Current Psychology
https://doi.org/10.1007/s12144-021-01532-x

Development of the growth mindset scale: evidence of structural validity, measurement model, direct and indirect effects in Chinese samples

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Accepted: 23 February 2021
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Abstract
To improve the efficiency of learning and promote achievements, the current paper explores the correlation of the growth mindset to students and teachers. This study aims to develop the growth mindset scale with the evidence of structural validity, measurement of direct and indirect effects in Chinese samples. To achieve the research objective, this study investigates 654 participants, including 321 students at different learning stages and 266 teachers from primary and secondary schools. In the investigation, using SPSS 25.0 and Amos 24.0 software, we conduct exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), structural equation model (SEM), mediation analysis, and one-way ANOVA method with Welch's test to achieve the study aim. The analysis of effect presents that challenge, adversity, attitude, motivation, grit and a positive mindset are all important to the growth mindset. In conclusion, the results show that: (1) the growth mindset scale was successfully constructed, developed and validated by the SEM; (2) measurement model, direct and indirect effects were confirmed; (3) growth mindset is positively correlated with age (and learning stage). It also indicates the importance of cultivating the growth mindset for students and teachers. The other possibilities, limitations and implications are also discussed.

Keywords Growth mindset · Chinese samples · Scale development · Structural equation model · Psychological measurement

Traceback to the meaning of growth, John Dewey put forward an idea on individual growth through natural experiencing life in the 20th centuries and it still vibrant today, reconciling this notion to stimulate the growth of individuals, mindset and living environment in a new era (Blum, 2017). This theory seems to begin flourish again. Since the intelligence quotient (IQ) test was invented in the twentieth century, it has been highly believed that IQ dominates whether a person is suitable or smart enough to be taught and to allow an individual to develop. The consequence of IQ test tries to be label students and rank them by grades, as well as make comparisons. Until the recent study on neurology and psychology was published (Betsy, 2018; Bransford, Brown and Cocking, 2000), and they had already manifested that the intrinsic quality of learning behavior in human brain is obtained experience and these experiences are quite malleable. The attribute of growth mindset and perseverance aims to expand this kind of experience through challenge and adversity, which is imperative and crucial to lead a successful life (Duckworth, Peterson, Matthews, and Kelly, 2007; Duckworth, 2016).

There are a lot of studies have focused on the positive effect, the disadvantages and the significance of the growth mindset (see, e.g., Aronson, 2002; Blackwell, Trzesniewski, & Dweck, 2007; Dweck & Leggett, 1988; Kamins & Dweck, 1999; Mueller & Dweck, 1998; Deal & Peterson, 1999; Deal & Peterson, 1994; Guidera, 2014; Bellini, 2017; Bethge, 2018; Blum, 2017; Brougham, 2016; Northrop, 2014). The stereotype has exerted a negative effect on student's intellectual ability of different races, black students who performed badly in school will attribute these results to the wrong causes, like the definition of the race and IQ (Marx, Ko, & Friedman, 2009). Positive

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Published online: 10 March 2021

and collaborative school cultures may have a positive impact on a school, that improved the school effectiveness, encouraged the motivation of professionals and students (Abboud, 2017; Deal & Peterson, 1999). Current studies also seek out the positive relationship between growth mindset and academic achievement, motivation and so on (see, e.g., Nasto, 2017; Garcia, 2016; Blackwell et al., 2007; Rosenthal and Jacobson, 1992; Good, Aronson, & Inzlicht, 2003; Johns, Schmader, & Martens, 2005; Franklin, 2016; Duco, 2016; Auten, 2013; Charette, 2016; Delasandro, 2016; Doebel, 2015). Under assistance of existing research, a thoughtful examination with growth mindset is a must and necessary. Few studies challenged the effect of the growth mindset (see, e.g., Menanix, 2015; Garofalo, 2016; Zakrajsek, 2017; Thlele, 2016).

Heretofore, qualitative method and quantitative method have been used to identify the influences of the growth mindset, clarify the relationships between the growth mindset and the others. But few studies in psychological investigation used the structural equation model (SEM) to examine the effect of the growth mindset in Chinese educational context (see, e.g., Zhao, Niu, Hou, Zeng, Xu, Peng, & Yu, 2018; Wang, Luo, Nie, & Wang, 2019; Zeng, Chen, Cheung, & Peng, 2019). Zhao et al. (2018) have demonstrated the positive impact of the growth mindset on motivation and grit in Chinese students from third to ninth grade. A growth mindset could be useful to alleviate the adverse effect of substance use among teenagers through SEM (Wang et al., 2019). Teacher's growth mindset could strengthen the work engagement when well-being and perseverance serve as a mediator in the secondary school (Zeng et al., 2019). But neither of them challenged or examined the structure of the growth mindset theory and its application to education. According to the theory of the growth mindset (Dweck, 2006; Dweck, 2017; Dweck, 2005; Dweck, 2006; Dweck, 2015), which is not an ordinary theory to demand you to put endeavor physically, but a theory that based on change personal disposition, attitude and character to make yourself better survived in an ever-changing and competitive environment.

As an research in the feild of educational psychology, this is not only about improving performance and achievement, it is looking deeply into individual psychology, to change their negative attitudes and prejudice, to help them how to improve and assess their growth mindset to finally promote the success. Therefore, this study intends to develop the measurement tool of the growth mindset, and to examine the structural validity and reliability, to construct a structural equation model, to inspect the interrelationship, direct and indirect effects in Chinese samples.

Literature Review and Conceptual Framework

In the area of learning theory, psychology and pedagogy have done so much about growth mindset. Not only related to a student's growth, but also refers to one person's whole life (Dweck, 2017). In the early twentieth century, the IQ test scale was popular to examine student's intellectual levels at the age of 3–16. A lot of organizations and educators applying IQ test to evaluate whether a person is gifted or not in the world, it produces an effect on the stereotype and labeling about one's intelligence and the ability to learn, it is the opposite of growth mindset. Neurology research has been explored the growth mindset and intelligence, providing evidence to support this theory and against the fixed mindset (Bransford, Brown and Cocking, 2000; Guidera, 2014; Betsy, 2018). Then, a series of empirical studies manifested that its support of the effectiveness of teaching and learning.

Mindset and IQ

It should be mentioned that the IQ measurement scale if you want to get to know what a fixed mindset is. The IQ test was invented by Alfred Binet and his colleagues in 1905. Alfred Binet, a famous experimental psychologist in France, has invented an IQ measurement tool to test one's intelligence and strongly believed that an individual's IQ cannot be improved throughout all the lifetime (Binet, 1909; Binet & Simon, 1973). This assertion has been dominated in our school for so long a time, not only in America, but also in China, emerging an upsurge of blind worship of high IQ across the world. This will always lead to a fixed mindset that you anchor your idea and mindset even towards different person or situation, stay stagnant and inactive. It is also brought about some problems in education system and it was seriously eroding educational equity. For instance, stereotype (Steele, 1997) and *Pygmalion effect* (Rosenthal & Jacobson, 1992) have been limited student's potential ability and confined oneself in one particular area even for a whole life, it also makes teachers and parents be convinced by an idea of genetic inheritance and IQ are something what cannot be changed or improved. Stereotype caused an negative effect on achievement, women and low-income families have suffered from stereotype with less ability and intelligence (Spencer, Steele & Quinn, 1999; Gonzales, Blanton and Williams, 2002; Croizet & Claire, 1998). IQ test promotes fixed mindset and stereotype, especially underprivileged class. It has been cleared that fixed mindset is deleterious to growth which requires correction of deficiencies. Thus, studies found cultivating teachers' growth mindset are also very important (Short, 2017; St. Amant, 2017; Stenzel, 2015; Waid, 2018).

Growth Mindset Theory

On the other hand, some researchers, psychologists and educators hold different ideas towards intelligence. They believed that non-cognitive competence may have positive effects on engineering students' achievement than higher IQ, for instance, growth mindset and emotional factors (Reid & Ferguson, 2014). Intelligence is flexible to be changed based on one's

motivation and effort, it is possible to improve it through hard-working and sustainable pay (Levy, Stroessner & Dweck, 1998). A growth mindset is a sort of concept that oneself believes acquire characteristic via hardworking, embracing challenges, learning from the adversity or failure, grit and perseverance, holding a positive attitude and adopting skillful approaches, while fixed mindset is equal to demonstrate your best performance and stereotyping (Dweck, 2017). Through various studies on intrinsic motivation, learning goals with a focus on the process strengthen intrinsic motivation, while performance goals with praise lessen it (Heyman & Dweck, 1992). Thus, it is necessary for educators to get to know the concept of growth mindset, because knowing the difference of growth mindset and fixed mindset can improve the intelligence of a student, expand the life experience and reflection.

As an emerging field, brain research and neurology have already demonstrated human mind is resilient, it is similar to an infinite container that you can contain experience infinitely (Guidera, 2014). Neuroscience research has found that learning behavior (e.g., processing information or acquiring experience) shapes the form and construct of the brain, it also stimulates the growth of brain, and vice versa (Bransford, Brown & Cocking, 2000). As the foundation theory of learning, the study of neuron system suggested that the synapses of neuron transmit the information and driven by experience, the production of it will involve the whole lifespan of an individual (Bransford et al., 2000). Neuroscientific research proved that a growth mindset is helpful to enhance internal motivation (Betsy, 2018). Brain researches have been laid a solid foundation for the theory of the growth mindset, it provides more strong evidence for people to believe that human brain is malleable and can be filled with different experience through learning and activities. It is also a beneficial to educators to understand the essence of education and student's learning behavior.

Above all, within the growth mindset theory of Dweck (2017) and among other research of growth mindset, it shows the strong relationship among the growth mindset, motivation, grit, fixed mindset and the attitude towards learning, challenge, adversity and obstacle.

Academic Achievement Impact

A student's mindset determines his or her behavior strategy and productivity, adopting the right method makes student growth rapidly, choose the wrong measures hinders students to moved forward. When students hold a fixed mindset, they are reluctant to put effort into literacy tasks because they do not believe hardworking could make any difference, which was totally different with a growth mindset (Saia, 2016). Fixed mindset tempt student to disagree with the learning objectives, while the growth mindset helps them better forecast their engineering learning outcomes (Garcia, 2016). Labeling students are detrimental to boost student's performance in math, treat every student as the same will motivated students most (Blackwell et al., 2007). Stereotyping have been one part of teacher's fixed mindset, it will transform the mindset of students, and consequently impact the student performance and attitude towards learning (Hadley, 2017; Jones, 2016; Kassaee, 2016; Mowbray, 2014; Nestor, 2017).

A growth mindset brings more contributions to student's progress and development. One experiment presents that intelligent students may hold lower IQ score actually, but they can improve their academic achievement through growth mindset intervention (Rosenthal & Jacobson, 1992). An experiment has done in the classroom with students who were taught to make great efforts to defeat stereotype and it did improve their intelligence (Good et al., 2003; Johns et al., 2005). A two-month project assist ninth grade students to overcome difficulties and developing potentialities via cognitive behavioral therapy to fostering a growth mindset (Bellini, 2017). Grading models using growth mindset, such as frequent feedback offering multiple methods, has a significant impact on student performance (Franklin, 2016). The study also found that a first-year student and man holding more growth mindset and positive attitude than other grades and woman (Duco, 2016). Students hold the idea that a growth mindset could increase their resilience and intelligence (Stern, 2015), there also exist gender difference (Symonette, 2018). Students better relationship with teachers and others, self-efficacy could spur their enthusiasm and progress as there are very few students have high self-efficacy, vice versa, if most students study in a competitive atmosphere, they will not concern the process and challenges (McWilliams, 2014). Mixed research was conducted to confirmed the growth mindset workshops improved students' perception and adaptability, especially conducive to those inferior students to conquer obstacles (Pismeny, 2016).

The theory also facilitating narrowing the achievement gap, especially to those average students and poor students. A growth mindset promotes higher performance to students with disabilities, but the relationship between the mindset of teachers and students is negative (Froedge, 2017).Through mixed-methods in a freshman at an elementary school, teaching intervention with a growth mindset is pivotal means to hold fortitude and resilience for individuals when confronted with tribulation (Smith, 2017; Barrington, 2017). A cross-sectional correlation research finding shows that a positive relationship between students' growth mindset and NWEA MAP achievements, GPA scores and gifted program, meanwhile high SES background and gifted student as a privilege to students' performance (Volpe, 2016).

Nevertheless, a growth mindset has no or little significant effect to gifted and talented students. As motivation and exertion areprominent trait of an excellent student, it always promotes their outstanding performance (Reis & Renzulli, 2009; Subotnik, Olszewski-Kubilius, & Worrell 2012). Whether a gifted student knowing the concept of a growth mindset or not

has no impact on them to take the challenge (Leach, 2015). That is mainly because they are already processed the core part of the growth mindset and they put an effort into the task constantly.

Even a lot of existing study have been done to testify the theory of the growth mindset, most of them based on psychology background to realize this application. Therefore, this study combines the theory and practice of education and psychology research, and focused on the verification of the internal structure and relationship of the growth mindset, make comparison among different groups to gain a deep analysis, investigate and identify the relationship of the factor.

Conceptual Model and Hypotheses

Dweck (2006) has laid down the central idea of a growth mindset when individuals facing different situation, what kind of mindset and behavior they would like to choose (see pp. 487). This has laid the foundation of the conceptual model in this study. The conceptual model was proposed and revised according to the theory of Dweck (2006), it has been widely used in the area of self-inspection and self-correcting the mindset rooted in one's heart, and it aims to shift the behavior and concept to make oneself have better progress and development. According to previous finding, intrinsic motivation, positive attitude, embracing challenge, fight against with adversity, positive mindset and stereotype are the most valuable factor to the growth mindset. Make a summarize and abstract the essential indicators of the growth mindset, conceptual model was formulated, and the hypothesis proposed waiting to test, as it is shown in Fig. 1.

Based on the framework of growth mindset theory developed by Dweck (2006) and existing study, this study intends to accomplish next assignment:

1. Develop the growth mindset scale, examine the structural validity and reliability;
2. Test and verify the structural equation model of growth mindset;
3. Measure the invariance, direct and indirect effects of the model through using Chinese samples;
4. Evaluating the effects of different variables and groups.

According to research and theory related to growth mindset (Dweck, 2006; Levy, Stroessner & Dweck, 1998; Heyman & Dweck, 1992; Dweck, 2017; Guidera, 2014; Duckworth, Peterson, Matthews, & Kelly, 2007), the growth mindset scale can be summarized as six dimensions, which is motivation, attitude, grit, challenge, adversity, positive mindset. Thus, in this research, the growth mindset can be concluded as below (also shown in Fig. 1 and Table 1): motivation means the inner reason of learning new things, if a persons' motivation was derived from inner desire and needs, not for extrinsic rewards, then it could means that this person hold growth mindset; attitude stands for the beliefs towards IQ, talents, achievements and hardworking; challenge represents the thinking and mind when dealt with difficulties, problems and new changes; grit signifies an individuals' perseverance and diligence; adversity indicates that unpleasant cases with disapproving and unlucky situation; positive mindset denotes feeling confident and openness with strong belief towards oneself in all kind of cases.

Furthermore, following hypotheses are formulated:

Hypothesis 1: Motivation, challenge, grit, attitude, adversity and positive mindset are all the important factor to growth mindset.
Hypothesis 2: Grit could exert positive impact on motivation and adversity.
Hypothesis 3: Positive mindset has positive cause effect on adversity and motivation.
Hypothesis 4: Adversity and challenge have significant effect on attitude.
Hypothesis 5: There are significant correlated relationship between challenge and grit, challenge and positive mindset, grit and positive mindset.
Hypothesis 6: Motivation has significant effect on attitude.

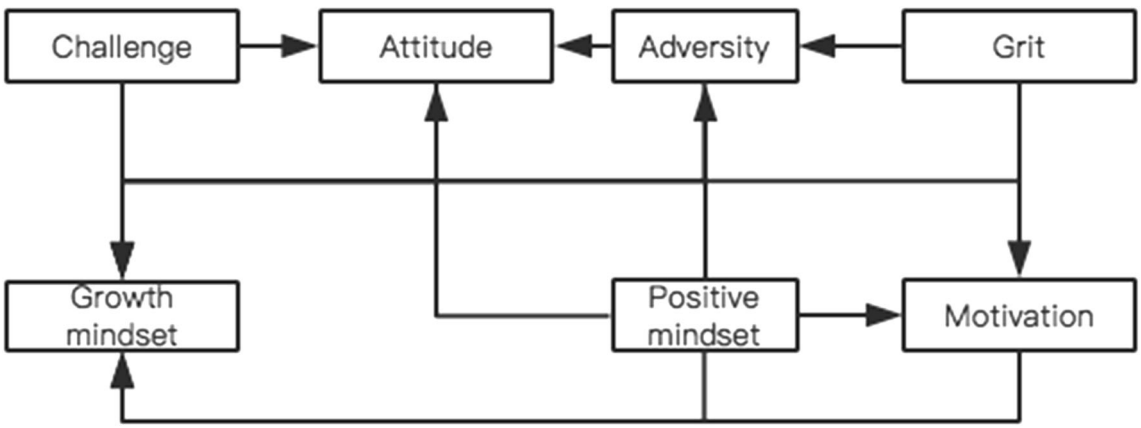

Fig. 1 The conceptual model of growth mindset

Table 1 Scale Items and factors

Items and factor dimensions	Extracted communities	Mean(SD)
Dimension 1: motivation		
1. Learning is aim to acquire more knowledge, broaden your horizons, satisfy curiosity and improve your ability.	0.857	1.38(0.78)
29. If I succeed, it is mainly the consequence of hard working and the exert of potentials, my own interests and pursuits, and I will continue to pursue higher goals.	0.624	1.78(0.79)
Dimension 2: attitude		
3. No matter how smart I am, I can improve my IQ by studying hard and make myself more smart.	0.738	2.26(1.121)
8. IQ and talent can be improved by study hard.	0.740	2.22(1.093)
6. As long as I study hard and keep trying, I could improve my IQ and make myself smarter.	0.801	2.02(0.869)
Dimension 3: challenge		
9. I'd like to constantly accept challenges to improve myself.	0.700	1.9(0.909)
11. I am very curious and I like to try new things constantly, dare to accept new things, and I will start again if I fail.	0.732	1.94(0.913)
13. I am willing to challenge difficulties. I am not afraid of failure. I don't care about the opinions of others. I will persevere in finding solutions to problems.	0.758	2.1(0.909)
15. Faced with difficulties, I believe that I will be able to work tirelessly to solve problems and break with problems.	0.731	1.98(0.869)
Dimension 4: grit		
18. As long as I persevere, put enough effort, and try all kinds of method, my goals will be achieved.	0.652	2.32(0.978)
22. Efforts will definitely bring positive results and unexpected gains.	0.860	2.2(1.069)
Dimension 5: adversity		
23. If someone criticizes me, I will seriously analyze and reflect on myself.	0.723	1.98(0.795)
25. I am willing to accept criticism from others, and I will learn a lot from it.	0.767	2.3(0.789)
27. When my partner succeeds, I will think and analyze the conditions and reasons for his success, and learn from it actively.	0.686	1.88(0.773)
Dimension 6: positive mindset		
28. When my partner succeeds, I will have a sense of threat, and I will feel unhappy with a little jealous.	0.625	3.34(1.002)
26. Other people's criticisms are wrong and worthless, and they don't like others to criticize themselves.	0.709	4.02(0.937)
20. Talented people often succeed in putting no efforts.	0.682	3.84(1.201)
10. I don't like challenges. It is difficult for me to exceed my current level. My IQ is constant.	0.697	3.84(1.095)

Hypothesis 7: The age may play an important role to an individual's growth mindset, and it has a significant meaning to growth mindset.

Hypothesis 8: Individual's growth mindset has significant difference according to different learning stages.

Methods

Research Design

An investigation was conducted and a questionnaire designed to examine the growth mindset in Chinese primary schools, secondary schools and colleges. The proposed questionnaire was designed based on the theory of growth mindset (Dweck, 2017) and the research of Guidera (2014), then revised and deleted some of items through select good factors and verified data. Proposed conceptual model is manifested in Fig. 1. Variables are listed as below: Motivation, Attitude, Challenge, Grit, Adversity and Positive mindset (also shown in Fig. 1 and Table 1). Through the review of literature, the growth mindset scale was developed. It consist of 6 dimensions and 18 items that are based on the theoretical framework and through the inspection of EFA. And Professor Dweck and her team also developed the growth mindset measurement tool, which is similar to this, but it was confidential and private. Thus, this research was designed to examine the growth mindset scale based on different cultural backgrounds.

Initially, study results are acquired by the version of SPSS 25.0 and AMOS 24.0, include participants' demographic characteristics, the reliability of the questionnaire, the validity of model structure through the analysis of the results of EFA and CFA, the structural equation model (SEM). Eventually, the amendment of various fit indices of SEM and the assessment and interpretation of the SEM and its mediating effects. The sample included 654 participants under the circumstance of random sampling and the principle of willingness, 104 primary school students and secondary schools, 100 college students, 117 graduate students and PhD students, 266 teachers from primary school and secondary school, and 67 employees with 236 males and 418 females, as its demographic detail and information are shown in Table 2. The study also noticed that, conducted with bootstrap program to identify the mediation effects, and employed Welch's test of one-way ANOVA to check out the impact on different groups.

Data Analysis

Data analysis was divided into three segments. In the first portion, test the reliability and validity of the measurement model and each item. Based on existing theory framework and empirical study, referencing and revising the available items in questionnaire and scale (Dweck, 2017; Guidera, 2014) to make it applicable for this study in Chinese samples,

Table 2 Demographic profile of participants ($N = 654$)

Demographic variables	Frequency	%	Total
Learning stages			654
Primary and secondary school students	104	15.90%	
College students	100	15.29%	
Post-graduates and PhD students	117	17.89%	
Primary and secondary school teachers	266	40.67%	
Employees	67	10.24%	
Ages			
Under 18	103	15.75%	
18–25	162	24.77%	
25–35	200	30.58%	
36–45	118	18.04%	
45 and above	71	10.86%	
Race			
Ethnic	45	93.12%	
Majority	609	6.88%	
Gender			
Male	236	36.09%	
Female	418	63.91%	
Residence			
Urban	417	63.76%	
Rural	237	36.24%	

the questionnaire of growth mindset was formulated. Then, study used Cronbach's alpha index to examine the reliability of each item in the questionnaire. Secondly, in order to assess the construct validity of the questionnaire, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were executed (Kline, 2011). The result of EFA will be helpful to screening data, exploring the relationship between different factors in the measurement model (Priyadarshinee, Raut, Jha, & Gardas, 2017). Combining the results of CFA and EFA is optimum choice for researchers to fit and construct a measurement model (Kline, 2011). Finally, through the analysis of CFA and EFA, the study could propose a SEM of growth mindset and verify the inner relationship in the model, so as to get the consequence and result.

All statistical analyses were conducted in the software of Analysis of Moment Structures (AMOS) version 24.0 and Statistical Package for Social Sciences (SPSS) version 25.0. Maximum likelihood estimation was operated in the Amos 24.0 environment to test CFA and SEM pattern. Under the purpose of constructing model, the factor loading of first order and second order CFA was derived correspondingly, as it is shown in Fig. 2 and Fig. 3.

On account of SEM required large sample, assess the whole model and the limitation of statistical significance, as well as researchers should not simply focus on significance testing but should be more attached to the analysis data and its reliability, the significance testing was less important than any other fitting criterion. As a general rule, the goodness of fit in the measurement model was assessed through various indices. Generally, in most cases, if a model with x^2/df value was less than 3, the figure of GFI, CFI, NFI, AGFI and PGFI was over 0.9, the number of RMSEA was smaller than 0.10 and RMR was under 0.05, then we can safely draw a conclusion that the measurement model could be accepted and the pattern goodness of fitting was good (Kline, 2011; Jöreskog & Sörbom, 1993; Schumacker & Lomax, 2004; Byrne, 2016).

Results

In this section, the result of data was analyzed through SPSS 25.0 and Amos 24.0, and it include demographic features, the reliability and validity of the measurement model (EFA & CFA), conceptual model was verified and revised through various fit indices, and identify the mediating effects through Bias-Corrected Bootstrap program. The results are as follows.

Participants and Demographic Features

As the concept of growth mindset related to the lifelong learning, it regards learning as a process and divided it into several stages in the whole life, the research focused on different grade and age levels students and teachers through online

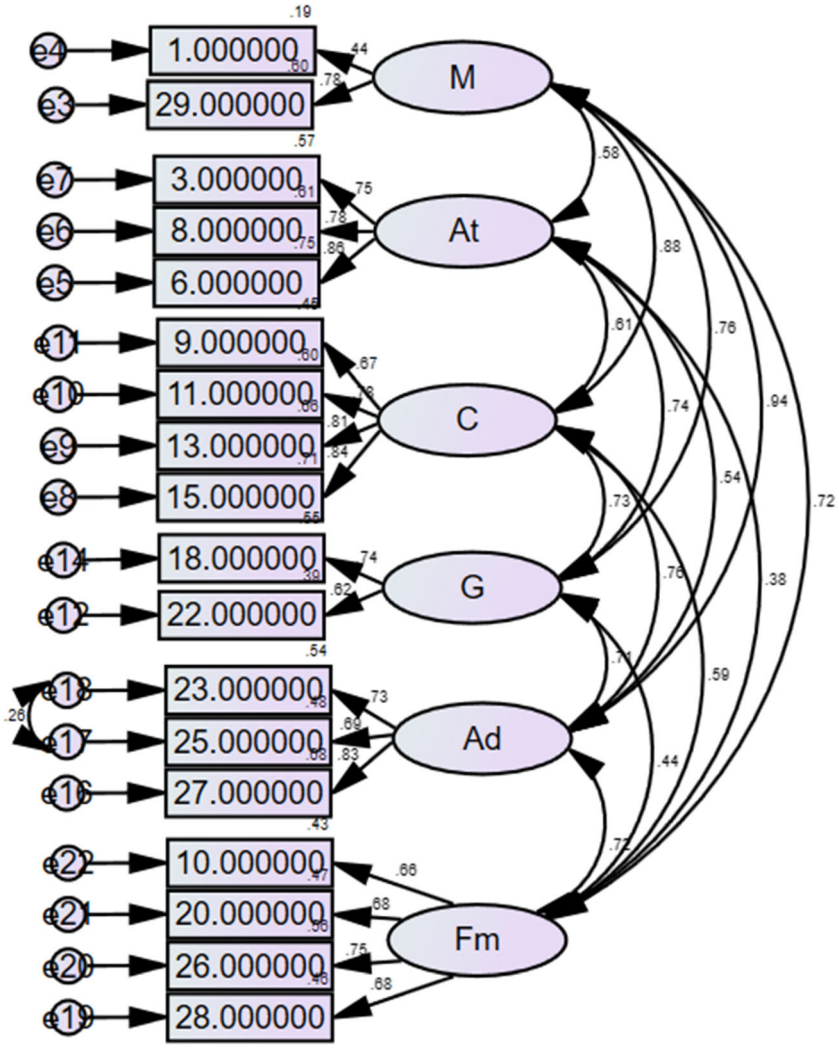

Fig. 2 The first order CFA model

survey. There are total 654 participated people (36.09% were male and 63.91% were female).

Questionnaire and its Reliability

The questionnaire comprised of two parts, the first part covered the demographic characteristics (e.g., learning stages, age, grade level, race, gender, urban or rural resident). It is used in this study was modified and referenced from the theory and research of growth mindset (Dweck, 2006; Dweck, 2017) and the study on grit by Duckworth (2016). Borrowing five-point Likert scale (5 = totally agree, 4 = agree, 3 = almost agree, 2 = disagree, 1 = totally disagree) (Likert, 1932), divided growth mindset into six dimensions, which are motivation, attitude, grit, challenge, adversity and positive mindset. The operational definition of growth mindset was standardized by Dweck (Dweck, 2006; Dweck, 2017), an adapted scale by Guidera (2014) was also referenced. Both items in their scale was revised and integrated to measure.

As Cronbach's alpha coefficient as widely accepted tool to examine the reliability of measurement instrument, as well as test the proposed hypothesis in the formulated model (Kaplan, 2009). In order to confirm the reliability of the questionnaire, we used Cronbach's alpha values to check out. The Cronbach's alpha value of the questionnaire was detected to be 0.911. If the value of Cronbach's alpha is greater than 0.8, it means high reliability (Kline, 2011). So the reliability of the questionnaire was fairly good and acceptable, which means the data is reliable for the subsequent analysis.

Measurement Model (CFA)

EFA was executed to examine. Six factors extracted from the analysis with six values exceed 0.624, explaining a total of 58.648% variance (as Tables 1 and 3 show). The Kaiser-Meyer-Olkio (KMO) measure results was 0.929, it was close to 1.0, which indicates the overall variable is adequate for further analysis (as Table 4 show). At the same time, p value was significant ($p < 0.001$), it means there are correlation

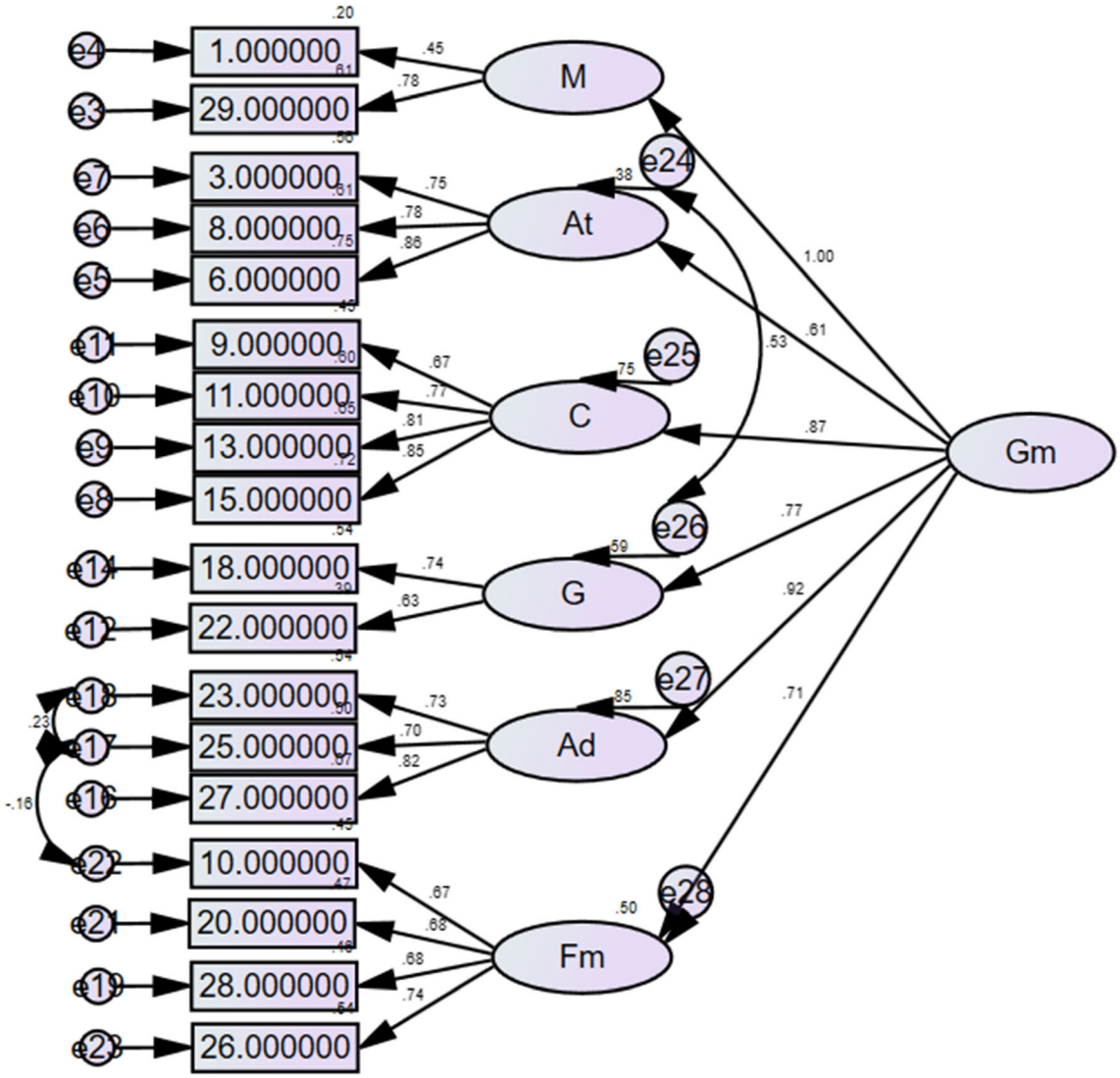

Fig. 3 The second order CFA model

between the variables. Although the sample and data are reliable and valid, it is just a kind of statistically significant but not based on theory, so its results cannot be used to construct a theoretical model. Therefore, research conducted CFA to evaluate the reliability and validity of the questionnaire, construct structural equation model, as well as verify the different variables and the relationship between them. Table 5 demonstrate the consequence of the CFA in this measurement model,

Table 3 Total variance explanation of EFA

Total Variance Explained					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
1	7.443	41.352	41.352	7.443	41.352
2	1.770	9.836	51.188	1.770	9.836
3	1.169	6.494	57.682	1.169	6.494
4	1.055	5.859	63.540	1.055	5.859
5	.920	5.113	68.654	.920	5.113
6	.726	4.035	72.689	.726	4.035

Table 4 KMO and Bartlett's test results

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.929
Bartlett's Test of Sphericity	Approx. Chi-Square	5614.541
	df	153
	Sig.	.000

and its factor loading, average variance extracted (AVE), composite reliability (CR) and any other model fitness indices. Through CFA analysis, it shows the goodness of fit in the measurement model reaches the standard. It also indicates the relationship between factors and items are consistent with the expected model,good convergent validity and discriminant validity, as well as construct validity.

As Figs. 2, 3 and Table 5 shows the results of the first order and the second order in CFA. In the first order in CFA, it indicates that the measurement model needs to be modified, and there is residual correlation between e17 and e18 that is 19.463. Suppose that the relationship between the residual variable of e17 and e18 are not independent with each other, according to Modification Indices, adding a group of correlate coefficient relationship between e17 and e18 to make revision. The second order in CFA, there are three groups of residual correlate coefficient relationship in the residual variables of e18 and e17, e17 and e22, e24 and e26. Through the result analysis of the first order and second order of CFA model, it can be concluded that the second order of CFA model accepts the hypothesis 1.

Convergent validity of the measurement model signifies the correlation of each items, if the AVE (Average Variance Extracted) is greater than 0.50 and CR (Construct Reliability) exceeds 0.70 (Fornell & Larcker, 1981; Hair Jr, Black, Babin, & Anderson, 2009). Table 5 shows the consequences of CFA, the AVE values fluctuated from 0.3967 to 0.6416, and CR values ranged from 0.5498 to 0.8593. Thus, we can draw the conclusion that the measurement model has a good convergent validity.

Conceptual Model (SEM)

The proposed conceptual model was run in the Amos 24.0 to check out its good fitness. Figure 4 display the structural relationship in different factors. Table 6 displays the the weights of factors and indicators in SEM, the indicators are exemplary to reflect the feature of factors, relation path are significant and positive. Table 7 shows the goodness of fit about measurement model and conceptual model, through the comparison, structural equation model had shown the best fitting. As Fig. 4 shows the results of the structural equation model, the structural equation model has goodness of fit with Chi-square = 356.645, Degrees of freedom = 124, x^2/df = 2.876, RMSEA = 0.054, CFI = 0.958, SRMR = 0.036 (see Fig. 4 and Table 7). There are three group of residual correlate coefficient relationship in the residual variables of e18 and e17, e14 and e 12, e14 and e27.

As seen through the Fig. 4, the research finding presents a significant association between challenge and grit, challenge and positive mindset, grit and positive mindset. And grit

Table 5 Confirmatory factor analysis of questionnaire

Constructs		Items	First order values			Second order values			R^2
First order	Second order		AVE	CR	Factor loading	AVE	CR	Factor loading	
Motivation	Growth mindset	1	0.3967	0.5498	0.439***	0.6801	0.9256	1.000***	0.193
		29			0.775***				0.601
Attitude		6	0.6416	0.8426	0.863***			0.614***	0.745
		8			0.784***				0.614
		3			0.752***				0.566
Challenge		15	0.6059	0.8593	0.843***			0.867***	0.710
		13			0.811***				0.658
		11			0.776***				0.602
		9			0.673***				0.453
Grit		22			0.623***			0.771***	0.388
		18			0.741***				0.549
Adversity		27	0.5648	0.7947	0.826***			0.923***	0.682
		25			0.689***				0.475
		23			0.733***				0.538
Positive mindset		28	0.4814	0.7874	0.679***			0.711***	0.460
		26			0.750***				0.562
		20			0.684***				0.467
		10			0.659***				0.435

***$p \leq 0.001$

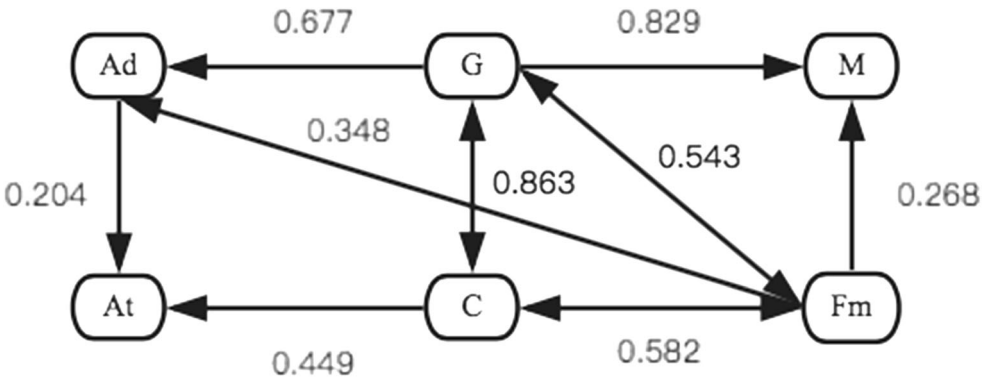

Fig. 4 The structural equation model. *Note.* G grit, Ad adversity, At attitude, C challenge, M motivation, Fm positive mindset

exerts positive direct effect on motivation and adversity respectively. Positive mindset imposes direct effect on adversity and motivation. Adversity and challenge exert direct effect on attitude. Therefore, the SEM accept the hypothesis 2, 3, 4 and 5, except hypothesis 6. As the model shows motivation has no significant or small effect on attitude. Thus, study finally got the structural equation model of growth mindset.

Table 6 Regression weights and standardized regression weights of SEM

			Standardized Estimate	Estimate	S.E.	C.R.	P
Ad	<---	Fm	0.348	0.293	0.054	5.463	***
Ad	<---	G	0.677	0.644	0.068	9.523	***
At	<---	Ad	0.204	0.273	0.104	2.63	0.009
At	<---	C	0.449	0.548	0.097	5.642	***
M	<---	G	0.829	0.405	0.052	7.817	***
M	<---	Fm	0.268	0.116	0.033	3.509	***
29	<---	M	0.786	2.084	0.194	10.761	***
1	<---	M	0.437	1			
6	<---	At	0.860	1.107	0.053	20.773	***
8	<---	At	0.789	1.037	0.055	18.835	***
3	<---	At	0.749	1			
15	<---	C	0.843	1.163	0.063	18.362	***
13	<---	C	0.809	1.235	0.069	17.945	***
11	<---	C	0.775	1.122	0.064	17.563	***
9	<---	C	0.674	1			
18	<---	G	0.594	1			
10	<---	Fm	0.658	1			
20	<---	Fm	0.684	1.056	0.073	14.376	***
26	<---	Fm	0.751	1.059	0.073	14.559	***
28	<---	Fm	0.676	1.077	0.079	13.714	***
27	<---	Ad	0.822	1.161	0.061	19.002	***
23	<---	Ad	0.734	1			
25	<---	Ad	0.691	1.09	0.057	19.287	***
22	<---	G	0.538	0.942	0.077	12.188	***

***Significant at 0.001 level

Assessment of Mediation

Furthermore, the study employed a Bias-Corrected Bootstrap program and maximum likelihood to examine the mediating effects. Therefore, the mediating effects of the relationship among the growth mindset, positive mindset, grit, adversity and attitude were verified in Amos 24.0. Moreover, 1000 bootstrap samples were produced employing random sampling with substitute in the data set ($N = 640$). Table 8 describes the significant effect of standardized path coefficients. Results reported that adversity was the fully mediator between grit and positive mindset, it also as a fully mediator variable between positive mindset and attitude. Grit exerted significant indirect effects on attitude through adversity and positive mindset exerted significant indirect effects on attitude through adversity ($P < 0.001$).

Welch's Test of ANOVA

One way ANOVA method with Welch's test was utilized to process the sample with unequal variances and analysis the difference. As the results of Table 9 and Table 10, in the test of homogeneity of variances, $p < 0.05$, the samples have unequal variances. Then, the p value equals to $0.000 < 0.05$, which means different groups of ages and learning stages have significant discrepancy. Table 9 displays the profile of different age level, it can be seen that the age group of under 18, 36–45 and above 45 acquire similar score and the minimum, while the age group of 18–25 achieve the highest score, the age group of 26–35 take the second place. It shows a large gap between students under 18 and 18–25. learning stages maybe a contributory factor to an individual's growth mindset. As it is shown in the Table 10, students from the elementary education stage get the lowest average score, undergraduates and postgraduates receive the highest score, 67 employees and 266 teachers from primary school and secondary school obtain similar one, teachers are slightly higher than other professional staff. Basically, learning stages have a positive influence on individual's growth mindset, the growth mindset of

Table 7 Goodness of fit test for the proposed model (Kline, 2011; Jöreskog & Sörbom, 1993; Schumacker & Lomax, 2004; Byrne, 2016)

Model	x^2	df	x^2/df	RMSEA	RMR	GFI	CFI	NFI	AGFI
accepted fit			<3	<0.10	<0.05	>0.90	>0.90	>0.90	>0.90
First order of CFA	333.935	119	2.806	0.053	0.033	0.944	0.961	0.941	0.920
Second order of CFA	360.299	127	2.837	0.055	0.037	0.939	0.958	0.936	0.918
Structural model	356.645	124	2.876	0.054	0.036	0.940	0.958	0.937	0.917

students and teachers still needs to be improved in primary school and secondary school.

Discussion and Conclusions

This study examined how significant factors and mediating effects of growth mindset are associated with Chinese students and teachers. It is quite important to conduct this research, because of its unclear state of mindset between students and teachers, as so much finding shows the importance of growth mindset and its impact on the development of individuals.

Firstly, the value of the growth mindset lies in education, ages and learning stages are really important to an individual's growth mindset. If teachers convey negative feelings to students, students may accept this opinion and give up easily without critical thinking, then it caused a vicious circle (Rattan, Good & Dweck, 2012; Spencer, Steele & Quinn, 1999; Gonzales, Blanton & Williams, 2002; Croizet & Claire, 1998). It reveals the power of positive psychology and the significance of growth mindset.

Secondly, the positive relationship between challenge and grit, challenge and positive mindset, grit and positive mindset demonstrates the study by Duckworth (2016) which presented psychology evidences showing that grit and perseverance are essential quality to promote well being and realize individual potential. Growth mindset is highlighting the power of grit and the positive side of things, that is why it helps individuals to get through the adversities and difficulties. As it already shows the positive relationship between motivation, difficulties, attitude and grit, especially to those poor student's achievements (Saia, 2016; Garcia, 2016; Blackwell et al., 2007; Rosenthal & Jacobson, 1992; Good et al., 2003; Johns et al., 2005; Zhao et al., 2018; Wang et al., 2019; Zeng et al., 2019).

Thirdly, growth mindset should be integrated into the lifelong learning and ubiquitous learning more than school and classroom. Be confident to accept the challenge, hold a positive attitude and mindset towards the adversities, possess the good qualities of grit and perseverance are all important to an individual's growth mindset. It is not about academic achievement of students or work efficiency of teachers, it is applied positive psychology with educational value to transform the school culture and to create a positive harmonious atmosphere around the school (Guidera, 2014).

Finally, growth mindset should be aiming to promote the long-term development of students. As growth mindset may be inefficient to rote learning, or improve the academic achievement and achieve short term interests (Menanix, 2015; Garofalo, 2016; Zakrajsek, 2017; Thlele, 2016). For instance, a study had proved that reading book loudly was inefficient to fostering the growth mindset or good qualities (Zakrajsek, 2017). When students participated in the summer courses about mathematics content, their mindset changed with more engagement, but it was ineffective in formal education when the teaching method is not based on student's learning approach and ignoring the study material (Menanix, 2015). Therefore, simply applying the growth mindset to academic achievement was far from enough, it should be regarded as a strategy to cultivate a character and quality with grit and perseverance.

Table 8 Standardized Indirect Effects and 95% confidence intervals

Model pathways	Estimated	95%	
		Lower	Upper
G-AD-AT	0.138 [a]	0.025	0.299
FM-AD-AT	0.071 [a]	0.017	0.143

G grit, *AD* adversity, *AT* attitude, *FM* positive mindset

[a] 95% confidence interval with excluding zero

Table 9 The impact of different age level on growth mindset

Age level	n	($\bar{x}$±s)	F	p
1	103	31.45 ± 12.54	16.475	0.000
2	162	39.85 ± 9.06		
3	200	36.14 ± 9.45		
4	118	32.32 ± 9.42		
5	71	32.96 ± 9.42		

Table 10 The impact of different learning stages on growth mindset

Education experience	n	($\bar{x}$±s)	F	p
1	104	31.69 ± 12.49	11.329	0.000
2	100	39.30 ± 9.68		
3	117	38.39 ± 9.37		
4	67	33.52 ± 9.37		
5	266	34.28 ± 10.36		

Limitation

This study overemphasizes the importance of growth mindset, strategic thinking, and other things that are also important to growth mindset or success. Moreover, growth mindset seems to be ineffectiveness in some cases, which means even if you are put great effort into the work, you may achieve nothing in the end. The model may be invalid in some extreme circumstance. For instance, a study had proved that reading book loudly was inefficient to fostering growth mindset or good qualities (Zakrajsek, 2017). On account of rote memorizing abstract theory while without certain learning context could be tedious and monotonous for students (Piburn & Baker, 1993). If researchers are exaggerating the effect of growth mindset, then they will ignore the inequities which happened in the school. Because teacher's poverty awareness and economic inequality have nothing to do with their mindset, which means many teachers are generally overlooked injustice and poverty that happened in the classroom, such as emphasized standardized examination and overlooked the poverty rate (Copich, 2014). This can be explained that why some students who accept fixed mindset or hold growth mindset still acquire a low academic achievement, this mainly cause it seems to ignore the inequities of social-economic status and something underlying the facts and behavior.

Therefore, it can be explained that why a teacher hold with high growth mindset, but he or she still cannot persuade or stimulated their students to accept a growth mindset and make a difference in improved academic achievement. Because of the self report questionnaire, it is likely to lead the discrepancy between the behavior and mindset, people may overstate or overconfidence about his or her growth mindset while he or she did not practice it into the class or the real world.

Implication

Most of teachers agree with growth mindset and make it related to the student's academic achievements and grades. Researchers have done a lot of this work, some achieved the expected goal, others are not because of various reasons. This measurement model provides an useful instrument to test the growth mindset from an empirical perspective for researchers and scholars. It also presents the generic signature of growth mindset in Chinese education background. The results of the study may produce a series of implications for researchers in the future.

First, make a deeper reflection about growth mindset and remedy for its defections. Researchers should reconsider the relationship between academic achievement and their mindset. A lot of studies have done about it and proved that growth mindset is no impact or small impact on the academic achievement of students (Menanix, 2015; Garofalo, 2016; Zakrajsek, 2017; Thlele, 2016; Brougham, 2016; Wilson, 2016). One person may hold a little growth mindset to gain achievement in one area, but hold more stereotypes towards other things. How to deal with it?

Secondly, it is unclear that the cultivating strategy of growth mindset for teachers or individuals, teachers or parents have no idea about developing a growth mindset of their student or child. The effective and operative strategy of growth mindset will need to be developed and test in the future, it needs a lot of empirical studies to demonstrate the righteous and virtuous of acquiring growth mindset.

Thirdly, there are something behinds the growth mindset that will highly influence the growth of a student, which is inequities and socioeconomic status, but it was highly neglect. Growth mindset theory has its limitations and it cannot be ignored by educators. On account of this limitation, growth mindset should change its way and make others know about it, it cannot make the inequities obscured. As many teacher's poverty awareness and economic inequality have nothing to do with a growth mindset, but it is an obligation to resolve the complex problems (Copich, 2014). It is something that not just about increase the academic achievement of students, it is something concerned about the lifelong development of a student, it should be comprehensive and systematic rather than unilateral.

Finally, educators, parents, school leadership and decision-makers should appreciate the value of growth mindset, not only attach importance to the academic achievements, but also concern about the influence of non-intelligence factors. Bridging the relationship between growth mindset and student's achievement, scientifically measure the student's achievement.

Declarations

Ethical Approval All processes performed in studies involving individual participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declared no conflicts of interest with respect to the authorship or the publication of this article.

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