Pak. j. life soc. Sci. (2025), 23(1): 3696-3710 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2025-23.1.00292

RESEARCH ARTICLE

Psychometric Properties of Adapted Mindset Instruments: A Comprehensive Comparison

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ARTICLE INFO

Received: Nov 19, 2024

Accepted: Jan 24, 2025

Keywords

Mindset instrument
exploratory factor analysis
PLS-SEM
Rating scale model

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ABSTRACT

Mindset currently gains considerable attentions in educational field. Nevertheless, mindset effect on students' achievement and teachers' performance is still obscure. Inconclusive result potentially comes from variation of mindset instruments. Therefore, there is a need for assessing psychometric properties of mindset instruments. Current research is aimed at comparing psychometric properties of 2 adapted mindset instruments, namely Mindset Assessment Profile (MAP-V16) and Mindset Quizzes (MQ-V20). Prior to be distributed, both mindset instruments were translated into Indonesian language. Respondents of current research are 243 students of Elementary School Teacher Education Department at the University of Mataram, Indonesia. Most of them are female (89.5%) with 20.3 years old in average. Respondents filled both instruments via Google form. Data then analyzed by performing exploratory factor analysis, Partial Least Square Structural Equation Model, and item characteristic analysis. Result reveals that both mindset instruments accurately measure mindset with different coverage; MAP-V16 measures growth mindset and fixed mindset as two distinct constructs and MQ-V20 only measures growth mindset. All items in both instruments met the criteria for item fit and well-functioning response categories, but only 2 items did not meet the criteria of item invariance. Finding of this research indicates that adaptation of mindset instrument lacks inclusive definition of intelligence because they did not elicit cultural-based intelligent behavior. Current research suggests for researchers and school leader to clearly define mindset and research aims before deciding the instrument to be used for measuring it.

INTRODUCTION

Mindset is currently caught considerable attention in educational field. Nevertheless, mindset effect on students' achievement and teachers' performance is still obscure. Some researchers found mindset significantly affect student academic achievement (Limeri et al. 2020; Park et al. 2020), whereas the other reported the opposite result (Brez et al. 2020; Burnette et al. 2020; Ganimian 2019; Li and Bates 2020). In terms of direction of mindset effect, some researchers reported the positive one, whereas other researchers found it negatively affected academic achievement (Bahník and Vranka 2017; Corradi, Nicolaï, and Levrau 2019).

A mixed result also reported in terms of mindset relation to teachers' performance and well-being. Some researchers found that mindset can predict teachers' self-efficacy and performance (Lüftenegger and Muth 2024), life satisfaction (Lee et al. 2023), well-being (Nalipay et al. 2022), and their intent to burn out (Zilka, Nussbaum, and Bogler 2023). Other researchers found no relationship between mindset and teachers' performance and students' achievement (Bardach et al. 2024). Despite the extensive research, inconclusive findings about mindset effect on both, students' achievement and teachers' performance, stimulate heated debate among scholars.

The inconclusive findings of mindset effect on academic achievement come from various factors, such as moderating variables and instruments being used (Bardach et al. 2024). Yeager & Dweck (2020) pointed out psychological, demographic, and socio-cultural aspects as moderating variables. Such variables confirmed by the fact that different community has different ideas about intelligences manifested in unique everyday behavior (Bernardo, Cai, and King 2021; King and Trinidad 2021; Yan, King, and Haw 2021). Haimovitz & Dweck (2016) demonstrated that the way parents treat their children who are failed is shaped by their point of views, and those point of views were presupposed by communal ideas about efforts and intelligences. Other researchers found the same cases in terms of teacher-student relationship as well (Mesler, Corbin, and Martin 2021).

Second factor considered as sources of inconclusive findings of mindset effect pertains to instruments used in the measurement processes. Despite the common framework of development, mindset instruments also embrace high variation in practices. Mindset instrument is rooted in the work of Carol S. Dweck (2006), who develops the 8 items instrument. The items are intended to measure one's beliefs about ability and personality change. The original instrument then adapted by researchers around the world. The adapted instruments differ in terms of number of items, number of constructs measured, and targeted language and culture. Variation in terms of item number can be found in several research. For example, PISA 2018 used only 1 item with 4 options in Likert scale (Bernardo et al. 2021; King and Trinidad 2021; Yan et al. 2021), whereas other researchers used either 2 items with 7 options (Bahník and Vranka 2017), 3 items with 6 options (Park et al. 2020; West et al. 2016) or 4 items with 5 options in Likert scale (Bai, Wang, and Nie 2020).

Variation of mindset instruments also comes from definition of construct being used as framework for item development. Originally, mindset is defined as a single construct (Dweck 2006). Further, as it is being adapted, researchers began to define mindset as two exclusive constructs. For example, Aditomo (2015) used 6 items divided into 3 items measuring growth mindset and the other 3 measuring fixed mindset. Other researchers used 12 items divided into 6 items to measure growth mindset and the other 6 to measure fixed mindset (Lai et al. 2018).

Along with extensive research around the globe, mindset instrument also adapted into various language and culture. Scherer and Campos (2022) found 39 research related to instrument adaptation and validation in 12 countries. Instrument adaptation presupposed terminology translations to accommodate specific research aim and socio-cultural factor. As a result, researchers used key terms in different meaning. For example, Burnette and colleagues (2020) replace the term "intelligence" with "entrepreneur" to measure entrepreneurship mindset among university students. Other researchers adapted mindset instrument to capture broader behavioral manifestations and produce a 20 items questionnaire with 4 to 6 options in Likert scale (Beziat, Bynum, and Klash 2017; Hacisalihoglu et al. 2020; Lim et al. 2020). Diehl (2008) adapted mindset instrument and produce 16 items and further named Mindset Assessment Profile (MAP).

Extensive adaptation of mindset instrument arises concern about its psychometric properties. To address such issues, researchers usually investigate adapted instruments to collect validity and reliability evidences. Ingebrigtsen (2018) conducted analysis of 6 items of mindset instrument translated into Norwegians and reported that the instrument has satisfactory reliability value and good convergent and discriminant validity. Cooper and colleagues (2020) evaluated 14 items with 4 options in Likert scale used to measure mindset of pharmacy workers. They found that 8 items of the instrument measure 2 construct, whereas its reliability is satisfactory (0.827). Midkiff and team (2018) assessed the quality of adapted mindset instrument by performing item response theory and found only 4 of 8 items that are truly measuring mindset construct with satisfactory reliability index (0.89).

Previous studies on psychometric properties of adapted mindset instruments contain some limitations, mostly pertain to partial framework of analysis and lack of items level examination. Partial analysis framework is shown by Scherer & Campos (2022) who reported that researchers partially used either factor analysis or Items Response Theory (IRT) framework. Factor analysis is a means for addressing construct biases (Van de Vijner and Poortinga 2005), whereas IRT is intended

to analyze item biases (Sireci, Patsula, and Hambleton 2005). Furthermore, due to partial framework of analysis, previous studies rarely showed result of analysis at item level. Scherer & Campos (2022) reported most of studies (35 out of 39) perform exploratory factor analysis and confirmatory factor analysis in identifying psychometric properties of the mindset instruments. Such partial analysis can severe from validity threat yielded from translation processes, particularly when a word has no identical translation to targeted language or the same word has different connotation in different culture (Van de Vijner and Poortinga 2005).

Potential construct biases and item biases in adapted mindset instruments, therefore, need for more comprehensive analysis. Construct biases occurred when constituent elements of construct are not exactly the same across cultural groups. Construct biases come from dissimilarities in definitions of the construct across cultures and differential appropriateness of behavior associated with the construct (Van de Vijner and Poortinga 2005). Furthermore, item biases are the biases that comes from poor translation, stimulus familiarity, or unfair functioning of the items to different group of samples (Sireci et al. 2005). Item functioning analysis usually used by researchers as a means for identifying response categories functioning to ensure that options provided in an item functions as it is intended (Masters 2010). Polytomous IRT framework provide a comprehensive procedure for psychometric properties analysis at item level (Andrich 2010).

Ideally, factor analysis can be combined with item functioning analysis to assess psychometric properties of any adapted instrument in more holistic ways (Hughes 2018). By performing construct validity and reliability analysis in tandem with item functioning analysis, researchers can gain substantial advantages. In cross-cultural research, researchers can make equivalent comparison of certain variable among different group of samples (Hambleton 2005). At the same time, factor analysis in combination with item functioning analysis can help researchers assessing the quality of adapted instruments against validity and reliability threats in terms of construct and item biases.

Current research purpose is examining psychometric properties of two adapted mindset instruments. Those instruments are Mindset Assessment Profile and Mindset Quiz. Mindset Assessment Profile consists of 16 items with 5 options in Likert scale (Diehl 2008), and is further labeled MAP-V16. Mindset Quiz is developed by National Council for Community and Education Partnerships with 20 items in 4 Likert Scale options. The instrument is further labeled MQ-V20. In current research, both mindset instruments are compared in terms of measured construct(s) and items functioning.

LITERATURE REVIEW

Mindset can be defined as one's beliefs about intelligence and personality (Dweck 2006). Those beliefs manifested in how people perceive learning and effort in relation to individual development. There are two types of beliefs, namely entity theory believe and incremental theory believe. Person with entity theory accrues that intelligence is fixed, whereas person with incremental theory believes that intelligence is open for development (Dweck 2012). When confronting with challenges, each person will conceive them differently according to his or her believe. Person with entity theories will perceive challenges as something to be avoided and failures as symptoms of inabilities. In contrast, person with incremental theory will see challenges as opportunities for learning and failures as indication of lack of effort. In turn, person with entity theory embraces fixed mindset, whereas person with incremental theory holds growth mindset.

Mindset is shaped by experiences and environment. How people give meaning to what they encounter determines how they perceive who they are and what they will do to make it better (Howe and Dweck 2016). Furthermore, frequent experiences of failure are reported to push individuals to hold beliefs that intelligence is an unchanged matter. For students, failure in academic and social lives was reported as having negative effect on their mindset (Limeri et al. 2020). In short, negative experiences can produce fixed mindset that leads students to see their intelligence as unchangeable things.

At the same time, mindset also shaped by environment factors such as cultural values (Huang, Shi, and Wang 2022) and its behavioral manifestation (Lin-Siegler, Dweck, and Cohen 2016). A culture with strong social support will rise individuals' confidence to confront challenges. Even when they failed, social support can help them create a more positive interpretation. Supportive social environment saliently seen in how parents treat their children. Parents who see failure in their children as a weaken factor tend to conceive intelligences as fixed (Haimovitz and Dweck 2016). Patterns of parents' responses to children failure shape how children perceive the nature of intelligence and ability. The same patterns of mindset transmission from adult to child also found in school context. Students tend to support growth mindset when their teachers performed learning strategies that stressed social-emotional skills development. In contrast, students tend to have fixed mindset when teachers assign them into the tasks that are irrelevant to their abilities (Yu, Kreijkes, and Salmela-Aro 2022). Indeed, positive environment in which students are courage to try their best can drive students to see that intelligence is developed through learning and trying.

Measurement of mindset is a domain of debate among researchers. Researchers use various type of questionnaires to collect information about mindset. Some researchers use only 1 item with 4 options in Likert scale (Bernardo et al. 2021; King and Trinidad 2021; Yan et al. 2021). Whereas the other uses either 2 items with 7 options (Bahník and Vranka 2017), 3 items with 6 options (Park et al. 2020; West et al. 2016), or 4 items with 5 options in Likert scale (Bai et al. 2020). Researchers usually decide which type of questionnaire to use based on their specific research aim and mindset construct definition. Variation of instruments used to measure mindset can produce different conclusion about effect of mindset on students' achievement.

METHOD

Current research was carried out in a survey design which enables researchers to capture pattern of responses needed for assessing psychometric properties of adapted mindset instruments. Respondents of this research are 243 students of Department of Elementary School Teacher Education, University of Mataram, Indonesia. Most of them are female (89.5%) with 20.3 years old in average. Each participants filled 2 type of adapted mindset questionnaires. The first questionnaire is Mindset Assessment Profile consists of 16 items with 5 options in Likert scale. The second instrument is Mindset Quiz consists of 20 items with 4 options in Likert Scale. The reason behind decision to choose the two mindset questionnaires is because they have been widely used in previous research and both instruments covered broad range of behavioral manifestations of mindset (Beziat et al. 2017; Hacisalihoglu et al. 2020; Lim et al. 2020). Both questionnaires are translated into Indonesian language prior to be distributed to respondents.

Data analysis in current research was carried out in three stages. In the first stage, researchers performed Exploratory Factor Analysis (EFA) to identify constructs measured by each instrument. EFA was performed by applying principal axis factoring as extraction method followed by Promax as factor rotation method. Criteria for factor retaining are eigenvalues >1, factor loading ≥0.40 for each item, no item with cross-factor loading, factor constituted by at least 3 items, and supported by theories (Hair et al. 2019). The retained factor(s) then being labeled based on theories and by considering item(s) with highest factor loading. Analysis in this stage is conducted using SPSS for Windows.

In the second stage, researchers assessed measurement model by performing Partial Least Square Structural Equation Model (PLS-SEM). In this stage, the retained factors found in the first stage are treated as latent variables. Procedures of analysis in this stage are as follows. Firstly, researchers create a model of measurement. Measurement model consists of relationships among latent variables and between latent variable and its indicators (represented by the items). If the retained factor in the previous stage is a single factor, researchers will include other unretained factors that consists of at least three items. In PLS-SEM, models of measurement were classified either as reflective or formative measurement. Reflective measurement assumes that latent variable is reflected in or caused by the indicators (Hair et al. 2019). Theoretically, mindset is treated as reflective measurement since indicators are placed as manifestation of latent variable. In the second step,

researchers evaluate measurement model by assessing construct reliability, convergent validity, and discriminant validity. Evidences of satisfactory construct reliability are Cronbach alpha value and composite reliability value between 0.70 and 0.90. Evidence of acceptable convergent validity is average variance extracted (AVE) value ≥0.5 and indicator loadings equal to or greater than 0.708. Indicator loading 0.40-0.70 should be examined further to decide whether or not the items should be eliminated. The items can be eliminated if it increases construct reliability and AVE values to satisfactory level. But if elimination of the item does not give any substantial increase in construct reliability and AVE values, the item is better retained. Moreover, the item with indicator loading lower than 0.40 should be eliminated regardless of the result it brings about. Lastly, discriminant validity is evidenced by Heterotrait-Monotrait (HTMT) correlation ratio ≤0.90 (Hair et al. 2017). The analysis in this stage is conducted using SmartPLS 3.2.9.

In the last stage, analysis is carried out to assess items' characteristics using Rating Scale Model (RSM) (Andrich 2010). In this stage, latent variables found in the previous stage are treated as sub-instrument. Each sub-instrument then analyzed separately. To do this, researchers conduct item fit analysis, categories functioning analysis, and invariant measurement analysis. Item fit analysis used outfit mean squared (MNSQ) values instead of infit mean square (Boone and Noltemeyer 2017). Range of acceptance values for outfit MNSQ for Likert scale items is 0.6-1.4 (Bond, Yan, and Heene 2021). Furthermore, analysis of response categories is based on criteria as follows; each category should have at least 10 responses, shows monotonic increase average measure (Bond et al. 2021), and has monotonic increase of threshold between 1.4 and 5 logit (Boone and Noltemeyer 2017; Boone and Staver 2020). In invariant measurement analysis, the item is considered as free of biases if it has Mantel-Haenszel differential item functioning (DIF) probability value ≥0.05 (Bond et al. 2021; Sovey, Osman, and Matore 2022). Analysis in this stage is conducted using Winsteps 3.73.

RESULT

Exploratory Factor Analysis (EFA)

Before proceeding into EFA, there are two assumptions should be met, namely Bartlett test and Kaiser-Meyer-Olkin (KMO) test. Bartlett test is intended to ensure that assumption of inter-variables relations among items in the instrument is met. If p value for Bartlett test is <0.05, then it can be concluded that the assumption has been met. Whereas, KMO test is intended to test for sample adequacy. If KMO p value is >0.05, then it can be concluded that the assumption is met. Our data shows that p value for Bartlett test on both instruments is <0.05, whereas p value for KMO test is >0.05 (0.832 for MAP-V16 and 0.827 for MQ-V20) (see appendix 1A for more details). Therefore, it can be concluded that the items in both questionnaires have multivariate relations and the samples are adequate for factorizing.

Since the assumptions have been met, EFA can be conducted to identify the factor(s) underlain each instrument. Firstly, analysis is conducted to find the factor(s) with eigenvalues >1. The data shows that response to MAP-V16 can explain 64.09% of cumulative variance, whereas the response to MQ-V20 can explain 52.36% of cumulative variance. Both instruments have 4 factors have with eigenvalues >1 (see appendix 1B for more details).

Further, analysis is targeted at separating items based on factor loadings. Item will be retained if it has factor loading >0.4 and has no cross-loading. Our analysis reveals that in MAP-V16, there are 8 items in factor 1 (MAP3, MAP5, MAP7, MAP8, MAP11, MAP13, MAP15, and MAP16), 5 items in factor 2 (MAP6, MAP9, MAP10, MAP12, and MAP14), 2 items in factor 3 (MAP1 and MAP 2), and 1 item in factor 4 (0.429). A deeper analysis into items in each factor reveals that 8 items composing factor 1 represent growth mindset construct and 5 items composing factor 2 are closely related the fixed mindset construct. Whereas the other two factors can be eliminated because of insufficient number of items and lack of theoretical support. Hence, MAP-V16 is considered as an instrument underlain by 2 constructs, those are growth mindset and fixed mindset.

In MQ-V20 we found 5 items constitute factor 1 (MQ2, MQ3, MQ5, MQ6, and MQ10), 6 items in factor 2 (MQ9, MQ13, MQ14, MQ18, MQ19, and MQ20), 3 items in factor 3 (MQ1, MQ4, and MQ16), and 3

items in factor 4 (MQ7, MQ8, and MQ11). Analysis of items' content shows that the 5 items in factor 1 is representation of growth mindset construct. Group of items in factor 2 are more scattered and reflecting response to feedback, work completion, and basic nature of human being. Those items have little theoretical support. If the items should be labeled, then they are more appropriate to be named as performance improvement believe. Factor 3 which is composed by MQ1, MQ4, and MQ16 more appropriate to be labeled as self-representation. Lastly, factor 4 which is consists of MQ7, MQ8, and MQ11, is more appropriate to be labeled as believe of probability of success in learning new things. Indeed, our data reveals that only factor 1 can be retained as underlying construct in MQ-V20, namely growth mindset construct (see appendix 1C for more details).

Concisely, first stage analysis reveals that both instruments measure mindset variable with different coverage. MAP-V16 measures mindset as two distinct constructs, namely growth mindset and fixed mindset. Each construct has its own continuum and should not be treated as single variable with growth mindset as positive side and fixed mindset as the opposite. Growth mindset construct consists of 8 items, whereas fixed mindset consists of 5 items. In addition, analysis of factors underlain MQ-V20 shows that the instrument measures mindset only in terms of growth mindset construct. In the further analysis, the factors retained in MAP-V16 will be named MAP-V16 growth mindset and MAP-V16 fixed mindset. Whereas the retained factor in MQ-V20 will be named MQ-V20 growth mindset.

Evaluation of Measurement Model

Analysis of measurement model in PLS-SEM should be preceded by creation of measurement model. The model represents proposed theoretical structure that should be assessed against empirical data. If the model conforms to the data, then it can be concluded that the measurement model is valid. The retained factors found in the EFA are treated as latent variables. Thereby, there are three latent variables, namely MAP-V16 growth mindset, MAP-V16 fixed mindset, and MQ-V20 growth mindset. The first model of measurement is proposed for MAP-V16 and depicted in diagram 1 below. As can be seen, latent variable MAP-V16 growth mindset is manifested by 8 items (MAP3, MAP5, MAP6, MAP8, MAP11, MAP13, MAP15, and MAP16 respectively) and latent variable MAP-V16 fixed mindset is manifested by 5 items (MAP6, MAP9, MAP10, MAP12, and MAP14 respectively). Model of measurement can be tested if each latent variable is correlated to another variable. Therefore, measurement model for MAP-V16 assumes that MAP-V16 growth mindset correlates to MAP-V16 fixed mindset.

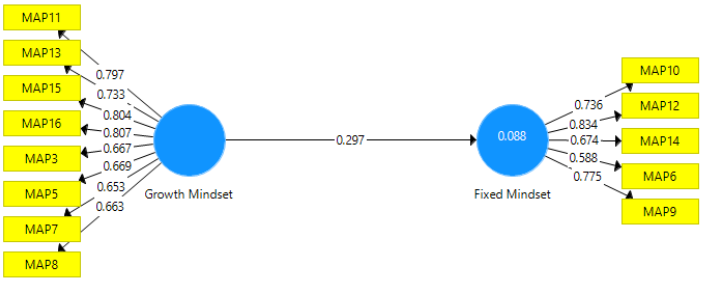

Diagram 1. Model of measurement for MAP-V16

Analysis of construct reliability for MAP-V16 measurement model shows satisfactory values of Cronbach alpha (0.776 for fixed mindset and 0.877 for growth mindset) and composite reliability (0.846 and 0.899 for fixed mindset and growth mindset respectively). AVE values for both latent variables are above 0.5 (0.528 and 0.529 for fixed mindset and growth mindset respectively) which indicates that both latent variables meet convergent validity criteria. Value of 0.528 for fixed mindset and 0.529 for growth mindset means that the construct explains 52.8% and 52.9% of variance of items in each construct.

Analysis of indicator loadings shows that none of the items has value <0.4. Although there are some items which indicator loading fall between 0.40 and 0.70, the items are retained because construct reliability and convergent validity criteria have been met satisfactorily. Thereby, all items in both latent variables are retained. Along with construct reliability and convergent validity assessment,

current research also assesses discriminant validity analysis to ascertain that both latent variables in MAP-V16 measure distinct and unique construct. Analysis of discriminant validity shows HTMT correlation ratio 0.302, far below 0.90 as acceptable threshold. As a result, it can be concluded that both latent variables are unique and measuring distinct construct, namely fixed mindset and growth mindset.

The same procedures are also applied in evaluation of measurement model for MQ-V20. Since EFA only produces one retained factor and PLS-SEM needs more than one variable to be correlated, researchers decide to add another factor. The unretained factors from previously analysis are performance improvement factors, self-representation, and probability of learning new things. The retained factor and unretained factors then being correlated to develop model of measurement. The model depicted in diagram 2 below shows that MQ-V20 growth mindset latent variable correlate with the three other factors. In the model, MQ-V20 growth mindset latent variable is manifested by 5 items (MQ2, MQ3, MQ5, MQ6, and MQ10).

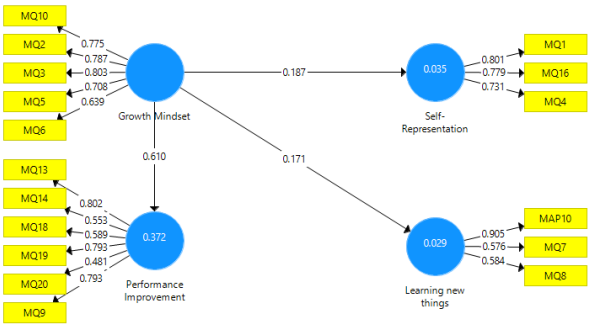

Diagram 2. Model of Measurement for MQ-V20

Analysis of construct reliability produce satisfactory values for MQ-V20 growth mindset latent variable (Cronbach alpha 0.800 and composite reliability 0.861). Convergent validity analysis also shows acceptable value of AVE (0.555>0.5). Outer loading of each item representing MQ-V20 growth mindset ranges from 0.639 to 803. Because construct reliability and convergent validity criteria has been established, all items can be retained. Analysis of discriminant validity using HTMT correlation ratio shows that none of HTMT values exceed threshold 0.90, which means that MQ-V20 growth mindset latent variable measures the construct cannot be measured by other instruments.

Overall result of measurement model analysis reveals several important points. Firstly, measurement model for both mindset instrument (MAP-V16 and MQ-V20) meet construct reliability criteria. Second, two latent variables in MAP-V16 measurement models and one latent variable in MQ-V20 are proven to meet construct validity criteria, those are convergent validity and discriminant validity. Third, despite indicator loading around 0.40-0.70, all items can be retained because construct reliability and convergent validity has been established with satisfactory values. All analysis in this stage is mainly conducted at instrument level. Further analysis will address psychometric properties at item level.

Analysis of Item Characteristics

Analysis of item characteristics in Rasch Model presupposed by unidimensionality of measurement and item local independency assumptions. Assumption of unidimensional measurement is represented by eigenvalues of unexplained variances in the first contrast. Eigenvalues >2.0 indicates violation to unidimensional measurement assumptions. Item local independencies, on the other side, is shown by standardized residual correlations between all pairs of items. Correlation value <0.30 is a sign of item local independencies. As unidimensionality criteria should be met prior to main analysis, the three sub-instruments found in previous stage are analyzed separately. Dimensionality analysis shows that eigenvalues of raw unexplained variance in the first contrast are 1.9, 1.7, and 1.6 for MAP-V16 growth mindset, MAP-V16 fixed mindset, and MQ-V20 growth mindset respectively. Standardized residual correlation analysis also shows that all correlation values are <0.30 (see

appendix 3.A and 3.B for more details). Thereby, unidimensionality of measurement and item local independency assumptions have been met.

Since the sub-instruments meet Rasch model assumptions, analysis is proceeded to item fit assessment. An item is considered fit to the model if it has outfit MNSQ between 0.6 and 1.4. All items in both MAP-V16 sub-instrument (eight items in MAP-V16 growth mindset and five items in MAP-V16 fixed mindset) have outfit MNSQ from 0.71 to 1.20. In MQ-V20 growth mindset instrument, only one item has outfit MNSQ 1.45, slightly exceeds 1.4, that is MQ6. The item should be investigated further to uncover potential sources of misfit. Whereas the other 4 have outfit MNSQ from 0.75 to 1.01 (see appendix 3.C for more details).

Subsequent analysis is assessment of response category functioning. A well-functioning response category should meet at least 3 criteria, those are chosen by at least 10 respondents, showing monotonic average means increase, and showing increase of threshold from adjacent categories between 1.4 and 5 logit.

Table 1. Category Functioning of Items of Growth Mindset MAP-V16

Category		Observed		Obsvd Average	Sample Expect	Infit MNSQ	Outfit MNSQ	Andrich Threshold	Category Measure
Label	Score	Count	%						
1	1	34	2	-1.12	-2.39	2.65	2.72	none	-3.98
2	2	131	7	-0.75	-0.51	0.93	0.95	-2.74	-2.04
3	3	541	28	0.68	0.76	0.92	0.92	-1.26	-0.09
4	4	719	37	1.87	1.87	0.83	0.82	1.03	2.03
5	5	518	27	3.2	3.13	0.95	0.96	2.97	4.16
Missing		1	0	1.28					
Observed Average is mean of measures in category. It is not a parameter estimate.									

MAP-V16 growth mindset presents 5 response categories. Table 1 above shows that each category was chosen by more than 10 respondents. Average means of each category shows monotonic increase, from -1.12 to -0.75, and last in 3.2. At the same time, threshold for each category also following monotonic increase not less than 1.4 and more than 5 logit, such as shown in column 9. Therefore, it can be concluded that categories in MAP-V16 perform like they are intended.

Table 2. Category Functioning of Items of Fixed Mindset MAP-V16

Category		Observed		Obsvd Average	Sample Expect	Infit MNSQ	Outfit MNSQ	Andrich Threshold	Category Measure
Label	Score	Count	%						
1	1	58	5	-0.93	-1.39	1.66	1.72	none	-3.4
2	2	169	14	-0.74	-0.54	0.83	0.85	-2.13	-1.59
3	3	366	30	0.31	0.35	0.75	0.73	-0.86	-0.06
4	4	394	32	1.27	1.18	0.78	0.81	0.7	1.58
5	5	228	19	1.99	2.04	1.17	1.15	2.29	3.52
Missing									
Observed Average is mean of measures in category. It is not a parameter estimate.									

Table 2 shows each category functioning presented in MAP-V16 fixed mindset. The lowest category was chosen by 58 respondents. Average means of each category also increase in monotonic ways from its adjacent categories. The threshold also shows the same patterns as average means. It means that all categories perform well in measuring fixed mindset among respondents. Thus, all categories in both sub-instruments of MAP-V16 meet all criteria for being judged as well-functioning response categories.

Table 3. Category Functioning of Items of Growth Mindset MQ-V20

Category		Observed		Obsvd Average	Sample Expect	Infit MNSQ	Outfit MNSQ	Andrich Threshold	Category Measure
Label	Score	Count	%						
1	1	33	3	-1.05	-1.52	1.29	1.28	none	-4.24
2	2	237	20	-0.05	-0.02	1.07	1.09	-3.1	-1.59
3	3	580	48	1.64	1.67	0.88	0.88	-0.07	1.56
4	4	365	30	3.17	3.11	0.95	0.95	3.17	4.3
Missing									
Observed Average is mean of measures in category. It is not a parameter estimate.									

Category functioning for MQ-V20 growth mindset is shown in table 3. Based on the table, we can see that all categories meet the criteria for well-functioning categories (chosen by at least 10 respondents, having monotonic increase of average means, and monotonic increase of threshold). In addition, the last column of tables (Category Measure) shows values of mindset indicators. For example, category 4 in MQ-V20 growth mindset has category measures 4.3, which is mean that to choose the category, respondent should have 4.3 logit of the corresponding indicator.

Last analysis is assessing item invariance measurement. Measurement invariance indicates free of biases estimates. Measurement invariance is achieved when measurement remain constant across group of samples. In Rasch model analysis, item invariance is represented by Mantel-Haenszel DIF probability values. Current research analyses potential gender-related DIF. An item is not affected by gender differences if it has Mantel-Haenszel DIF probability value >0.05. Data of current research shows that the 8 items in MAP-V16 growth mindset sub-instrument have Mantel-Haenszel DIF probability values >0.05 (range from 0.0673 to 0.8633). The same fact also shown by data of the 5 items in MAP-V16 fixed mindset sub-instrument (Mantel-Haenszel DIF probability values range from 0.1389 to 0.8356). In contrast to the items in two sub-instruments in MAP-V16, 2 of 5 items in MQ-V20 growth mindset instrument have Mantel-Haenszel DIF probability <0.05, those are MQ2 and MQ5 with DIF probability values 0.0322 and 0.0264 respectively. Both items are flagged as gender-related DIF. It means that both items perform differently for different group of respondents. Item MQ2 is found to be easier to be endorsed by female, whereas item MQ5 is easier to be endorsed by male. Both items suggest for further investigation to uncover specific source of differential functioning (see appendix 3.E for more details).

DISCUSSION

Current research assesses psychometric properties of two mindset instruments, namely mindset assessment profile (MAP-V16) and mindset quizzes (MQ-V20). Analysis of psychometric properties of both mindset instruments reveals 3 important insights. Firstly, MAP-V16 is found to measure mindset as two distinct constructs (growth mindset and fixed mindset), whereas MQ-V20 only measures mindset in terms of growth mindset only. Second, and as strong evidence to the first result, the two constructs in MAP-V16 and single construct in MQ-V20 are supported by empirical data shows that they measure unique and different latent variable. Third, in terms of item quality, most of items in MAP-V16 and MQ-V20 appropriately measure the target as each of item presents relevant response categories.

In terms of dimensionality, current research shows that MAP-V16 measures two distinct latent variables, those are growth mindset on one hand and fixed mindset on the other hand. The result confirms previous research findings (Grüning, Rammstedt, and Lechner 2023; Ingebrigtsen and Svartdal 2018; Scherer and Campos 2022). Other researchers demonstrate that when the instrument is assessed in single and double factors, the double factors assumption met better good of fit (Midkiff et al. 2018). Thereby, mindset should be conceived as having two different continuums, the first one is continuum of growth mindset which is previously seen as positive side of mindset, and the second one is continuum of fixed mindset which is previously understood as negative side of mindset.

In addition, current research adds another perspective on the debate on measurement of mindset construct. Analysis of dimensionality on MQ-V20 shows that the instrument measures growth mindset as a single construct. Debate on mindset measurement shows that mindset was conceived as either single or double construct. The first group can be identified as proponents of mindset as a single dimension variable (Dweck 2012), and the other comes as proponents of double-dimension mindset by arguing that mindset consists of two distinct latent variables, namely growth mindset and fixed mindset. Current research provides a third stance by evidencing that MQ-V20 only measures growth mindset latent variable. Growth mindset, as reflected by most of valid items in MQ-V20, is manifested by the believe that anybody can make substantial changes in their capacities. It means that lower score reflects purely lower the believe.

Evidence of mindset dimensionality comes from factor analysis framework. The most frequently used framework for identifying instrument's dimensionality is exploratory factor analysis (EFA) (Fabrigar and Wegener 2012), followed by confirmatory factor analysis (CFA) as a means for testing latent construct found in exploratory factor analysis (Hair et al. 2019). Exploratory factor analysis (EFA) is a statistical procedure for latent construct identification through analysis of communalities among group of items in an instrument. Technically, communalities equal to common variance divided by observed variance. Common variance is assumed as source of influence on certain factor. The factor, then, is assumed as measured variable. In other words, measured variable consists of items having high common variance. In EFA, measured variable is treated as underlain construct measured by given instrument (Fabrigar and Wegener 2012). Subsequently, model of measurement created from constructs or latent variables found in EFA should be tested to confirm that theoretical-based definition supported by empirical observations. CFA is recommended as a means for such model examination (Hair et al. 2019).

Theoretically, factor analysis through EFA and CFA is a technique in analyzing response process. Response process reflects activities by which subject or respondent arrives at the answer or response to given stimulus presented in the measurement. If subject or respondent uses or implements content of construct being measured in responding to stimulus, then the measurement is deemed as having accuracy (Hughes 2018). Measurement accuracy reflects the degree to which an instrument catches the target it is intended. Thus, accuracy of measurement analysis is a method for ensuring construct validity.

Debate on the number of latent variables measured by mindset instruments and association between growth and fixed mindset underpinned by theoretical and psychometrical frameworks. Theoretically, mindset concept emerges from the work of Dweck & Legget (1988), who found that people are motivated to work by either learning orientation or performance orientation. People with learning orientation tend to see ability as malleable through learning and hard work. Thus, they hold growth mindset believe. On the other side, people with performance orientation tend to see work as opportunities to prove their abilities. Thus, they hold fixed mindset (Schraw and Olafson 2015). Implicit assumption behind this research is each person can be classified as either hold growth or fixed mindset. Such assumption tends to ignore the fact that people can have different goal orientation according to context and specific ability needed to complete particular task. As a result, treating mindset as a single construct in the measurement practice potentially reduce the actual believe held by most of people.

Debate on mindset concept also contains doubt about inclusiveness of intelligence definition presuppose mindset instrument development. Grüning, Rammstedt, & Lechner (2023) warned researchers that measurement of mindset that treats mindset as a single construct potentially contains theoretical fallacy pertains to the fact that intelligence is a cultural-bound terminology. People in certain culture hold different point of view about intelligence (Sternberg and Grigorenko 2004). At the same time, the term intelligence also defined differently according to theoretical framework. In its broadest definition, intelligence pertains to all good things. When it is specified, the term becomes restricted to what IQ test being measured (Stanovich and Stanovich 2010). For some, intelligence describes person's ability to learn from experiences and make efficient adaptation to

environment. Whereas for others, intelligence is specified according to particular domain such as mathematics, language, emotional, and so on (Sternberg 2010).

Another side of debate on dimensionality of mindset instrument pertains to psychometric properties of the instruments. Psychometric properties pertain to three aspects of measurement, those are precision, accuracy, and appropriateness. Accuracy refers to the extent to which measurement measures the target. Accuracy is the most important psychometric properties to be established because it is a basis for another psychometric properties such as appropriateness (Hughes 2018). Accuracy is reflected by validity criteria. Furthermore, precision is the extent to which measures produce consistent information when measurement conducted with replication across time and place. Consistent information comes from high proportion of true score to observed score. Precision frequently established by checking reliability criteria (Revelle and Condon 2018).

As mindset widely studied around the globe, it is being adapted to various culture and language. Cross-cultural adaptation of instrument potentially produces construct biases. Construct biases is the most serious bias because it potentially directs researchers to measure the construct other than intended to be measured (Van de Vijner and Poortinga 2005). Hambleton and Swaminathan (1985) pointed out that adapted instrument used to measure single construct in one culture can be multidimensional in other culture. The biases can come from the instrument itself, methods in information gathering, or the translation processes (Hambleton 2005). Moreover, infusing dictions and idioms into items in the instrument as it is translated potentially stimulates different interpretation from people in the targeted language (Rust, Kosinski, and Stillwell 2021). As a result, mindset instrument which was previously targeted at single construct in any given culture could measure more than one construct in other culture.

Lastly, it is important to recognize the fact that a closer look at a latent variable will always produce latent variable's subordinate (Bond et al. 2021). Analysis of dimensionality will always direct researchers to slice variable into smaller part and identify relation between and among those parts. It is researchers' prerogative to justify which parts will be included in the level of data aggregation from non-unidimensional measurement. Since current research shows that there is more than one dimension in mindset measurement, each dimension can be treated as sub-instrument. As independent sub-instrument, MAP-V16 growth mindset, MAP-V16 fixed mindset, and MQ-V20 growth mindset are evidenced to meet item characteristics standards in terms of model fit, response category functioning, and invariant measurement. Nevertheless, measurement of mindset using MQ-V20 should be based on cautious considerations due to some items with indication of differential item functioning. Such indication reminds us that there are potential gender-related biases because gender background affect interpretation to item statement or response options.

Implication of current research pertains to how school leaders perceive mindset. As it is found to be a predictor of teachers' mental health, life satisfaction and burn out intention (Huang et al. 2022; Nalipay et al. 2022; Zilka et al. 2023), school leader need to consider for promoting teachers' mindset. Nevertheless, school leaders need to clarify how they define mindset before deciding which instrument to be used as measurement tool. It is also important to discuss mindset definitions with teachers as they are reported to be familiar with the term mindset (Boylan, Barblett, and Knaus 2018). As school leaders understand how teachers perceive mindset, they can subsequently provide the right intervention for promoting growth mindset among teachers.

Current research contains a limitation in terms of the respondents. As it was conducted with prospective teachers, it is important to consider to validate the instrument by involving teachers who actually working in schools. Future research can also address of lack of strong and inclusive definitions of intelligence in terms of mindset instruments development. Therefore, current research suggests for specific definition of intelligence based on particular theories and accommodation of culture-specific behavioral manifestations of intelligence when researchers develop or adapt mindset instrument. Practically, researchers should clearly declare their specific research goal before deciding to use or adapt mindset instrument.

CONCLUSION

Current research reveals that the two adapted mindset instruments, mindset assessment profile (MAP-V16) and mindset quizzes (MQ-V20), measure different coverage of mindset. Whereas MAP-V16 measures mindset in two distinct dimensions, namely growth mindset and fixed mindset, MQ-V20 only measures growth mindset. Of 16 items in MAP-V16, only 13 items can be retained a tool for measuring mindset, those are 8 items for measuring growth mindset and 5 items for measuring fixed mindset. In MQ-V20, only 5 out of 20 items can be retained for measuring growth mindset. Nevertheless, researchers and school leaders should be cautious in using the 5 items due to indication of gender-related differential functioning.

Current research proposes recommendations for future research. Firstly, when mindset instrument will be adapted to other culture or language, it is important to formulate strong and inclusive definition of intelligence by accommodating culture-specific behavioral manifestation and specific theoretical explanations. Those culture-specific and theoretical-underpinned behaviors should appropriately and sufficiently represent uniqueness of targeted culture and language. Second, and in relations to the first recommendation, research on adapted mindset instrument that accommodate culture-specific behavioral manifestation should be conducted in order to produce accurate, precise, and appropriate estimates to subject mindset. Third, before deciding which mindset instrument will be used, researchers should clearly define their research goals.

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