all three need-supportive statements and all three basic psychological needs together. While the conjunction of basic psychological need-support and their respective satisfaction is theoretically meaningful (see Olivier et al., 2021; Roth et al., 2007; Vaughn, 2017), future research can consider manipulations that target one basic psychological need at a time. Such a research direction can look at the potentially unique effects of addressing different basic psychological needs (Nalipay et al., 2020; Vansteenkiste et al., 2012).

Third, the task-specific instrument to measure self-assessment practice was carefully devised and pilot-tested. However, measuring self-assessment practice after the completion of the task may be prone to recall bias. One way to amend this limitation is by implementing think-aloud protocols to ask learners about their learning strategies during the task. Future research can use such a method to determine how students use self-assessment practices on specific tasks beyond what self-report measures can capture (see Valdez et al., 2022 for an online intervention with both quantitative and qualitative components). Fourth, although the experiment was not intended to enhance it, self-assessment techniques mediated the link between intrinsic motivation and task performance. Subsequent studies can consider interventions specifically designed to foster or develop self-assessment practice (e.g., Yan et al., 2022). Finally, this study was only conducted among Filipino secondary school students and in a language learning task. Future studies could increase the study's representativeness by conducting it with higher education students as a sample and by implementing the intervention on various learning courses or domains.

5.2. The differential effect of need-supportive task instructions on intrinsic motivation and the role of self-assessment practices

Notwithstanding the study limitations, the findings point to important implications for thinking about how teaching and learning online can be transformed to be responsive to students' basic psychological needs. A key finding of this study highlights the feasibility and efficacy of embedding need-supportive statements on online school tasks to foster intrinsic motivation. This demonstrates students' reception of such statements, which leads to higher intrinsic motivation for the task. As evidenced by the manipulation check, participants who were presented with need-supportive statements in task instructions had significantly higher basic psychological needs satisfaction compared to those in the control group. Clearly, a variety of need-supportive statements can be incorporated by teachers depending on the nature of the task (e.g., Reeve, 2016; Ryan & Deci, 2017; Vansteenkiste et al., 2020). But by incorporating statements that offer task rationale, using invitational language, praising effort, giving encouragement, and expressing positive regard for task instructions (see Ahmadi et al., 2022 for an exhaustive list of need-supportive practices), students' basic psychological needs can be satisfied, and intrinsic motivation increases.

The finding that intrinsic motivation increased due to need-supportive statements supports the general tenets of SDT and the basic psychological needs theory (see Ryan & Deci, 2017; Vansteenkiste et al., 2020) and aligns with SDT-based interventions (Kanat-Maymon et al., 2015; Pavey et al., 2011; Sheldon & Filak, 2008). Brief interventions are potent and effective (e.g., wise interventions; Walton, 2014; Walton & Wilson, 2018; Walton & Yeager, 2020), especially when they are designed to modify a perceiver's view of a task. Extending previous research, the current results suggest that even if need-supportive statements are in written form, they remain perceivable to students. Research has shown that, even with the absence of physically observable cues, individuals are able to perceive psychological constructs from their environment (e.g., knowing that one aims to meet a certain deadline evokes you to strive for the same goal; Leander & Shah, 2013; see also Radel et al., 2015; King & Mendoza, 2020; King & Mendoza, 2021). Furthermore, experiments demonstrated that, despite the lack of contact between readers and writers, readers are able to perceive psychologically rich written contents (e.g., readers can perceive inspiration from texts written by inspired writers and, in effect, be inspired writers themselves; Thrash et al., 2017; see also Walton, 2014). The "power of the written word as a vehicle . . . among individuals separated in time or place" (Thrash et al., 2017, p.482) could explain how basic psychological needs can be satisfied through written texts. Written texts (e.g., task instructions) are transitive and can be maximized to communicate support for basic psychological needs, which fosters intrinsic motivation.

The other key finding of this study highlighted the indirect impact of intrinsic motivation on task performance, showing that intrinsic motivation requires a means to improve performance. Such a role is taken by self-assessment practice. Research has contended the need to examine behavioural mechanisms that can explain how motivation impacts achievement (see Elliot et al., 2017). The current result demonstrating that self-assessment practice mediates intrinsic motivation to task performance supports previous findings that underscore how self-regulated and self-directed learning strategies can mediate the motivation-achievement link (see Feraco et al., 2022; Holzer et al., 2021; Leenknecht et al., 2020; Schweder & Raufelder, 2021). This is also aligned with recent empirical investigations on the role of self-assessment practice as a crucial behavioural learning strategy (see Leenknecht et al., 2020; Panadero et al., 2012; Yan, 2018b, 2020), impacting even higher-order skills like creativity (Yan et al., 2022).

The cross-sectional study of Mendoza et al. (2022) has shown that autonomous motivation correlates with increased self-assessment practice, which, in turn, predicts achievement scores in English language learning among secondary school students. Intrinsic motivation could be the driver of self-assessment practice which involves the behavioural disposition to use available information as feedback to perform optimally or better (Yan, 2020; Yan & Brown, 2017). Because self-assessment practice is conceptualised as task-specific in this study, it is plausible that students who are motivated tend to practice self-assessment by paying close attention to the task instructions, reading the task material more deeply, or double-checking their task responses. These task-specific practices cohere with the determining assessment criteria, seeking feedback via monitoring and self-reflection as components of self-assessment practice (Yan & Brown, 2017; Yan & Carless, 2021).

The post-hoc moderated mediation results showed that the mediating role of self-assessment practice between intrinsic motivation and task performance was conditional on need-supportive task instructions. Specifically, the observed relationship between motivation, self-assessment, and task performance for those in the intervention group was dissimilar or lacking from that of the control group. It is possible that the intervention group's increased intrinsic motivation could potentially explain the mediating role of self-assessment practice. With significantly higher intrinsic motivation, it can act as fuel for self-assessment practice that can improve task performance. Such may not be the case for participants in the control group[4]. It can also be inferred that the need-supportive task instructions could have prompted genuine self-assessment practice. Studies have highlighted the importance of perceived learning environments in developing self-regulated learning processes (e.g., self-assessment practice; Mendoza & Yan, 2021a; Miller & Brickman, 2004; Mouratidis et al., 2013; Sierens et al., 2009; Wang et al., 2016). Although self-assessment practices are more effective when cued explicitly (Yan & Carless, 2021; Yan et al., 2021), students' perception of their learning environment, which, in this case, the instructions of their learning tasks, can also impact their self-assessment practice (see Mendoza & Yan, 2021a). Overall, the intervention provided evidence for a pathway to increase intrinsic motivation for online learning tasks and created a context where self-assessment practice can operate as a behavioural mediator that can improve task performance.

[4] Of note, although the intervention was designed to foster higher intrinsic motivation and not self-assessment practice, we ran a *t*-test to compare the self-assessment practice between the experimental groups. The self-assessment practice across groups was not significantly different. Research has shown that specific and explicit self-assessment interventions are necessary to foster self-assessment practice (see Yan & Carless, 2021; Yan et al., 2021).

5.3. Practical implications

This study holds practical implications for teaching and learning online and beyond. A direct implication of this study is that online task instructions could be modified to be responsive to students' basic psychological needs. Reading plain or default task instructions might affect students' intrinsic motivation toward a task, especially outside the context of the traditional classroom environment. There are various ways how to modify instructions to be need-supportive (e.g., Ahmadi et al., 2022; King & Ganotice, 2014; Reeve, 2016; Ryan & Deci, 2017; Vansteenkiste et al., 2020), but the goal is the same, that is, to communicate a sense of autonomy, competence, and relatedness in online learning and online tasks (Oga-Baldwin, 2015). Based on the findings, this could be achieved by incorporating statements in task instructions that (1) provide task rationale, (2) use invitational language, (3) give encouragement, (4) acknowledge students' perspective, and (5) show unconditional positive regard. In the absence of a classroom environment that is rich in opportunities to satisfy learners' basic psychological needs, it is contingent upon schools and teachers to use actionable and evidence-based strategies to support students' need for autonomy, competence, and relatedness online.

Another practical implication also involves the importance of developing self-assessment practices for students. As the study findings demonstrate, intrinsic motivation alone did not directly influence higher task performance; it should be coupled with behavioural learning strategies such as self-assessment practice. Hence, encouraging self-assessment practice and, more importantly, teaching explicit strategies on how to effectively practice self-assessment are both crucial. For instance, students can be taught to (1) focus on understanding the assessment criteria or how their work is being evaluated, (2) observe the overall task and find opportunities to seek feedback from external sources, (3) not hesitate to ask questions or seek clarifications, or (4) revisit their tasks, either current or completed, to find ways to improve.

6. Conclusion

School closures linked to the COVID-19 pandemic, combined with students' declining intrinsic motivation, pose a threat to students' learning. As schools adapt to the new norms of education, hybrid and online learning will become more prominent. Hence, sustainable interventions that can support students' intrinsic motivation for online learning tasks are necessary. Such is crucial not only to recover the learning losses caused by the pandemic, but also to support motivation forward. This study demonstrated experimental evidence for the differential effect of a brief SDT-informed intervention on students' intrinsic motivation. Specifically, compared to default task instructions, need-supportive task instructions on an online learning task generated significantly higher intrinsic motivation. Moreover, the results highlighted that self-assessment practice is a crucial behavioural mechanism that can maximize the impact of motivation to task performance. Although more research is needed to test this intervention at scale, it could offer a sustainable solution to support students' intrinsic motivation for online learning tasks. Task instructions that are responsive to students' need for autonomy, competence, and relatedness hold important implications to teaching and learning in the post-pandemic world.

Credit statement

Conceptualization: N.B.M., Z.Y. and R.B.K.; Data curation: N.B.M.; Formal analysis: N.B.M.; Investigation: N.B.M.; Methodology: N.B.M.; Project administration: N.B.M.; Software: N.B.M.; Supervision: Z.Y. and R.B.K.; Visualization: N.B.M.; Writing – original draft: N.B.M.; Writing - review & editing: N.B.M., Z.Y. and R.B.K.

Declaration of competing interest

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

Data availability

Data will be made available on request.

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