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Test-taking motivation and performance: Do self-report and time-based measures of effort reflect the same aspects of test-taking motivation?

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ABSTRACT

Several studies found a low correlation between two measures of test-taking effort: self-reported effort (SRE) and response time effort (RTE). This study examined test-taking motivation in low-stake cognitive ability testing (n = 1614) by applying expectancy-value theory as the framework. We investigated the complex relationship between test performance and test-taking motivation aspects (expectancy, importance, interest, test anxiety, time cost, and test-taking effort). Furthermore, we used both SRE and RTE, allowing us to examine whether the two measures of effort relied on the same underlying mechanism of test-taking motivation. Our finding showed that SRE and RTE simultaneously explained more than half of test performance variance, with the predictive power of RTE being higher. RTE and SRE were correlated lower than expected ($r = 0.28$). SRE is best predicted by expectancy, while RTE is best predicted by test anxiety. In practice, if motivation-filtering procedures are needed, it is better to use RTE.

1. Introduction

It has been shown that variables other than ability (e.g., fatigue, anxiety, motivation, test format, length of the test) can impact performance in a cognitive test (DeMars, 2010; Duckworth et al., 2011; Wolf & Smith, 1995). A lack of test-taking motivation becomes one of the main concerns in *low-stakes* tests (i.e., tests with no personal consequences for test-takers). Low test-taking motivation can manifest in low effort to complete the test, which can threaten test scores' validity. Numerous studies have demonstrated that motivated test takers perform better than unmotivated test takers (Baumert & Demmrich, 2001; Duckworth et al., 2011; Eklöf et al., 2014; Wise & DeMars, 2005), even when the ability is accounted for (Cole et al., 2008; Silm et al., 2019; Thelk et al., 2009). Therefore, it is crucial to consider how motivation affects performance when interpreting test results in low-stakes testing. Low test-taking motivation will create construct-irrelevant variances in the test scores, and test scores may not reflect the real ability. This issue is often addressed by motivation-filtering procedures (e.g., Rios et al., 2014, 2017).

1.1. Test-taking effort in expectancy-value theory

Expectancy-value theory is one theory that may explain the relationship between test-taking motivation and test performance. This theory is frequently used as a framework for test-taking motivation, a particular type of achievement motivation (Eccles & Wigfield, 2002; Wigfield & Eccles, 2000). According to this theory, achievement motivation for taking a test is a function of (1) expectancy (i.e., the expectation of success in solving the test items) and (2) value (i.e., the perceived values of the test). The expectancy component consists of ***ability beliefs*** (i.e., broad beliefs about competence in a given domain) and *expectancy* (i.e., expectancy for success on a specific task). The value component consists of four aspects: *importance, interest, utility,* and *cost.* Importance (or attainment value) refers to the personal importance of doing well on a task. Interest (or intrinsic value) refers to enjoyment from engaging in an activity. Utility refers to the perception that the task will be useful to meet future goals. Cost refers to the negative aspect of a task, including anticipated anxiety, loss of time to engage in other desired activities, and the effort required to complete the task. The grouping of effort in the expectancy-value model of Eccles and colleagues is vague. On one side, effort is described as an outcome of both expectancy and value. On the other side, it is linked with cost aspect

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since cost is interpreted as how much effort is required to succeed (Eccles & Wigfield, 2002).

The expectancy-value theory of achievement motivation offers an adequate framework for test-taking motivation because it explains the link between motivation and test performance in low-stakes tests. While the expectancy-value model was initially developed to explain choices with long-term individual consequences, its principles can be generalized to low-stakes tests. Individuals still make decisions about how much effort to put into the test based on their beliefs about their ability to succeed (expectancy) and how much they value the test and its outcomes (value). For example, test-takers of low-stakes tests may decide to put in more effort if they believe they can perform well (high expectancy) and value doing well on the test (high value). In contrast, test-takers who believe they cannot perform well (low expectancy) and do not value doing well on the test (low value) may decide to put in less effort. Test-taking effort plays a crucial role here because the decision about how much effort invested is influenced by expectancy and value on the one hand, and affects test performance on the other. According to the expectancy-value theory, it is reasonable that in low-stakes tests, test-takers have lower motivation. For some test-takers, the absence of personal consequences and intrinsic value in completing the test may contradict the loss of time and effort necessary to complete the items successfully. This is particularly true for test-takers with lower levels of ability (i.e., low expectancy) who must invest more effort to complete a test successfully.

Previous studies indicated that test-taking effort is an outcome of expectancy and value and a good predictor of test performance (Cole et al., 2008; Knekta & Eklöf, 2015; Penk & Richter, 2017; Penk & Schipolowski, 2015; Wigfield & Eccles, 2000). We conceptualize test-taking motivation in the present article consists of three interrelated constructs: expectancy, value, and test-taking effort. Test-taking effort is included in the model as a third main component and defined as "engagement and expenditure of energy toward the goal of attaining the highest possible score on the test" (Wise & DeMars, 2005, p.2). Indirect effects of expectancy and value on test performance have been examined for test-takers from different countries (Cole et al., 2008; Finney et al., 2018, 2020; Myers & Finney, 2021; Penk & Schipolowski, 2015; Satkus & Finney, 2021; Zilberberg et al., 2014). Expectancy and value affect effort, which affects performance. Therefore, In line with previous studies, we propose that test-taking effort is part of the test-taking motivation construct and serves as a mediator.

1.2. Measures of test-taking motivation

There are several methods to measure test-taking motivation. Three main strategies have been used to get a proxy for test-takers' motivation: a) self-reported measures, b) time-based measures, and c) person-fit statistics. Self-report instruments are the most common measures used for determining test-taking motivation. These instruments are administered to test-takers right after completing the test. Several self-report measures have been developed to measure test-taking motivation, For instance: the current motivation questionnaire (QCM; Rheinberg et al., 2001), the student opinion scale (SOS; Sundre & Moore, 2002), the effort thermometer (Baumert & Demmrich, 2001), and the motivation instrument (Knekta & Eklöf, 2015). Test-taking motivation measure is often used in the framework of the expectancy-value theory. However, most instruments that measure test-taking motivation do not include all expectancy-value theory components. Among these instruments, the motivation instrument (Knekta & Eklöf, 2015) is the most comprehensive expectancy-value-based questionnaire measuring five aspects of test-taking motivation (effort, expectancy, importance, interest, and test anxiety).

The other ways to measure test-taking motivation are time-based measures and person-fit statistics. The most extensively used time-based measure is Response Time Effort (RTE), proposed by Wise and Kong (2005). This measure attempts to quantify the proportion of rapid responses in the test based on the response times for each question. This measure is calculated based on the assumption that unmotivated test-takers will answer the question too quickly (i.e., before they have a chance to read and properly analyze the question). The benefit of RTE is that it is unobtrusive that does not disrupt test-takers. In addition, RTE is more beneficial than self-report when individuals are not interested in responding to questionnaires. RTE is considered a more objective measure of effort since its score is not influenced by response bias. Self-reports can reflect many things besides test-taking motivation (e.g., social desirability, perceived failure or lack of ability), making their interpretation less clear. However, RTE specifically only measure one aspect of test-taking motivation: test-taking effort. In addition, RTE is a very specific, egregious form of non-effort. Sometimes, test takers do not answer rapidly but give less-than-full effort to items. Wise and Kuhfeld (2020) referred to these as partially engaged responses, and RTE may not represent those non-effortful responses. This idea is supported by findings showing that test-takers reduce their performance during the test even when their responses do not reflect rapid guessing behaviour (Nagy et al., 2022; Wise & Kuhfeld, 2021). They empirically found that non-rapid responses are not necessarily given with effort. These findings indicate that rapid guessing behaviour does not fully capture all aspects of disengaged response.

Another measure of test-taking motivation, person-fit statistics, is less popular due to the lack of correlation between self-reported effort (SRE) and RTE (Wise & DeMars, 2005). In addition, the person fit statistic is a global measure of aberrant response patterns with multiple influences. Thus, it is difficult to conclude that person's misfit is due to a lack of motivation (Wise & Kong, 2005). Therefore, our study only focuses on two measures of test-taking motivation: self-report and time-based measures.

Although SRE and RTE are designed to measure test-taking effort, previous studies showed that the correlation between these measures is lower than expected. Wise and Kong (2005) found that the correlation between the two measures was $r = 0.25$, and even lower in more recent studies, $r = 0.17$ (Silm et al., 2019) and $r = 0.18$ (Hofverberg et al., 2022). A meta-analysis study found that the average correlation between SRE and test performance was $r = 0.33$, and the average correlation between RTE and performance was $r = 0.72$ (Silm et al., 2020). The difference between the two is noticeable, indicating that they may not reflect the same underlying mechanism of test-taking motivation (Silm et al., 2020). However, the reason behind this difference is not clear.

1.3. Motivation for the current study

Two aspects of previous studies on this topic motivate the current study. First, numerous studies have shown that test-taking effort is a significant predictor of test performance that mediates the effect of other components (i.e., expectancy and value) (Cole et al., 2008; Knekta & Eklöf, 2015; Penk & Schipolowski, 2015). However, the number of studies examining both SRE and RTE as measures of test-taking effort is still limited. Although a meta-analysis study (Silm et al., 2020) indicated that SRE and RTE relied on a different mechanism of test-taking motivation, no studies examine these two measures in the framework of the expectancy-value theory. Several studies involving SRE and RTE together (e.g., Kong et al., 2007; Rios et al., 2014; Silm et al., 2019; Wise & Kong, 2005) did not involve other components of test-taking motivation (i.e., expectancy and value). Therefore, this study tried to extend previous studies by applying both SRE and RTE along with other test-taking motivation aspects to better understand the two measures of test-taking effort.

Second, although many studies used expectancy-value theory as a framework for test-taking motivation, only a few studies have measured more than four aspects of the theory. Since expectancy-value theory has the potential to predict test-taking motivation and test performance, it is critical to investigate all components of the test-taking motivation construct. So far, the study by Knekta and Eklöf (2015) is the most comprehensive study examining the relationship between five aspects of test-taking motivation and test performance. However, they only include one aspect of cost: emotional cost (anxiety). To better represent the expectancy-value theory, we added one more aspect of cost: opportunity cost (time cost). This aspect refers to the perceived loss of valuable time due to participating in the testing. Our study was web-based, meaning participants could take the test anywhere at any time. The time cost is crucial since, in web-based low-stakes testing, the loss of time to complete the test contradicts the consequences of the test.

1.4. Study objectives

This study aimed to examine the interrelation of expectancy, value, test-taking effort, and test performance in low-stakes cognitive ability testing. This study was conducted in the context of online cognitive ability testing (fluid reasoning test). The fluid reasoning test in the present study was anticipated to enhance the state of knowledge on the applicability of expectancy-values theory to different tasks in a broader setting. The testing was a part of the data collection for developing fluid reasoning tests.

We aimed to examine three models. This first model focused on the predictive power of test-taking efforts measures solely. Two measures of effort (SRE and RTE) served as predictors of test performance. Based on previous studies (Cole et al., 2008; Kong et al., 2007; Penk & Schipolowski, 2015; Rios et al., 2014; Silm et al., 2019, 2020; Wise & Kong, 2005), we hypothesized that test-taking effort significantly predicts test performance. The predictive power of RTE on test performance is higher than SRE, in line with previous studies involving SRE and RTE together (e.g., Kong et al., 2007; Rios et al., 2014; Silm et al., 2019; Wise & Kong, 2005). This hypothesis is also supported by a meta-analysis study which found that RTE has a stronger relationship with test performance than SRE (Silm et al., 2020).

The second model was proposed based on the expectancy-value theory. The theory proposed that test-takers' efforts will mediate the impact of expectancy and value aspects on test performance (Finney et al., 2018; Myers & Finney, 2021; Penk & Schipolowski, 2015; Satkus & Finney, 2021). Based on previous findings, we hypothesized that all aspects of expectancy and values (i.e., expectancy, importance, interest, anxiety, time cost) would significantly predict efforts (both SRE and RTE), and efforts will significantly predict test performance. We freely estimated the correlation between SRE and RTE since those two measures of effort are conceptually related. Although our main interest model was in a fully mediated model, we also tested a partially mediated model as a previous study found a direct effect of expectancy and interest on test performance (Penk & Schipolowski, 2015). A partially mediated model was tested by including direct effects of all expectancy and values components on performance. We compared fully and partially mediated models to test whether these direct effects were necessary or whether the effects of expectancy and values on performance were completely mediated. The fully mediated (model 2a) and partially mediated (model 2b) models are represented in Fig. 1.

2. Method

2.1. Participants

A total of 2041 Indonesians participated in this study, but only 1614 participants (996 females) completed all the tests. The age of participants ranged from 14 to 59 (M = 23.52, SD = 7.23). The data was collected using an online test using the PsyToolkit platform (Stoet, 2010, 2017). Participants were recruited in May–June 2022 using various strategies, including advertisements on social media (Facebook, Twitter, Instagram, and WhatsApp groups). No monetary incentives were given for participating in this study. The testing was a part of the data collection for developing fluid reasoning tests. Participants were told that they would face fluid reasoning tests and they would be the first ones who had the chance to try this test. At the end of the test, all participants got the test score result with a warning that the test was under development.

2.2. Measures

2.2.1. Fluid reasoning test

The fluid reasoning test consisted of three subtests: Classification, Deduction, and Hagen-Matrices Test – Short Form (HMT—S; Heydasch et al., 2020). Each participant completed one form of the test, consisting of 25 items of the Classification test, 25 items of the Deduction test, and six items of HMT—S. All subtests used a multiple-choice format. The fluid reasoning test was scored using the Rasch model separately for each subtest. EAP reliability for Classification, Deduction, and HMT-S were 0.71, 0.77, and 0.60, respectively.

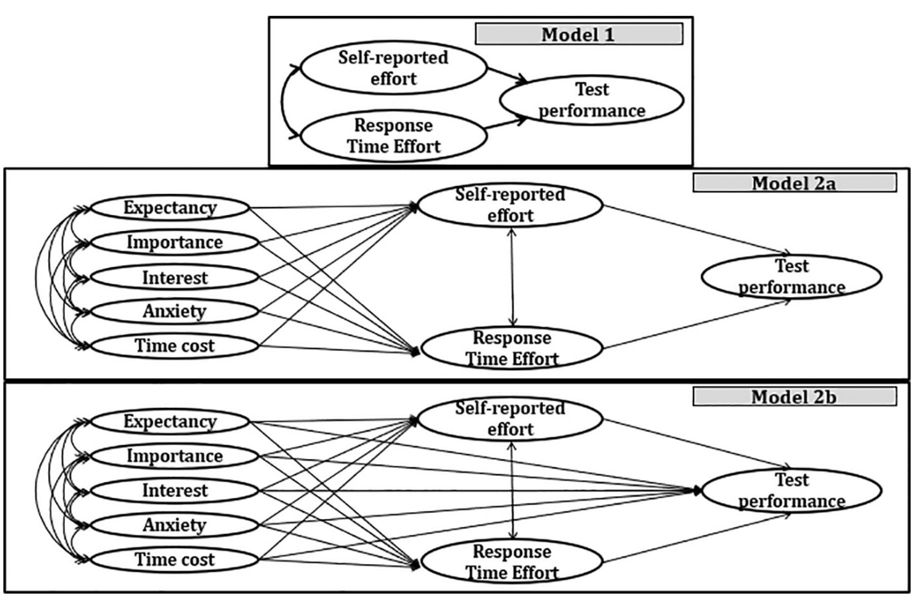

Fig. 1. Overview of the model
Note: Manifest indicators and disturbance terms omitted for simplicity.

2.2.2. Test-taking motivation instrument

Test-taking motivation instrument was modified from Knekta and Eklöf (2015). This instrument measures five aspects of the expectancy-value theory: Effort, Expectancies, Importance, Interest, and Test Anxiety. We also added one more aspect of test-taking motivation: time cost. Participants rated all items on a 4-point Likert-type scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). The original instrument was used in the school context. We translated and modified the instrument into a more general context. For instance, the original item of "*Compared with other students, I think I did well on this test*" was modified to "*Compared with other test-takers, I think I did well on this test*". The number of items in this instrument was 23 (see Appendix A for the complete items of each aspect).

2.2.3. Response time effort (RTE)

RTE is a time-based measure of test-taking effort. This measure is a proportion of solution behaviour during the testing session. We used the 30 % Normative Threshold (NT30) approach to determine whether participants provided a solution or rapid-guessing behaviour, as Wise and Kuhfeld (2020) recommended. The NT30 proposes that 30 % of the average response time be used to determine the threshold. For example, if it takes 50 s on average to complete a particular item, then any response below 15 s will be classified as rapid-guessing behaviour (RG). In contrast, if a participant responds slower than the threshold, their response will be classified as solution behaviour (SB). RTE was calculated by summing the SB values across all items and dividing them by the number of items in the test. RTE index ranges from zero to one, with an index near one indicating high test-taking effort.

2.3. Procedures

After completing demographic questions, participants were asked to complete three fluid reasoning tests in a sequence: Classification, Deduction, and HMT—S. Participating in the online cognitive test had no implications for the research participants and could be considered a low-stakes test situation. It took around 50–70 min to complete the test. After completing all the tests, all participants completed the motivation instruments consisting of 23 items. At the end of the testing session, participants got the test result. During the test, the response time to answer each question was recorded. Participation in this study is voluntary. All participants gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Research Ethics Committee from the first author's institution (number 2022/291).

2.4. Analyses strategy

Confirmatory Factor Analysis (CFA) and latent variable regression analysis were performed using the 'lavaan' package (Rosseel, 2012), while Rasch analysis was performed using marginal maximum likelihood estimation in 'TAM' package (Robitzsch et al., 2022) in the R program. First, the measurement model of six factors of the test-taking motivation construct (interest, importance, expectancies, anxiety, time cost, and effort) was specified and tested using CFA. Second, we investigated the relationship between expectancy, value, effort, and test performance using three latent regression models. Fig. 1 shows the specification of each regression model. Please note that the structural parts of Model 1 and Model 2b are fully saturated; thus, all misfit is associated with the measurement part of the model. Test performance was a latent variable comprising three Rasch theta scores from three subtests. Test-taking motivation construct was also modelled as latent variables. RTE was also modelled as a latent variable with a single indicator (i.e., average SB values across all items) by specifying the error variance of the observed variable to be equal to 0. Therefore, the latent variable will account for all of the variances in the observed variable.

We used weighted least squares means and variance adjusted (WLSMV) estimation in all analyses as this estimator is more appropriate for ordinal data (Beauducel & Herzberg, 2006). We used multiple fit indices to evaluate model fit: $\chi 2$, comparative fit index (CFI); the standardized root-mean-squared residual (SRMR); and the root mean squared error of approximation (RMSEA). The following criteria were used to evaluate the adequacy of the models; CFI > 0.90, SRMR <0.10, and RMSEA <0.08 were considered adequate, and CFI > 0.95, SRMR <0.05, and RMSEA <0.05 were considered a good fit (Schermelleh-Engel et al., 2003). Local misfit was determined by assessing correlation residuals, reflecting how well the model reproduces each relationship between pairs of variables. Values greater than $|0.10|$ are often regarded as non-ignorable and indicate a relationship that is not adequately captured by the hypothesized model (Kline, 2016).

3. Results

3.1. Measurement model of the test-taking motivation instrument

The measurement model of six factors of test-taking motivation construct was analyzed using confirmatory factor analysis. The motivation instrument consisted of 23 items measuring six aspects of the expectancy-value theory: effort, expectancy, importance, interest, anxiety, and time cost. The initial model fit of the correlated six-factor model was unsatisfactory, $\chi^2 = 1871.77$, $df = 215$, $p < .001$, $CFI = 0.89$, *RMSEA [90 % CI]* = 0.069 [0.066, 0.072], $SRMR = 0.07$. A closer inspection was then carried out on the factor loading of each item. Four items (EF5, EX2, IM4, and AN3) had low standardized factor loading. The model was then modified by removing those four items. The modified model with 19 items was specified and tested. This model displayed an acceptable fit, $\chi^2 = 684.82$, $df = 137$, $p < .001$, $CFI = 0.96$, *RMSEA [90 % CI]* = 0.050 [0.046, 0.053], $SRMR = 0.05$. Moreover, localized misfit was minimal. All correlation residuals were smaller than $|0.10|$, suggesting that the relationship between variables was well established. Coefficient ω for expectancy, importance, interest, anxiety, time cost, and effort was $\omega = 0.66$, $\omega = 0.79$, $\omega = 0.73$, $\omega = 0.76$, $\omega = 0.78$, and $\omega = 0.81$, respectively.

3.2. Descriptive statistics of studied variables

As shown in Table 1, the mean of the SRE and RTE scores indicates that most of the test-takers reported that they had invested effort to complete the test. Test takers were also confident of being successful, perceived the test was important and were interested in the test. Test-takers also perceived losing valuable time due to participating in the testing. Surprisingly, the test-taker's anxiety was relatively high, even though it was a low-stakes test with no personal consequence. The correlation matrix shows that both SRE and RTE significantly correlate with test performance. However, the correlation magnitude was different, $r = 0.61$ for RTE and $r = 0.24$ for SRE. The correlation between SRE and RTE was relatively low ($r = 0.28$) despite both being measures of test-taking effort.

Fig. 2 shows the agreement between SRE and RTE in identifying low-effort responses. RTE threshold of 0.90 was associated with unmotivated participants, as suggested by Rios et al. (2014). For SRE, because there is no guideline on the threshold for determining unmotivated participants, we set a value of 2.5 (i.e., the median of the possible scores) as the threshold. As shown in Fig. 2, Most participants were classified as having high RTE and SRE (48%). RTE classified some participants as unmotivated who reported high levels of effort (37 %), while SRE identified some participants who did not display rapid-guessing behaviour (5 %). Some participants also reported high effort despite low performance (i.e., average theta <-0.5).

Table 1
Descriptive statistics and raw score correlation among studied variables.

Variables	Mean	SD	1	2	3	4	5	6	7
1. Expectancy	2.77	0.61							
2. Importance	2.83	0.63	0.41***						
3. Interest	2.92	0.58	0.40***	0.44***					
4. Anxiety	2.48	0.70	−0.08**	0.19***	0.06				
5. Time cost	2.40	0.63	−0.07**	0.00	−0.14***	0.32***			
6. SRE	2.94	0.58	0.59***	0.52***	0.53***	−0.01	−0.10***		
7. RTE	0.79	0.25	0.18***	0.17***	0.14***	−0.17***	−0.15***	0.28***	
8. Performance	0.00	0.66	0.21***	0.09*	0.15***	−0.24***	−0.18***	0.24***	0.61***

Note: SRE = Self-Reported Effort, RTE = Response Time Effort, Performance was calculated using average Rasch theta scores of three subtests.
*** $p < .001$.
** $p < .01$.
* $p < .05$.

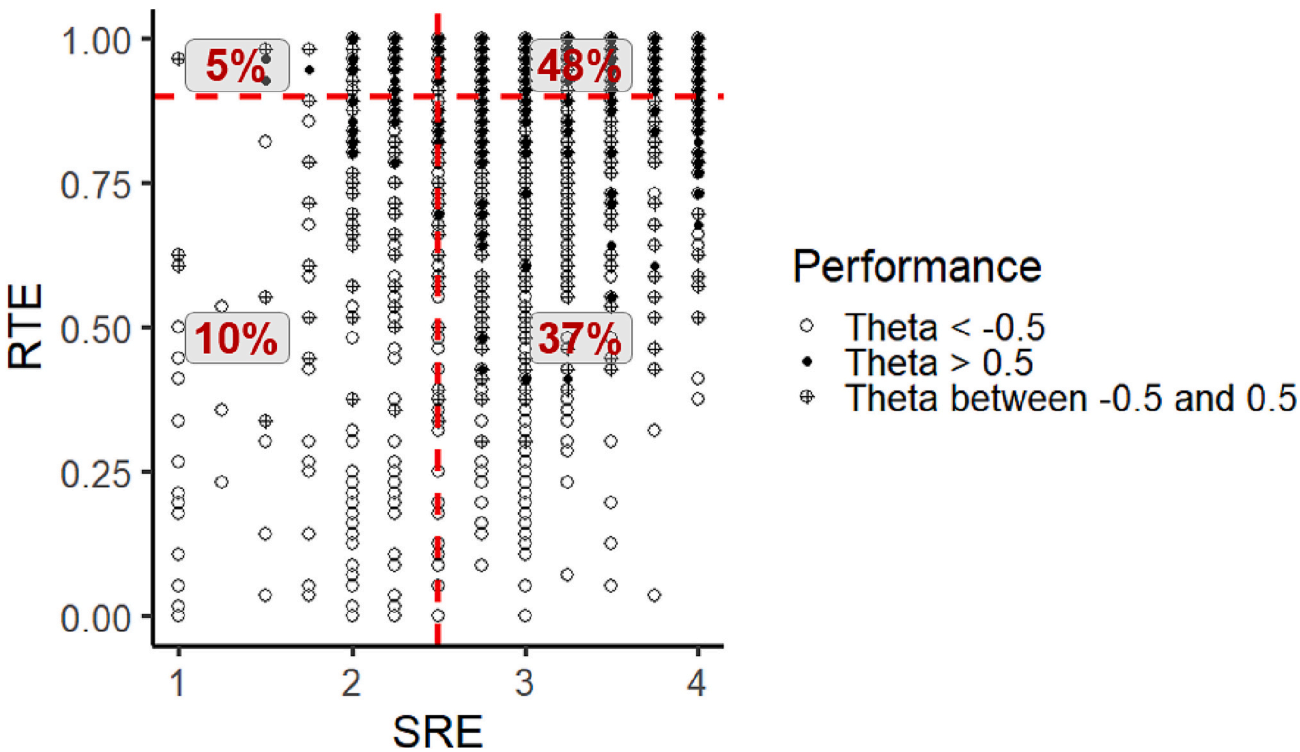

Fig. 2. The relationship between self-reported effort (SRE) and response time effort (RTE).

3.3. *Test-taking effort as a predictor of test performance*

A latent regression model was performed. The model predicted test performance with two measures of test-taking effort as predictors, SRE and RTE. The model indicated that both SRE and RTE were significant predictors of test performance. These variables explain 51 % of the variance in test performance. The predictive power of RTE on test performance was higher (b = 0.96, SE = 0.05, $p < .001$, β = 0.67) in comparison to SRE (b = 0.17, SE = 0.04, $p < .001$, β = 0.12). The model had good model fit with χ^2 = 38.58, df = 18, $p < .001$, CFI = 0.99, *RMSEA [90 % CI]* = 0.027 [0.015, 0.038], *SRMR* = 0.028. This result is in line with our hypothesis.

3.4. *The effects of expectancy and value on test performance mediated by test-taking effort*

In a subsequent model, we investigated whether test-taking effort mediated the effects of expectancy and value components on test performance. The fully mediated model (Model 2a) had a good model fit with χ^2 = 922.48, df = 208, $p < .001$, CFI = 0.96, *RMSEA [90 % CI]* = 0.046 [0.043, 0.049], *SRMR* = 0.053. In addition, there is no localized misfit, with all correlation residuals being smaller than |0.10|. However, this model fit significantly worse than the partially mediated model: $\Delta\chi^2$ (5) = 107.66, $p < .01$. When examining the partially mediated model (Fig. 3), the paths from anxiety to performance were statistically significant; thus, setting this path to zero in the fully mediated model resulted in significantly worse fit. In contrast, we could not find a significant direct effect of SRE, expectancy, importance, interest, and time cost on test performance.

Given that expectancy-value theory posits that expectancy and value influence performance via test-taking efforts, we were interested in these indirect effects (see Table 2). In a fully mediated model, RTE mediated the effects of almost all aspects of expectancy and value on test performance (except interest). In contrast, none of the indirect effects via SRE was significant. These results partially support our hypothesis. The effect of all aspects of expectancy and values (except interest) on test performance was significantly mediated via RTE, but not via SRE. All aspects of expectancy and values (except interest) significantly affected RTE, which in turn affected test performance. Given the direct effects on test performance, RTE fully mediated the impact of importance, time

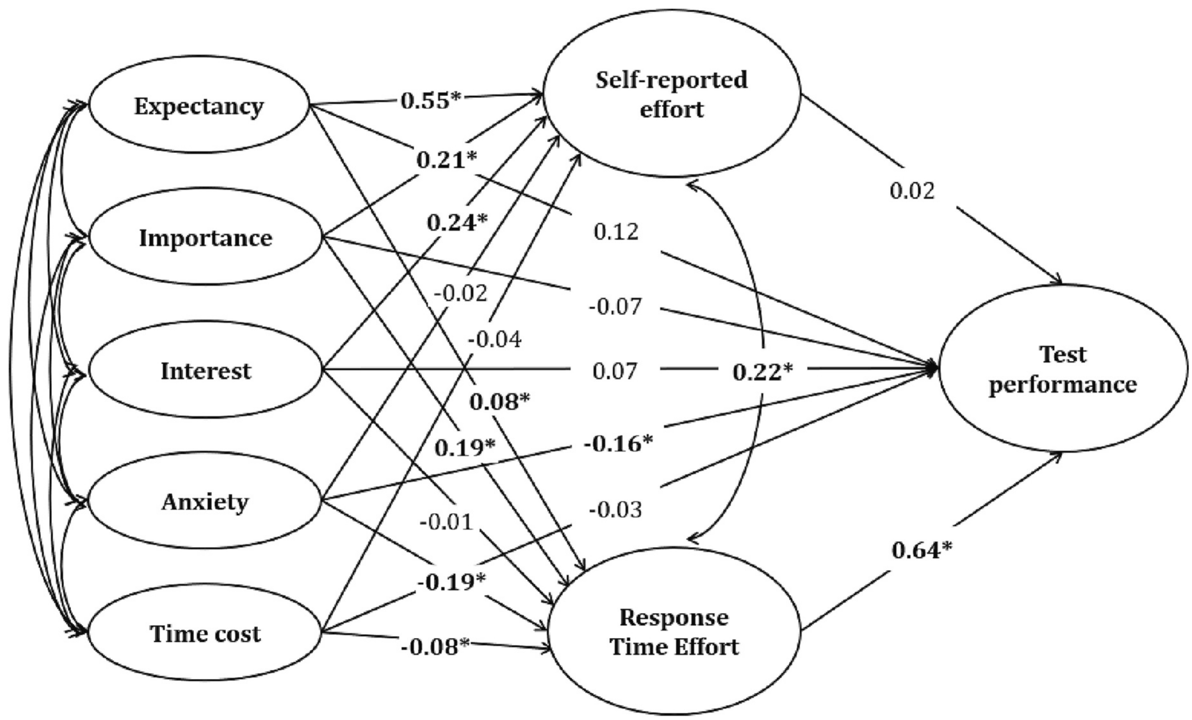

Fig. 3. Partially mediated model of expectancy, importance, interest, anxiety, time cost, test-taking effort, and test performance
Note: Manifest indicators and disturbance terms omitted for simplicity, * $p < .05$.

Table 2
Direct and indirect effects for the fully mediated model.

	SRE				RTE		
Structural path	b	SE	β	Structural path	b	SE	β
Direct effect				Direct effect			
Expectancy➔SRE	1.07***	0.14	0.55	Expectancy➔RTE	0.17*	0.07	0.15
Importance➔SRE	0.40***	0.09	0.20	Importance➔RTE	0.14*	0.06	0.12
Interest➔SRE	0.47***	0.09	0.24	Interest➔RTE	0.04	0.06	0.04
Anxiety➔SRE	−0.04	0.07	−0.02	Anxiety➔RTE	−0.31***	0.05	−0.28
Time cost➔SRE	−0.07	0.06	−0.04	Time cost➔RTE	−0.10*	0.04	−0.09
Indirect effect				Indirect effect			
Expectancy➔SRE➔Performance	0.04	0.03	0.02	Expectancy➔RTE➔Performance	0.25*	0.10	0.13
Importance➔SRE➔Performance	0.01	0.01	0.01	Importance➔RTE➔Performance	0.20*	0.10	0.10
Interest➔SRE➔Performance	0.02	0.01	0.01	Interest➔RTE➔Performance	0.06	0.09	0.03
Anxiety➔SRE➔Performance	−0.01	0.01	−0.01	Anxiety➔RTE➔Performance	−0.46***	0.08	−0.24
Time cost➔SRE➔Performance	−0.01	0.01	−0.01	Time cost➔RTE➔Performance	−0.15*	0.06	−0.08

Note: SRE = Self-Reported Effort, RTE = Response Time Effort, CFI = comparative fit index, SRMR = standardized root-mean-squared residual, RMSEA = root mean squared error of approximation.
*** $p < .001$.
* $p < .05$.

cost, and expectancy, and it partially mediated the effect of anxiety on test performance.

4. Discussion

The present study examined the interrelation of expectancy, value, test-taking effort, and test performance in low-stakes cognitive ability testing. Unlike other studies grounded on the expectancy-value theory conducted in a school setting (e.g., Knekta & Eklöf, 2015; Penk & Richter, 2017; Penk & Schipolowski, 2015), this study was conducted in an unproctored online testing context. Our findings indicated the expectancy-value theory seems to be a useful general framework for interpreting the test-taking motivation construct in a broader context.

Before performing latent regression analysis, we tested the six-factor model of the test-taking motivation instrument. Measurement model testing was performed because the instrument was translated and modified from the original instrument to adjust to the context of our research. The final model showed a good fit. Correlations between the scales showed that expectancy, value (importance and interest), and effort had moderate to high correlations. However, the correlation between cost (anxiety and time cost) and other test-taking motivation components was lower. These findings escalate the debate regarding the role of cost within the expectancy-value theory. Several studies suggested that cost was categorized as a component of task value (e.g., Buehl & Alexander, 2005; Safavian & Conley, 2016), and others indicated that cost had formed a separate factor (Flake et al., 2015; Jiang et al., 2018; Perez et al., 2014). Our findings support the latter. Time cost positively correlated with anxiety ($r = 0.32$), but their correlation with other aspects of value was low ($r < 0.3$). In addition, cost and task value also showed different patterns when predicting test-taking effort and test performance. Unlike other aspects of task value, anxiety directly affects test performance, indicating it has a substantial impact even after considering other aspects of test-taking motivation.

Model 1 in our study aimed to examine whether test-taking effort significantly explains test performance. Our finding showed that SRE and RTE simultaneously explain 51 % of the variance in test performance. However, the predictive power of RTE was much higher than SRE, and the correlation between SRE and RTE was weaker than that was expected ($r = 0.28$). These findings confirm our hypothesis and are in line with the results of previous studies (Rios et al., 2014; Silm et al., 2019, 2020; Wise & Kong, 2005). Although SRE and RTE are intended to measure test-taking effort, they may not reflect on the same underlying mechanism of test-taking motivation. SRE is a global measure of test-taking effort administered right after completing the tests. In our study, there were three subtests in one testing session, and participants might use different time samples to assess their own effort when completing the questionnaire. A deeper investigation showed that some participants switched to rapid guessing behaviour at some point. Several studies also support this argument, showing that test-taking efforts can rise or fall during testing sessions (Barry et al., 2010; Barry & Finney, 2016; Pastor et al., 2019; Penk & Richter, 2017; Wolgast et al., 2020).

Model 2 aimed to explain the different mechanisms of test-taking motivation when assessed using self-report and time-based measures. The result of our study is consistent with previous studies (Knekta & Eklöf, 2015; Penk & Schipolowski, 2015) showed that expectancy was the best predictor of SRE. Moreover, anxiety and time cost do not affect SRE. Interestingly, anxiety is the strongest predictor of RTE, and those two aspects of cost are significant predictors of RTE. It shows that SRE and RTE have entirely different mechanisms of test-taking motivation. RTE is a measure of effort based on rapid guessing behaviour. Participants who have unpleasant test experiences (i.e., feeling anxious) and perceive that taking the test was a waste of time may wish to finish the test as soon as possible. Therefore, they have a higher tendency to respond rapidly.

On the other hand, SRE, which is completed right after the test, can be a consequence of how the testing has been experienced. It is logical that expectancy, which is also measured right after the test, was the best predictor of SRE. If participants perceived the test was easy (i.e., high expectation of success), they would say they put in much effort. In contrast, if participants perceived the test was difficult (i.e., low expectation of success), they would better say they put in little effort, even though, in reality, they might invest high effort. Otherwise, they might look stupid.

Our present study makes an essential contribution to the field by demonstrating that SRE and RTE have different predictive power on test performance. It seems plausible that RTE could explain more variance in test performance since it is nothing more than a count of rapid responses that are more likely to be incorrect than correct (i.e., the higher RTE, the higher the test score). As a result, the strong correlation between RTE and test performance is not surprising. Since RTE has higher predictive power than SRE, it is more helpful for filtering the unmotivated test-takers using RTE. Using the RTE to filter out unmotivated test-takers also allows researchers and practitioners to use two approaches of filtering: examinee-level filtering and response-level filtering (Rios et al., 2017). However, as also noted by other researchers (Nagy et al., 2022; Wise & Kuhfeld, 2021), RTE itself might not fully represent non-effortful responses but rather represents the least motivated and most likely to respond randomly. Fig. 2 shows that the RTE indexes for 5 % of participants were at their maximum, but they reported low effort.

SRE, in contrast, is an overall measure of test-taking motivation. It could reflect, among other things, the objective effort expended. As shown in Fig. 2, 37 % of participants reported high efforts even though they provided substantial rapid-guessing responses. Participants may have overestimated their efforts for reasons (e.g., to fulfil the researcher's expectation). It is also likely that they had invested a lot of effort in one part of the test and either skipped over or went into rapid responses for the rest of the items. Although SRE is subjective, it may provide additional information, particularly when the goal is not to filter out participants with extremely low motivation. SRE allows test-takers to consider their perceived degree of effort; thus, it could help identify partial test-taking engagement. SRE is also helpful in investigating the effect of motivation on test performance, especially when response time data is not unavailable.

Our finding is also consistent with the previous studies indicating effort has a stronger relationship with expectancy than with value (Eccles & Wigfield, 2002; Knekta & Eklöf, 2015; Penk & Schipolowski, 2015; Wigfield & Eccles, 2000). This implies that the ratio of individual ability to item difficulty (ability-difficulty fit) is a relevant aspect of test development from a motivational point of view. However, developing a single test that completely fits all test-takers' ability levels is difficult. Thus, applying computerized adaptive testing (CAT) could be a solution to make a test tailored to the test-takers ability level. Several findings suggest that using easier CAT (i.e., CAT with a higher probability of success) is more favourable in terms of motivational aspects of test-takers compared to regular CAT or fixed-item testing (Häusler & Sommer, 2008; Ling et al., 2017; Revuelta et al., 2003; Tonidandel & Quiñones, 2000).

4.1. Limitations and future research

Several limitations of our study should be noted. Notably, the present study is correlational in nature, precluding causal generalizations about the relationships between test-taking motivation and performance. Expectancy, value and effort are measured simultaneously right after the test. A longitudinal study design with adequate time delays between construct measurements is required to test causal theories, such as expectancy-value theory. However, the path analytic technique used in this study was still valuable for identifying correlations among variables and designing future studies. Similarly, test-taking motivation scales were administered after completing all three subtests, not after completing each subtest. Future researchers are encouraged to administer test-taking motivation scales right after each subtest or even before the test, as participants' test-taking motivation highly depends on the test they just faced (Wolgast et al., 2020).

Second, our study was web-based, allowing participants to join and leave the testing session easily. In our study, there were 427 incomplete data, indicating that not all participants were motivated to finish the test and had no chance to respond test-taking motivation questionnaire right after the test. It suggests that we excluded a group of unmotivated test-takers from our sample. In a similar vein, the study context is specific to unproctored online testing aimed at test development, which is not fully representative of typical low-stakes assessments in educational settings. It is reflected in somewhat lower effort than in other typical studies (e.g., Hofverberg et al., 2022). Therefore, the conclusion should be limited to similar test types and testing conditions. Third, cognitive ability is not taken into account in this study. The non-existence of the actual cognitive ability data prevents us from answering an important question: whether test-taking motivation is not just serving as a proxy for general cognitive ability. Fourth, expectancy in our final model was only measured with two items. Generally, more item is needed to get better reliability. Fifth, we did not measure utility value. In the future, the inclusion of a utility value scale would better represent test-taking motivation. Future research should also address what factors behind the inconsistency between SRE and RTE. The question should be emphasized whether it is caused by response bias (including social desirability) or test characteristics (including test length).

5. Conclusion

Our results indicated that all aspects of test-taking motivation accounted for more than half of test performance variance. In terms of predictive power, our finding indicates that RTE is the best predictor of test performance. Thus, if motivation-filtering procedures are needed, it is better to use RTE, coupled with SRE, whenever possible. We also found a low correlation between SRE and RTE, as well as having different predictors. SRE is best predicted by expectancy, while RTE is best predicted by test anxiety. Although both measures are intended to measure test-taking effort, they do not reflect the same motivation mechanism. Finally, our findings also provide initial support that cost has formed a separate factor from value. Therefore, we suggest incorporating cost as an independent motivational construct in the expectancy-value framework.

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Declaration of competing interest

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Appendix A. Test-taking motivation instrument

EF1. I did my best on this test./ *Saya melakukan yang terbaik pada tes ini.*

EF.2 I worked with all items in the test without giving up, even when an item was difficult./ *Saya mengerjakan seluruh soal tanpa menyerah, bahkan ketika menghadapi soal sulit sekalipun.*

EF3. I felt motivated to do my best on this test./ *Saya merasa termotivasi untuk melakukan yang terbaik pada tes ini.*

EF4. I spent more effort on this test than I do on other tests./ *Saya mengerahkan lebih banyak usaha pada tes ini dibanding tes yang lain yang saya kerjakan.*

EF5. I could have tried harder on this test./ *Saya seharusnya berusaha lebih keras lagi dalam mengerjakan tes ini.*

EX1. I did well on this test./ *Saya mengerjakan dengan baik tes ini.*

EX2. This was a difficult test./ *Ini adalah tes yang sulit.*

EX3. Compared with other test-takers, I think I did well on this test./ *Dibanding orang lain, saya pikir saya mengerjakan dengan baik tes ini.*

IM1. This was an important test to me./ *Tes ini penting bagi saya.*

IM2. It was important to me to get a good result on this test./ *Penting bagi saya untuk mendapat hasil yang baik bagi dalam tes ini.*

IM3. I am very curious about the result I received on this test./ *Saya penasaran dengan hasil tes saya.*

IM4. It is important for my closest people that I get good results on this test./ *Penting bagi orang terdekat saya jika saya mendapat hasil yang baik pada tes ini.*

IN1. I looked forward to doing this test./ *Saya menantikan untuk mengerjakan tes ini.*

IN2. It was fun to do this test./ *Mengerjakan tes ini sungguh menyenangkan.*

IN3. I learned something new by doing this test./ *Saya belajar sesuatu dari mengerjakan tes ini.*

AN1. Before taking this test, I worried about how difficult it would be./ *Sebelum tes, saya khawatir seberapa sulit tes ini nantinya.*

AN2. I was scared of failing on this test./ *Saya takut gagal dalam tes ini.*

AN3. I felt relaxed while taking this test./ *Saya merasa santai saat mengerajakan tes.*

AN4. I was so nervous when I took this test that I forgot things I usualy know./ *Saya sangat gugup saat mengerjakan tes sehingga saya melupakan hal yang bisanya saya ketahui.*

TC1. I have to sacrifice a lot of free time to complete this test./ *Saya harus mengorbankan banyak waktu luang saya untuk mengerjakan tes ini.*

TC2. I have to give up other activities that I like to do well in this test./ *Saya harus berhenti mengerjakan hal yang saya sukai untuk mengerjakan tes ini dengan baik.*

TC3. Taking this test requires too much of my time./ *Mengerjakan tes ini memakan banyak waktu saya.*

TC4. Spending time taking this test makes me feel mentally exhausted./ *Menghabiskan waktu mengikuti tes ini membuat saya lelah secara mental.*

Note: EF = effort, EX = expectancy, IM = importance, IN = interest, AN = anxiety, TC = time cost.

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