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University students in COVID-19 lockdown: The role of adaptability and fluid reasoning in supporting their academic motivation and engagement

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ABSTRACT

This study drew on Job Demands-Resources theory and data from 500 Australian university students to investigate the role of COVID-related lockdown, perceived adaptability, and fluid reasoning in students’ self-efficacy—and the role of these factors in students’ engagement and disengagement. Lockdown was associated with higher disengagement; perceived adaptability was associated with higher self-efficacy; and both perceived adaptability and fluid reasoning were significantly and positively associated with engagement. Self-efficacy significantly mediated the relationship between perceived adaptability and engagement and disengagement, while moderation tests revealed that fluid reasoning yielded a significant positive role for the self-efficacy of students in lockdown. These findings shed light on factors during COVID-19 that are implicated in students’ academic development and provide direction for psycho-educational interventions.

1. Introduction

During the COVID-19 pandemic, students around the world have experienced mandated lockdown that has required them to stay confined (typically at home) while continuing their academic studies. The extent to which students have successfully adjusted to lockdown disruptions is vital to how they cope academically (Australian Academy of Science, 2020). This being the case, adaptability has been identified as a personal attribute that can help students navigate mandated lockdown and other COVID-related disruption (Besser et al., 2020; Martin et al., 2021a). However, one question that has lingered in the adaptability space is the extent to which positive responses to disruption are due to individuals’ capacity to regulate their cognition, behavior, and emotion (i.e., their adaptability)—or due to factors such as fluid reasoning and problem-solving ability (Huepe et al., 2011; Martin et al., 2013; Schneider & McGrew, 2012). Disentangling the relative contributions of these two factors will directly influence the weighting of intervention given to each of them when seeking to support students through disruption in their academic studies. Guided by Job Demands-Resources theory (JD-R theory; Bakker & Demerouti, 2017) and recent academic adaptation of it (Academic Demands-Resources model; AD-R model, Martin & Collie, 2022) and harnessing these perspectives’ key components (demands, resources, motivation, and outcomes), we investigated the comparative roles of COVID-related lockdown (demand), students’ self-perceptions of adaptability (resource), and fluid reasoning (resource) in university students’ self-efficacy (motivation)—and in turn, the role of these four factors in students’ engagement and disengagement (outcomes). Fig. 1 shows the central model. We also explored the extent to which perceived adaptability and fluid reasoning moderate (buffer or boost) the (negative or positive) effects of lockdown on self-efficacy, engagement, and disengagement.

2. Job Demands-Resources theory

To set the context for JD-R theory and the related AD-R model in this education-oriented study, we first summarize JD-R theory as typically applied in workplace research. We then expand from this to explore its application to students’ academic experience during COVID-19 (including mandated lockdowns).

2.1. JD-R theory in workplace research

According to JD-R theory, there are specific contextual factors in work roles that assist or impede employees’ motivation and performance (Schaufeli & Bakker, 2004). Job demands are aspects of work that require physical and/or psychological exertion (e.g., addressing
accumulating deadlines, performing under a demanding workload), and are associated with physical and/or psychological costs (e.g., poor physical and emotional aspects of burnout; Bakker & Demerouti, 2017; Collie et al., 2020). Job resources are aspects of work that support employees to attain desired workplace growth and goals (e.g., peer support; Demerouti et al., 2001), and are associated with positive experiences and outcomes (e.g., motivation, health; Skaalvik & Skaalvik, 2018).

JD-R theory also recognizes there are personal resources that impact employees’ workplace motivation and performance (Collie et al., 2020; Xanthopoulou et al., 2007). These are personal capacities that are modifiable, reflecting one’s potential to influence their work environment. Like job resources, personal resources are associated with positive experiences and outcomes (Schaufeli, 2002). According to Demerouti et al. (2001), postulated that adaptability is a personal resource, being a modifiable capacity enabling individuals to navigate change in the workplace and bring about positive workplace outcomes.

Under JD-R theory, demands and resources can be considered as “main effects” — that is, they uniquely predict employees’ workplace motivation and in turn, their performance (Collie et al., 2020). Importantly, however, beyond their function as main effects, “moderated effects” may also be at play. Specifically, JD-R theory suggests potential “buffering” and “boosting” effects (Bakker & Demerouti, 2017). Thus, for example, there may be factors that buffer the negative effects of job demands or boost the positive effects of job resources. According to Granziera et al. (2022), adaptability may be one such moderating factor. They suggested that adaptability may buffer the adverse effects of job demands such that adaptable employees may be less likely to experience potential negative impacts of job demands. Indeed, Granziera et al. (2022) then showed that employees’ (teachers) adaptability offset the negative impact of role conflict on their emotional exhaustion (see also Dicke et al., 2018).

2.2. JD-R theory in educational research

When considering JD-R in the educational context as suggested under the JD-R model (Martin & Collie, 2022), it is evident the same processes implicated in workplace functioning are implicated in students’ academic processes and outcomes (Martin et al., 2021a). There are factors in students’ learning that help or hinder their motivation and in turn their educational outcomes (Martin & Marsh, 2009). This being the case, job demands in the education context refer to features of learning requiring physical and/or psychological exertion (e.g., meeting clashing due dates, performing under a demanding study load), and are linked with physical and/or psychological costs (e.g., dropout, stress, underachievement). Extrapolating from this (and as we explain below), we suggest that lockdown may be considered a demand that can impede students’ academic motivation and outcomes. There are also job resources in the education context that are features of learning helping students to attain desired academic growth and goals (e.g., teacher/instructional support), and are associated with positive outcomes (e.g., motivation, engagement, achievement) (Martin et al., 2021a). In terms of personal resources, consistent with Collie et al. (2020), adaptability is a personal capacity that can help students navigate disruption and yield positive learning outcomes. Inferring from this (and as we explain below), we suggest that fluid reasoning may also be considered a personal resource that can assist students’ motivation and academic outcomes. Furthermore, there may be buffering or boosting roles for adaptability and fluid reasoning in the education context. For example, in terms of a buffering role, students with higher self-perceived levels of adaptability and fluid reasoning may be less likely to experience the negative effects of lockdown demands. Operationally, this buffering (or boosting) role would be explored by modeling the interaction of perceived adaptability x lockdown status and fluid reasoning x lockdown status to ascertain the extent to which perceived adaptability and fluid reasoning may moderate the effects of lockdown status.

2.3. Demands, resources, motivation, and outcomes in the present study

We propose there is significant scope for applying JD-R theory to our investigation of lockdown (demand), self-perceptions of adaptability (resource), and fluid reasoning (resource) among university students — and how these may predict students’ self-efficacy (motivation) and in turn their engagement and disengagement (outcomes). We now review each construct as relevant to the substantive focus of the present investigation.

2.3.1. Lockdown

Although the COVID-19 pandemic is a relatively recent phenomenon, there is an evidence base growing about its academic effects, including effects during lockdown. In fact, “lockdown” was declared the 2020 ‘word of the year’ by the Collins Dictionary. Lockdown encompasses numerous potential impediments to students’ academic development. These include difficulties accessing appropriate computing and technology, unreliable internet access, and distracting home environments — as well as the social-emotional cost of isolation that is known to affect academic outcomes (Australian Academy of Science, 2020; Fong, 2022; Peña-López, 2015).

Among university students (the focus of our study), Aristeidou and Cross (2021) found negative impacts of lockdown on study habits and these were associated with difficulties in managing workload and limited interaction with other students and instructors. Maqableh and Alia (2021) found that university student dissatisfaction in learning during lockdown was due to distractions and reduced focus when isolated at home. Adverse impacts on perceived competence have also been

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**Fig. 1.** Hypothesized model.
identified (Alemany-Arrebola et al., 2020). Isolation is another factor in mental health concerns among university students during lockdown, in large part attributed to disconnection from peers and lecturers (Akpinar, 2021). In related research: Biswas and Biswas (2021) found a majority of their university sample experienced anxiety due to pandemic lockdowns (that Hong et al., 2021 showed adversely impacted self-efficacy during COVID-19); Commodari et al. (2021) reported negative personal wellbeing effects of lockdown; and Gaeta et al. (2021) identified a mix of negative (e.g., boredom, anxiety) and positive (e.g., gratitude) wellbeing effects among university students in lockdown. It thus appears that lockdown-related learning generally yields negative effects for university students’ academic outcomes and for social-emotional wellbeing. We extend this knowledge base by investigating the role of lockdown in university students’ self-efficacy, engagement, and disengagement (beyond the effects of perceived adaptability and fluid reasoning).

2.3.2. Adaptability

As noted earlier, adaptability refers to individuals’ capacity to regulate behaviors, thoughts, and feelings in response to disruption, such as novel, variable, uncertain, and unexpected situations and circumstances (Martin et al., 2013). Of relevance to the present investigation, Martin et al. (2021a) found that school students’ adaptability significantly predicted self-efficacy and achievement during a period of COVID-19 where they were at various stages of remote learning and lockdown. Among university students, Holliman et al. (2018, 2019, 2021) found significant links between adaptability and students’ engagement, achievement and psychological wellbeing, while recent work by Besser et al. (2020) found that university students’ adaptability during the COVID-19 pandemic was associated with greater depth of learning, motivation, and attainment of self-expectations. Importantly also, an intervention study among university students by Putwain et al. (2019) showed improvements in adaptability—providing empirical support for the modifiability of adaptability. The present study significantly expands this knowledge base by investigating the main and moderating (buffering, boosting) effects of perceived adaptability in university students’ self-efficacy, engagement, and disengagement (beyond the effects of lockdown status and fluid reasoning).

2.3.3. Fluid reasoning

Alongside psycho-behavioral factors such as adaptability, there are also personal attributes such as fluid reasoning that are known to affect individuals’ responses to novel problems (Huepe et al., 2011). To the extent this is the case, when developing interventions to assist individuals’ responses to disruption, it is important to understand how much variance in effective responses are due to student reports of adaptability and how much is due to fluid reasoning. Fluid reasoning refers to “the deliberate but flexible control of attention to solve novel, ‘on-the-spot’ problems that cannot be performed by relying exclusively on previously learned habits, schemas, and scripts” (Schneider & McGrew, 2012, p.111). Individual differences in fluid reasoning predict educational outcomes including grade point average and standardized test scores (Brandt et al., 2020; Deary et al., 2007; for a meta-analysis see Peng et al., 2019). As the broad factor in the Cattell-Horn-Carroll model of cognitive abilities (Carroll, 1993; Cattell, 1987) most strongly loading on the higher-order factor of general mental ability (“g”), fluid reasoning is multidimensional, comprising capacities in inductive, sequential, and quantitative reasoning. In work settings, there is long-standing evidence that higher levels of cognitive ability (including fluid reasoning) predict occupational success, and that these predictive validities increase as job demands, particularly job complexity, increases (Salgado & Moscoso, 2019). Extrapolating from this literature, we frame the “work” of students as having increased in complexity under COVID-19-related lockdowns; hence, fluid reasoning may play a significant role in determining students’ responses during these challenges. This is the first study to investigate the main and moderating (buffering, boosting) effects of fluid reasoning on students’ self-efficacy, engagement, and disengagement (beyond the effects of lockdown status and perceived adaptability).

2.3.4. Adaptability and fluid reasoning as complementary resources

Adaptability has been identified as particularly relevant to young people’s capacity to respond to the disruptions implicated in COVID-19 (Besser et al., 2020; Martin et al., 2021a). Accordingly, we suggest it as a personal resource that can assist students to navigate mandated lockdown as well as other COVID-related disruption. That said, in the earliest research using our study’s operationalization of adaptability (Martin et al., 2013), the question was raised about the extent to which individuals’ capacity to navigate disruption is due to psycho-behavioral self-regulation in the form of adaptability and how much it may be due to cognitive competencies such as fluid reasoning and problem-solving ability (see also Huepe et al., 2011; Schneider & McGrew, 2012). For example, Schneider and McGrew (2012) note that fluid reasoning supports solving unfamiliar problems, especially when prior knowledge is insufficient to meet situational demands. The disruptions imposed by COVID-19 have presented unfamiliar problems to young people (Australian Academy of Science, 2020), who have little prior knowledge about how to meet its situational demands—including mandated lockdown. This being the case, the present study offers an ideal context in which to assess student reported adaptability and their fluid reasoning as resources capable of supporting their academic development through lockdown.

2.3.5. Self-efficacy

Under JD-R theory, demands and resources impact individuals’ motivation (Bakker & Demerouti, 2017). Consistent with Collie et al. (2020) and Martin et al. (2021a), motivation is represented in our study by self-efficacy. Self-efficacy in the academic domain refers to students’ perceived competence in performing and completing learning and learning-related tasks (Bandura, 1997). Although motivation encompasses numerous factors, we focus on self-efficacy for three reasons. First, self-efficacy is a construct that is theoretically and operationally aligned with phenomena that require a motivational response to disruption, change, uncertainty, and the like. According to Bandura (2001), individuals who are self-efficacious have positive self-beliefs that lead them to engage in adaptive ways when task demands are unfamiliar and novel. Second, alongside Bandura’s (1997, 2001) social-cognitive perspective, we describe below (see 2.3.7) notable alignments between JD-R and other psycho-educational theorizing relevant to students’ academic development that place self-efficacy as a major motivational force explaining significant variance in student outcomes, including their engagement (e.g., Cleary & Zimmerman, 2012; Schunk & DiBenedetto, 2014; Schunk & Mullen, 2012). Third, perceived competence (including self-efficacy) is a well-researched construct in JD-R research and given the various novel elements we introduce in the present study (lockdown, fluid reasoning, and to some extent adaptability) we felt it important to concomitantly anchor the study in a known and “proven” construct in the form of self-efficacy.

We investigate the role of lockdown status, self-perceived adaptability, and fluid reasoning in predicting students’ academic self-efficacy and the role of self-efficacy in predicting engagement. With regard to lockdown (demand), as described earlier, the weight of evidence suggests there are small negative effects on academic outcomes as well as negative effects on factors such as perceived competence (Alemany-Arrebola et al., 2020; Hattie, 2012; Martin et al., 2021a). With regard to adaptability (resource), Collie et al. (2020) suggested that this psycho-behavioral attribute fosters mastery and efficacy experiences. Their research among teachers demonstrated this and subsequent research among high school students provided further support (Martin et al., 2021a). In terms of fluid reasoning (resource), the substantial body of research linking it to educational success (Brandt et al., 2020; for a meta-analysis see Peng et al., 2019) provides grounds for predicting that students higher in fluid reasoning will have acquired a larger
number of academic success experiences, a key foundation of self-efficacy (Bandura, 1997). Accordingly, we hypothesize that lockdown will be negatively associated with students’ self-efficacy, while perceived adaptability and fluid reasoning will be positively associated with self-efficacy. There is insufficient research into the roles of adaptability and fluid reasoning in moderating (buffering or boosting) the (negative or positive) effects of lockdown on self-efficacy, so we leave this aspect of the study as an open empirical question.

2.3.6. Engagement and disengagement

The final part of the JD-R model comprises outcomes that are reflected in diverse forms of domain-specific functioning (e.g., engagement, retention, achievement; Collie & Martin, 2016). Applying this to academic learning, we contend that academic engagement and disengagement are important outcomes that result from students’ self-efficacy (Martin et al., 2012; see Fig. 1). Following Fredricks et al. (2004), engagement is approached from a tripartite perspective (behavioral, cognitive, and emotional), and utilizes Martin et al. (2021b) operationalization via participation (behavioral engagement), aspirations (cognitive engagement), and enjoyment (emotional engagement). Following Martin (2009; Martin et al., 2012), disengagement is operationalized as a unidimensional factor. The link between self-efficacy and engagement and disengagement is supported by conceptualizing from social cognitive theory (Bandura, 1997, 2001) and by empirical research in education (Martin et al., 2012). Students with higher levels of self-efficacy tend to generate alternative courses of action if they do not initially succeed, invest effort and persistence in task demands, enact cognitive and emotional processes that facilitate them to meet task demands, and are less likely to give up or withdraw effort (Bandura, 1997, 2001). COVID-related evidence for this is beginning to emerge; for example, in a multi-nation study, students’ perceived competence during distance education predicted engagement indicators such as time management (Pelikan et al., 2021). All this being the case, we hypothesize a positive link between self-efficacy and engagement (participation, aspirations, and enjoyment), and a negative link between self-efficacy and disengagement. We also explore the indirect association between these three predictors and both engagement and disengagement via self-efficacy. In addition, to understand the unique role of self-efficacy (beyond the effects of lockdown, perceived adaptability, and fluid reasoning) in predicting engagement and disengagement, we also model the direct associations between lockdown, perceived adaptability, and fluid reasoning and students’ engagement and disengagement (thus a “fully-forward” model).

2.3.7. JD-R and cognate frameworks

The processes posited by JD-R are complemented by related theoretical frameworks that crystallize key concepts underpinning the hypothesized phenomena in our study (Bakker & Demerouti, 2017). For example, theories of cognitive appraisal (e.g., Lazarus & Folkman, 1984; for review, see Moors et al., 2013) suggest that when presented with a task demand or task resource, individuals subjectively appraise these demands and resources and their capacity to respond or harness them. For example, the individual may experience threat and self-doubt (including, potentially, low self-efficacy) when they perceive that task demands are beyond them (see also Putwain & Symes, 2014, 2016; Uphill et al., 2019)—such as when lockdown is deemed by students as unacceptably burdensome. Related to this are themes under goal theory where individuals may perceive task demands in feature ways and resources in approach-oriented ways that have negative and positive (respectively) implications for their perceived competence in responding to these demands and resources (Elliot, 2006; Martin et al., 2021). Indeed, from a social-cognitive perspective, these demands and resources may also be considered akin to the contextual/environmental factors that underpin self-efficacy and lead to behavioral outcomes—as articulated under Bandura’s triadic model (Bandura, 1997; see also Schunk & DiBenedetto, 2014). Extrapolating this to the present investigation, lockdown would negatively, and perceived adaptability and fluid reasoning would positively, predict self-efficacy that in turn would lead to higher engagement and lower disengagement.

In support of our hypothesized ordering of factors, we can also draw on recent developments in motivation and engagement research. In work that theorizes and tests the respective roles of motivation and engagement, there is tentative agreement that motivation (e.g., self-efficacy) is generally considered to lead to engagement (see Martin, 2012, 2022 for reviews). For example, Schunk and Mullen (2012) harnessed social-cognitive theory to explain how motivation and engagement inter-relate, with self-efficacy (motivation) predicting behavioral engagement. Likewise, from a self-regulation perspective, Cleary and Zimmerman (2012) described how self-efficacy (motivation) leads to changes in engagement. This hypothesized ordering of motivation and engagement is pertinent to the present study as it augments contentions under our focal JD-R theory and AD-R model to guide the central modeling (viz. self-efficacy predicting engagement; see Fig. 1). Taken together, the factors and processes investigated in this study are not only rooted in JD-R theory, but also have notable alignments with other major theoretical traditions that emphasize the role of contextual and personal factors that are implicated in self-perceptions of competence (motivation) that in turn are associated with important behavioral outcomes (engagement).

2.3.8. Relevant background and contextual attributes

To better ascertain the unique roles of demands and resources, we included numerous background and contextual attributes (covariates) expected to be associated with one or more of the study’s substantive variables. These background and contextual factors are: gender, age, language background, socio-economic status, year of candidature, university location, area of study, prior achievement, and learning mode. For brevity in the main article, the theoretical and empirical rationale for including these variables in the study is explained in Supplementary Materials.

3. Aims of the present study

Drawing on JD-R theory, and its academic adaptation (the AD-R model), this study investigated the role of COVID-related lockdown (demand), self-perceived adaptability (resource), and fluid reasoning (resource) in university students’ self-efficacy (motivation)—and in turn, the role of these four factors in students’ engagement and disengagement (outcomes). We pose the following hypotheses and research questions:

Hypothesis 1. Lockdown (negatively), perceived adaptability (positively), and fluid reasoning (positively) will be significantly associated with students’ self-efficacy, beyond the effects of background and contextual attributes.

Hypothesis 2. Self-efficacy will be positively associated with engagement (participation, aspirations, enjoyment) and negatively associated with disengagement, beyond the effects of lockdown, perceived adaptability, fluid reasoning, and background and contextual attributes.

Research Question 1: What is the role of perceived adaptability and fluid reasoning in buffering or boosting the potentially negative or positive effects of lockdown on self-efficacy, engagement, and disengagement? Research Question 2: To what extent does self-efficacy mediate the relationship between lockdown, perceived adaptability, fluid reasoning and students’ engagement and disengagement?
4. Method

4.1. Participants

The sample comprised 500 Australian undergraduate university students from 41 universities, recruited from all states across the nation (see Procedure below for recruitment). Three-quarters of students were attending urban universities, with 25% attending regional/rural universities. Students were enrolled in STEM (25%), Business (23%), Arts/ Humanities (14%), Health (33%), or Other (5%) degrees. Students reported attending campus in-person (13%), online (52%), or a hybrid/blend of in-person and online (35%). A total of 70% of students reported being in mandated lockdown at some time in the previous two weeks. Just under two-thirds (64%) of students were female. Students were in 1st Year (28%), 2nd Year (29%), 3rd Year (30%), and 4th-6th Year (13%). The average age was 20.31 years (SD = 1.55 years). All students were enrolled full-time and were “local” students (not overseas students). Fifteen percent of students spoke a language other than English at home (comprising 4% Cantonese and Mandarin, 2% Vietnamese, 1% Spanish, 1% Macedonian, 1% Arabic, 1% Filipino/Tagalog, and the remaining 5% speaking ‘other’ languages). Students varied in SES (range 821–1164, M = 1016, SD = 72) based on the Australian Bureau of Statistics Index of Relative Socio-Economic Advantage and Disadvantage classification with higher scores indicating higher SES; in aggregate students were higher than the Australian average of 1000 (SD = 100).

4.2. Procedure

Data were collected via online questionnaire and participants were recruited through Qualtrics and their market research partners. These market research companies have contact details of a broad sample of the Australian population. Participants had previously signed up to receive information about studies run by Qualtrics and their partners. Given that students in different parts of Australia were in various stages of lockdown due to COVID-19 at the time of data collection, this approach was an ideal means of Australia-wide sampling of students who were and were not in lockdown. The study invitation was sent out via email or app notification to Australian university students. Participants clicked on the questionnaire URL to participate and provide consent. Following that, screening questions were asked to ensure students were full-time “local” (Australian) students enrolled in undergraduate studies. Respondents who did not meet these criteria were thanked and withdrawn from the questionnaire. Students who qualified on the screening question but responded the same way across many items in a row or completed the survey very quickly (less than 1/3 of the median time for completion) were excluded from the final sample. Students’ IP addresses were cross-referenced with their sociodemographic characteristics to check there were not duplicate respondents. Students completed the survey in one sitting. Institutional review board ethics approval was attained for the study.

4.3. Materials

4.3.1. Demands, resources, motivation, and outcomes

Lockdown status (demand) was a dichotomous item (0 = No, 1 = Yes) indicating whether students had been in a mandated lockdown any time in the previous two weeks. Adaptability self-perceptions (resource) comprised 3 items (using the Adaptability Scale – Short; Martin et al., 2016) asking students about the extent to which they adjust their behavior, thinking, and emotion to effectively navigate novelty, variability, and uncertainty (e.g., “To assist me in a new situation, I am able to change the way I do things”). Fluid reasoning (resource) was assessed by the 9 items of the Letter and Number Series sub-test of the International Cognitive Ability Resource (ICAR; Condon & Revelle, 2014). Items of this sub-test require participants to identify the next position in the sequence from six choices across short digit or letter sequences (e.g., “In the following alphanumeric series, what letter comes next? C, F, I, L, O, . . .”). To reduce the number of required parameters in the structural model and improve distributions of indicators of the fluid reasoning latent variable, three item parcels were created, each consisting of an item selected from the start, middle, and end sections of the test; i.e. parcel 1 = items 1, 4 and 7; parcel 2 = items 2, 5 and 8; parcel 3 = items 3, 6 and 9. Participants had 30 s per item to choose an answer to a given item. Self-efficacy (motivation) was assessed using the Motivation and Engagement Scale – University/College (MES-UC; Martin, 1999-2021). It was measured with four items (e.g., “If I try hard, I believe I can do my university work well”). In line with the tripartite engagement framework proposed by Fredricks et al. (2004), behavioral, cognitive, and emotional dimensions of engagement (outcome) were measured. They were adapted from the high school items to apply to university students and validated by Martin (2009). Behavioral engagement was measured in terms of student participation via 4 items (e.g., “I participate when we discuss things in class”). Aspirations represented the cognitive dimension of engagement, and was also measured by 4 items (e.g., “I’d like to continue studying or training after I complete this degree”). Emotional engagement was conceptualized in terms of enjoyment and measured with 4 items (e.g., “I enjoy being a student at this university”). Disengagement was assessed using the MES-UC (Martin, 1999-2021) and measured with 4 items (e.g., “Each week I’m trying less and less”). Unless otherwise stated, all items were rated using a 1 (Strongly Disagree) to 7 (Strongly Agree) scale.

4.3.2. Background and context attributes

We also assessed background attributes as covariates, comprising gender, age, language background, socio-economic status, year of candidature, university location, area of study, prior achievement, and learning mode. For brevity, we detail these measures in Supplementary Materials.

4.4. Data analysis

Confirmatory factor analysis (CFA) and structural equation modeling (SEM) were the central analyses, conducted with Mplus version 8.80 (Muthén & Muthén, 1998-2022). We used the MLR (maximum likelihood robust to non-normality) estimator that provides parameter estimates with standard errors and a chi-square test statistic that are robust to non-normality (Muthén & Muthén, 1998-2022). A Comparative Fit Index (CFI) greater than 0.90 and a Root Mean Square Error of Approximation (RMSEA) less than 0.08 indicated acceptable fit (Hu & Bentler, 1999; Kline, 2016). Missing data were 0.05% and dealt with using the Mplus default, Full Information Maximum Likelihood (FIML; Arbuckle, 1996). To appropriately adjust standard errors for students’ nesting within universities, the ‘Type = Complex’ option in Mplus was used with the cluster variable set as the university attended by the student.

For the CFA, all demand, resource, motivation, outcome, and background variables were included—thus, a 20-factor CFA. Multi-item measures were estimated as latent factors and single item indicators (e.g., gender, age) had loadings set at 1.00 and residuals at 0. This CFA was also the basis of the inter-factor correlations and the measurement component underlying the hypothesized SEM (Fig. 1). In this SEM, (a) lockdown status, perceived adaptability, fluid reasoning, and all background attributes predicted self-efficacy and (b) these factors—including self-efficacy—predicted engagement and disengagement (a “fully-forward” model). For effect sizes, standardized beta coefficients (βs) at or over 0.05 were deemed small effect sizes, βs at or over 0.10 were deemed medium effect sizes, and βs at or over 0.25 were deemed large effect sizes (Keith, 2006).

Our data also enabled auxiliary tests of moderation (buffering or boosting) effects, indirect (mediation) paths, and invariance. For moderation (buffering or boosting) effects, two interaction terms were assessed: lockdown status x perceived adaptability and lockdown status...
x fluid reasoning. For tests of indirect paths, a parametric bootstrapping approach was used to explore the extent to which self-efficacy mediated the relationship between the demand and resources and students’ engagement and disengagement. For invariance, we conducted multi-group SEMs to examine the extent to which the substantive predictive (beta) paths varied as a function of students’ background and contextual attributes (covariates). For purposes of brevity, we detail these analytical methods and present these results in Supplementary Materials.

5. Results

5.1. Descriptive and measurement statistics

Table 1 shows means, standard deviations, skewness, kurtosis, and reliability (coefficient omega; McNeish, 2018) for each of the substantive factors (see Participants section for background covariate descriptors). The factors were approximately normally distributed and attained acceptable levels of reliability. The CFA yielded an excellent fit to the data, $\chi^2 = 764.500$, $df = 525$, $p \leq .001$, RMSEA = 0.030, CFI = 0.960. Factor loading means are shown in Table 1. The CFA also generated bivariate correlations. These are described and presented in Supplementary Materials in Table S1.

5.2. Central hypothesized model

The SEM (Fig. 1) yielded an excellent fit to the data, $\chi^2 = 764.500$, $df = 525$, $p \leq .001$, RMSEA = 0.030, CFI = 0.960 (indeed, the same as the CFA fit given the SEM was a ‘fully-forward’ model). Standardized beta coefficients are shown in Table 2. Statistically significant substantive parameters are displayed in Fig. 2. Findings showed that lockdown significantly predicted disengagement ($\beta = 0.12, p = .01$; medium effect), but it did not predict self-efficacy (the hypothesized mediator). Perceived adaptability significantly predicted self-efficacy ($\beta = 0.54, p \leq .001$; large effect)—and also participation ($\beta = 0.36, p \leq .001$; large effect), aspirations ($\beta = 0.16, p = .04$; medium effect), and enjoyment ($\beta = 0.33, p \leq .001$; large effect). Fluid reasoning significantly predicted enjoyment ($\beta = 0.09, p = .03$; small effect), but it did not predict self-efficacy (the hypothesized mediator). The model’s mediator, self-efficacy, significantly predicted participation ($\beta = 0.20, p = .05$; medium effect), aspirations ($\beta = 0.73, p \leq .001$; large effect), and enjoyment ($\beta = 0.45, p \leq .001$; large effect)—and inversely predicted disengagement ($\beta = -0.34, p \leq .001$; large effect). Although we present all auxiliary results in Supplementary Materials, it is also worth reporting here that self-efficacy significantly mediated the relationship between perceived adaptability and engagement and disengagement; and, moderation tests revealed a significant lockdown x fluid reasoning interaction effect for self-efficacy such that fluid reasoning yielded a significant positive role for the self-efficacy of students who were in lockdown.

6. Discussion

We drew on Job Demands-Resources (JD-R) theory, and its recent academic adaptation, the Academic Demands-Resources (AD-R) model, to investigate the role of COVID-related lockdown (demand), self-perceived adaptability (resource), and fluid reasoning (resource) in university students’ self-efficacy (motivation)—and in turn, the role of these four factors in students’ engagement and disengagement (outcomes).

6.1. Findings of note

As hypothesized (Hypothesis 1), we found that beyond the effects of lockdown, fluid reasoning, and background attributes, perceived adaptability significantly predicted academic self-efficacy. Perceived adaptability also directly predicted students’ engagement, assessed by way of academic participation, aspirations, and enjoyment. Thus, consistent with Martin et al. (2021a); see also Collie et al. (2020), it appears that students’ psycho-behavioral adjustments (i.e., adaptability) foster mastery and efficacy experiences that form the basis of perceived competence. We suggest that adaptability (including students’ self-perceptions of it) is thus an important factor in how university students navigate their learning during COVID-19, indeed surmounting variance attributable to lockdown. Moreover, because perceived adaptability uniquely predicted self-efficacy and engagement (beyond the effects of fluid reasoning), we infer that the adjustments required by participants to navigate learning during COVID-19 were adequately met by the psycho-behavioral attribute of adaptability beyond what fluid reasoning may account for. Notably, because adaptability and students’ perceptions of it are modifiable (Putwain et al., 2019), the finding represents a potentially fruitful direction for assisting students’ learning during COVID-19, including students in lockdown. Practical strategies are discussed below.

Counter to Hypothesis 1, lockdown was not significantly associated with self-efficacy. However, lockdown was significantly associated with disengagement and also significantly linked to self-efficacy via the moderating role of fluid reasoning (see Supplementary Materials for moderation results). Taken together, we conclude that lockdown is implicated in university students’ academic development, but its effects are not substantial. One reason for this may be how different students appraise lockdown. Recent developments in JD-R theory suggest there is variability between individuals in how they perceive demands (Bakker & Demerouti, 2017). Thus, although many students perceive numerous downsides to lockdown, there may be others who see lockdown as offering greater flexibility in learning and new modes of engagement with learning material, peers, and instructors (Abramson, 2021). These different appraisals of lockdown may counter-balance to yield generally low-level lockdown effects.

Also counter to Hypothesis 1, fluid reasoning was not significantly associated with self-efficacy, after accounting for the roles of lockdown, perceived adaptability, and background attributes. This may be because our measure of academic self-efficacy emphasized self-efficacy for “my
university work”, rather than the cognitive processes underpinning that work. We speculate that, given the level of study specialization required at university level, students perceive relations between their subject matter expertise and academic self-efficacy more clearly than their relations between fluid reasoning capabilities (as assessed by an objective reasoning test) and academic self-efficacy. We did, however, find that fluid reasoning was significantly associated with academic enjoyment. It is possible that this stems from fluid reasoning’s shared variance with investment trait constructs such as need for cognition and curiosity (Hill et al., 2013)—broadly framed by von Stumm et al. (2011) as intellectual curiosity, or “the hungry mind” (p. 574). Seminal research by Cacioppo and Petty (1982) defined need for cognition in terms of differences among individuals in their inclination to “enjoy thinking” (p. 116). In the present study, then, students with higher levels of fluid reasoning might also be expected to be higher in need for cognition, and thus higher in their overall enjoyment of the learning challenges presented by higher education.

In answer to Research Question 1, we did find that fluid reasoning significantly moderated the effects of lockdown on self-efficacy (see Supplementary Materials for detailed moderation results). Specifically, there appeared to be a booster effect consistent with JD-R in that a personal resource (fluid reasoning) yielded a stronger role for motivation (self-efficacy) when demands (lockdown) were high. This finding has some alignment with prior research in work settings showing that the predictive validity of cognitive ability (including fluid reasoning) on occupational success increases as job demands and job complexity increase (Salgado & Moscoso, 2015). In our introduction, we extrapolated from the workplace literature to frame the “work” of students as having

| Table 2 | Standardized betas from fully-forward main effects SEM. |
|---------|----------------------------------------------------------|
|        | MOTIVATION | SELF-EFFICACY | OUTCOMES |
|        |           | Participation | Aspirations | Enjoyment | Disengagement |
| COVARIATES | Self-efficacy | -.20*** | .05 | .03 | .03 | .00 |
| Gender (male) | .06 | .03 | .03 | -.04 | -.06 |
| Age | -.03 | .06 | .12** | .06 | .02 |
| SES | -.08* | -.02 | .05 | -.07 | -.08 |
| Enrolment year | -.07 | .04 | -.05 | -.06 | .13 |
| Uni location (urban) | -.03 | -.04 | .02 | -.03 | .08 |
| STEM | .04 | .01 | .01 | -.01 | .09 |
| Health | .00 | .06 | .09 | .05 | -.05 |
| Arts & Humanities | .09 | .03 | .01 | .04 | .08 |
| Prior achievement | .01 | -.03 | -.01 | -.01 | -.04 |
| Online learning | -.09 | -.17* | -.19*** | -.20** | .07 |
| Hybrid learning | .08 | -.03 | -.20*** | -.20*** | -.01 |
| DEMAND | In lockdown | -.09 | .04 | -.03 | .01 | .12** |
| RESOURCE | Fluid reasoning | .05 | .00 | .04 | .09* | -.09 |
| Adaptability | .54*** | .36*** | .16* | .33*** | .01 |
| MOTIVATION | Self-efficacy | -.20* | .73*** | .45*** | -.34*** |

*p ≤ .05 **p ≤ .01 ***p ≤ .001; Business/Economics/Commerce Degree is the reference category for STEM, Arts & Humanities, and Health Degrees; In-person learning is the reference category for Online learning and Hybrid learning; Adaptability is self-reported and thus self-perceived adaptability.

Fig. 2. Significant standardized betas from fully-forward main effects model. Note. Model controls for covariates – see Table 2.
increased in complexity and challenge under lockdown—and further contended that fluid reasoning may play a role in determining students’ responses during this. In support of our contention, the findings demonstrated that fluid reasoning played a particularly noteworthy role in self-efficacy for students in lockdown.

Consistent with Hypothesis 2, self-efficacy significantly predicted higher engagement (participation, aspirations, enjoyment) and lower disengagement. Moreover, in answer to Research Question 2, self-efficacy significantly mediated the link between perceived adaptability and these outcomes (see Supplementary Materials for mediation results). Therefore, students’ perceived academic competence is important for their engagement and disengagement (beyond lockdown, perceived adaptability, fluid reasoning, and background attributes). This is in line with classic conceptualizing (e.g., social cognitive theory; Bandura, 1997) and recent research (e.g., Martin et al., 2012; Martin et al., 2021a). As described earlier, self-efficacious students tend to generate alternative courses of action and persist in the face of difficulty and novelty; they are also less inclined to give up or withdraw effort (Bandura, 1997). Thus, during COVID-19, the positive academic orientations of students high in self-efficacy “cut through” and connected to adaptive outcomes in the forms of higher engagement and lower disengagement (see Fong, 2022 for review). In fact, as relevant to Research Question 2, the importance of self-efficacy in this process is even more notable given its mediating role in linking perceived adaptability and outcomes. Thus, self-efficacy is not only vital as a link to engagement and disengagement, but also critical in how it connects other factors (adaptability) to these outcomes.

6.2. Implications for theory and practice

Our study does suggest JD-R theory and the related AD-R model as informative perspectives to guide measurement and modelling that can identify what factors may help or hinder students as they navigate academic disruptions implicated in COVID-19. We demonstrated that personal resources in the form of adaptability (including students’ perceptions of it) positively impacted students’ motivation and outcomes, consistent with prior COVID-related research among high school students and workplace research among teachers (Collie et al., 2020; Martin et al., 2021a). Although not predicting self-efficacy as hypothesized, the study’s demand (lockdown) and personal resource (fluid reasoning) did (respectively) predict disengagement and enjoyment (outcomes) and so their presence as main effects is not out of step with JD-R theory. We also demonstrated a booster effect such that fluid reasoning had a stronger positive role for self-efficacy when demands were high—that is, when students were in lockdown. As described earlier, booster (and buffer) effects are important concepts in JD-R theory and our moderation finding provided support for the theory on this count as well (Bakker & Demerouti, 2017).

There are also practical directions suggested by the findings—though we emphasize that our data were cross-sectional and practical guidance will ultimately rely on research designs (e.g., cross-lag longitudinal; experimental) that can appropriately disentangle the causal nature of these factors (see also 6.3, below). Thus, what we suggest here is preliminary and intended to provide indicative applied direction pending longitudinal empirical validation. Here we focus on adaptability (and students’ perceptions of it) and self-efficacy as they yielded the largest effect sizes, but in Supplementary Materials we also present practical possibilities and causal inferences when “findings are consistent with theory, employ appropriate covariates, are based on large and representative samples, reflect strong measurement properties, and yield educationally meaningful effect sizes” (Martin, 2011, p.241)—all of which hold for the present study. Thus, we tentatively suggest that longitudinal data will yield effects of a similar nature to those found herein. Second, although our fluid reasoning data were based on a test tapping into key aspects of the higher-order factor of general mental ability (“g”; Carroll, 1993; Cattell, 1987), it will be important to expand on this measure to assess related cognitive factors predictive of academic outcomes such as broad general knowledge (i.e., “crystallized intelligence”; Cattell, 1987) and domain-specific prior knowledge (Tricot & Sweller, 2014), as well as personality traits (Ginns et al., 2014). We also point out that the survey’s time constraints meant our fluid reasoning measure was somewhat brief and restricted to 30 s per item. One effect of this was to truncate the variance and so it is possible we may have under-estimated the effect of fluid reasoning. Third, although we purposefully operationalized motivation via self-efficacy (see our rationale in 2.3.5), we acknowledge there are other motivation constructs that warrant investigation. As a case in point, if researchers integrated situated expectancy-value ( Eccles & Wigfield, 2020) and JD-R (Bakker & Demerouti, 2017) theories, the motivation mediators in subsequent research might include both self-efficacy and valuing in order to explore the demands and resources that predict them, as well as their relative contribution to engagement outcomes. Finally, we relied on student reports for the bulk of our measures and there are known biases in this. Other indicators such as instructor ratings might be administered in future to triangulate with student reports.

6.3. Limitations and future directions

The study comprised limitations that are important to consider when interpreting the results; they also provide direction for future research. First, our cross-sectional correlational design does not support causal conclusions. Longitudinal survey (e.g., cross-lag panel design) and classic experimental (pre-post/control-treatment) designs are necessary to establish the causal role of our demand (lockdown), resource (perceived adaptability, fluid reasoning), and motivation (self-efficacy) factors. Indeed, researchers recognize there are likely cyclical associations among these factors. For example, with regard to JD-R models it is known that the process is cyclical over time such that “outcomes” can in turn impact individuals’ personal resources (Collie et al., 2020; see also Martin et al., 2017 with regard to the cyclical processes implicated in motivation and engagement). Although we did account for prior achievement (that in part attends to the cycle of learning), longitudinal data on demands, resources, motivation, and outcomes would enable tests of the central substantive relationships—for example, the extent to which engagement (an outcome at one time point) predicts subsequent adaptability (a personal resource at a later time point). Notwithstanding this, we suggest that cross-sectional studies might yield prescriptive possibilities and causal inferences when “findings are consistent with theory, employ appropriate covariates, are based on large and representative samples, reflect strong measurement properties, and yield educationally meaningful effect sizes’ (Martin, 2011, p.241)—all of which hold for the present study. Thus, we tentatively suggest that longitudinal data will yield effects of a similar nature to those found herein. Second, although our fluid reasoning data were based on a test tapping into key aspects of the higher-order factor of general mental ability (“g”; Carroll, 1993; Cattell, 1987), it will be important to expand on this measure to assess related cognitive factors predictive of academic outcomes such as broad general knowledge (i.e., “crystallized intelligence”; Cattell, 1987) and domain-specific prior knowledge (Tricot & Sweller, 2014), as well as personality traits (Ginns et al., 2014). We also point out that the survey’s time constraints meant our fluid reasoning measure was somewhat brief and restricted to 30 s per item. One effect of this was to truncate the variance and so it is possible we may have under-estimated the effect of fluid reasoning. Third, although we purposefully operationalized motivation via self-efficacy (see our rationale in 2.3.5), we acknowledge there are other motivation constructs that warrant investigation. As a case in point, if researchers integrated situated expectancy-value ( Eccles & Wigfield, 2020) and JD-R (Bakker & Demerouti, 2017) theories, the motivation mediators in subsequent research might include both self-efficacy and valuing in order to explore the demands and resources that predict them, as well as their relative contribution to engagement outcomes. Finally, we relied on student reports for the bulk of our measures and there are known biases in this. Other indicators such as instructor ratings might be administered in future to triangulate with student reports.
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