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Beliefs and Attitudes that Influence Learning: A Mind, Brain, and Education Literature Review

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Abstract

Mind, Brain, and Education (MBE) is a transdisciplinary area that joins neuroscience, psychology, and education to inform teaching practices and educational policy with research that can be translated into applicable and reflective tenets and principles of how students learn more effectively. It is well established in the MBE literature that what leads students to success are not only cognitive abilities but also beliefs and attitudes towards learning, which forms a complex and multifaceted universe with different levels of influence. This study has conducted a literature review on the contributions of MBE concerning these beliefs and attitudes and attempted to summarise them into a useful guide that might help students reflect on their academic achievement throughout life. Four essential elements were analysed and discussed, namely: growth mindset, metacognition, self-efficacy, and neuroplasticity. It is argued that these concepts are of paramount importance to anyone who wishes to accomplish both academic and career goals and they are aligned with the notion of lifelong learning.

Keywords: academic achievement, growth mindset, metacognition, self-efficacy, neuroplasticity

1. Introduction

Much is debated about how students learn and intelligence seems to be the basis and most reliable predictor of how much they can learn. For years, educators and psychologists have tried to measure intelligence to make assumptions about how successful students would be in any type of learning environment. The most influential work was done by Alfred Binet and Theodore Simon (Binet & Simon, 1916, Terman & Merrill, 1937) with the development of a scale that was later adopted by several institutions to assess students' Intelligence Quotient (IQ). Despite Binet's apprehension and diverging opinion with Simon about the reliability of their own tool to measure intelligence, it became a widespread psychometric test in different arenas and levels of modern society, including school, mental institution admissions, psychological and educational research, a criterion for scholarships, and the like.

This is perhaps what led parents, school managers, and society in general towards the belief that children were born with a fixed intelligence quotient that could not be further developed throughout their lives. IQ testing became the norm in the following years because it was available and supported by research. Nonetheless, the advancement in psychological theories, associated with breakthroughs from cognitive neuroscience gave rise to new ways of looking at intelligence and what leads to long-term learning and success (Dweck, 2007). Non-cognitive skills, that is, those relating to behaviours, feelings, attitudes, and beliefs, have shown to influence school outcomes (Farrington et al., 2012; Duckworth & Yeager, 2015).

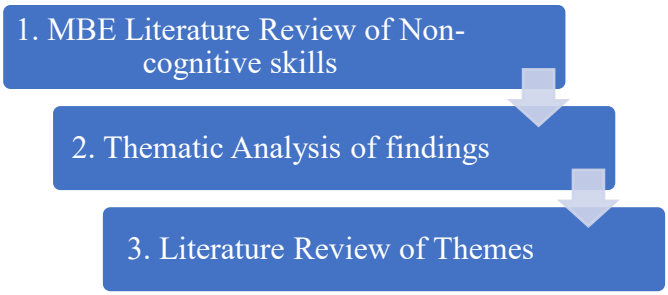
The birth of a new science that joined these new developments in psychology, neuroscience, and education together, namely, Mind, Brain, and Education (MBE), has given educators and policymakers the resources to understand learning more holistically and from an evidence-informed perspective (Tokuhama-Espinosa, 2014). One of the objectives of MBE, thus, is the fight against the dissemination of neuromyths as they can potentially hinder students' learning outcomes by misinforming teachers on effective classroom practices (Fischer, 2009; Dekker et al., 2012; Tokuhama-Espinosa, 2014). Its transdisciplinary character gives MBE a more holistic approach and assumes that no parent field alone should be prioritised over the other two.

This study has conducted an exploratory search in the MBE literature and, through a subsequent thematic analysis, has identified four non-cognitive skills that fall under the umbrella of beliefs and attitudes: *growth mindset*, *metacognition*, *self-efficacy,* and *neuroplasticity*. This review suggests that interventions based on these four concepts can potentially achieve positive results regarding students' academic performance and career goals. As indicated below, research seems to corroborate the effectiveness of beliefs and attitudes-based interventions when contrasted with interventions which are only concerned with cognitive tests such as IQ. Each of the concepts is discussed ahead, and it is argued that successful learning design, planning and delivering, should shift their focus onto building students' character based on these beliefs and attitudes and on the idea of lifelong learning.

2. Methodology

This was an exploratory study (Creswell, 2003) as it intended to search for the contributions of MBE authors regarding non-cognitive skills that affect learning outcomes. The search was conducted in three stages:

FIGURE 1. STAGES OF THE STUDY



Source: own compilation

2.1 MBE Literature Review

First a literature review was done in order to identify authors who had published studies about non-cognitive skills based on brain and mind research. I identified two books, regarded as major references in the area, that covered 97 influences on academic achievement. They were:

TABLE 1. CHOSEN MBE LITERATURE AND NUMBER OF INFLUENCES ON ACHIEVEMENT

Book	Author	Number of influences
Making classrooms better: 50 practical applications of Mind, Brain, and Education science	Tokuhama-Espinosa (2014)	50
Visible Learning for teachers: Maximizing Impact on Learning	Hattie (2012)	47*

* Hattie (2012) covers 150 influences on academic achievement. However, I decided to use 47 only based on Tokuhama-Espinosa's suggestion in her book (2014) as they are more directly related to the classroom environment.

Source: own compilation based on MBE literature review

Secondly, after selecting the authors, a thematic analysis (TA) was conducted. According to Braun and Clarke (2006, p. 76), "Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data". It is a type of qualitative method approach that allows the researcher to find common categories and group them to check for trends. Under the scrutiny of a TA, several apparently distinct items, concepts, or, in this case, strategies/practices, can be summarised into lists and allow for grouping (Matthews & Ross, 2010).

2.2 Thematic Analysis

Braun and Clarke (2006) recommend a six-phase framework for conducting a TA:

a) familiarise oneself with the data
b) generate initial codes
c) search for themes
d) review themes

e) define themes

f) write up

After familiarising myself with the data, I used their suggested influences as the codes. These influences were entered into tables (see Appendix I) to facilitate theme search. Non-cognitive skills were highlighted in blue and a new table was built based on the chosen codes as shown in Table 2:

TABLE 2. INFLUENCES ON ACHIEVEMENT ACCORDING TO MBE AUTHORS

Tokuhama-Espinosa (2014)	**Hattie (2012)**
14. Believe in the role of plasticity and in your students	1. Self-reported grades, self-expectations, self-efficacy
15. Foster metacognition and mindfulness	3. Response to intervention (attitude)
19. Reinforce effort and provide recognition	13. Metacognitive practices
21. Prepare students to set personal objectives and give themselves feedback	15. Classroom behaviour
32. Improve student self-efficacy	16. Self-verbalization and self-questioning
37. Award perseverance and celebrate error	17. Study skills
39. Never work harder than your students	20. Not labelling students
	37. Concentration, persistence, engagement
	41. Self-concept

Item numbers were kept as the original and columns were coded in different colours to facilitate the identification of authors

Source: own compilation based on MBE literature review

The next step was to group these 16 items into themes. Farrington et al. (2012) discuss how non-cognitive skills are highly associated with concepts such as *self-discipline*, *metacognitive strategies*, *academic mindsets,* and *behaviours*. I used these broader concepts as a reference and checked if the codes in Table 2 would fit them.

Similar codes were grouped together as indicated below:

TABLE 3. THEME SEARCH OF INFLUENCES ON ACHIEVEMENT

21. Prepare students to set personal objectives and give themselves feedback 32. Improve student self-efficacy 1. Self-reported grades, self-expectations, self-efficacy	Theme 1
15. Foster metacognition and mindfulness 13. Metacognitive practices 17. Study skills	Theme 2
19. Reinforce effort and provide recognition 37. Award perseverance and celebrate error	Theme 3

39. Never work harder than your students 20. Not labelling students 37. Concentration, persistence, engagement	
14. Believe in the role of plasticity and in your students*	Theme 4

*Items highlighted in grey are proposed by Tokuhama-Espinosa (2014), the ones without any highlight are proposed by Hattie (2012). Codes 3 (Response to intervention (attitude), 15 (Classroom behaviour), 16 (Self-verbalization and self-questioning), and 41 (Self-concept) proposed by Hattie (2012) were left out as: a) they did not fit well with any other theme; and b) they did not form a theme of their own as they were quite different.

Source: own compilation after thematic analysis

After considering the keywords and definitions, four themes emerged from grouping the codes. The first one emphasised students' self-efficacy. The second theme was aligned with the concept of metacognition. The third one fit with the definition of growth mindset. The fourth theme was about neuroplasticity.

The third stage of this study consisted of a literature review of the proposed themes to be aligned with Braun and Clarke (2006)'s three last steps: *review themes*, *define themes*, and *write up*.

2.3 Literature Review of Generated Themes

2.1.1 Self-Efficacy

The first belief and attitude is Bandura's idea of self-efficacy. He discussed in his work that self-efficacy relates to a person's ability to successfully cope with the demands of setting, keeping, and achieving goals. It involves prioritising, organising, planning, executing, and assessing tasks to make sure that performance is the closest as possible to what can be considered a successful outcome (Bandura, 1997).

Since self-efficacy is a broad concept and specific to different domains, which means a person can be self-efficacious in one area and not in another, this article will work with the concept of Academic Self-Efficacy (ASE) (Zimmerman, 2000). It relates to having the necessary mindsets and skills to perform well in school. It is connected with the beliefs and ability to carry out one's assignments, organise time to study, and get good marks in an educational setting for instance. The literature indicates that ASE is a strong predictor of positive school outcomes (Linnenbrink & Pintrich, 2002; Zajacova et al., 2005; Schunk et al., 2008; Usher & Pajares, 2008; Ferla, Martin, & Yonghong, 2009; Mann et al. 2014).

Bandura (1982, 2000) offers four sources of self-efficacy, namely, *enactive mastery*, *vicarious experiences*, *verbal persuasion*, and *arousal.* The first relates to the agent's own successful experience on a task as the most important way to increase self-efficacy. The second is linked to observing other people successfully accomplish a task and gaining the confidence to perform it too. Source number three claims that encouragement can be given orally by both the agent of a task and by others to accomplish it. Finally, the last one refers to the emotional state of the agent, particularly interest and excitement, and its impact on performance (Bandura, 1982; 2000).

In a meta-analysis, Richard, Abraham, and Bond (2012) found that higher self-efficacy scores are highly correlated with higher GPA scores in college. Other studies have demonstrated that

interventions based on ASE yield positive learning outcomes (Colquitt et al., 2000, Mathisen & Bronnick, 2009, Sitzmann & Ely, 2011).

2.1.2 Metacognition

The term originated in the works of American psychologist John Flavell (1979). He describes metacognitive people as those who are aware of their own cognitive processes and have the capacity to control, plan, monitor, regulate, and reflect on their ability to learn. Metacognition relates to "thinking about thinking" or "learning how to learn" (Zulkiply, 2009). Its basic premise is that students' should learn non-cognitive skills that relate to more effective learning strategies so that they may be able to overcome difficulties (Hacker et al., 2009). Different studies have also shown a positive correlation between using metacognitive practices, that is, having students think about the best way to learn and adopt certain habits, and academic achievement (Akama, 2006; Hacker et al., 2009; Karpicke et al., 2009; Dunlosky et al., 2013; Gutman & Schoon, 2013; Callan et al., 2016).

Metacognition is generally divided into two dimensions (Flavell, 1979; Brown, 1987):

1. Metacognitive Knowledge;
2. Metacognitive Regulation;

The first refers to people's knowledge about learning, their own abilities, and the experiences or strategies that can help them achieve a learning goal. The second one is about how well they can control their learning progress by planning, executing, monitoring, and making adjustments if need be.

This normally involves four stages:

1. planning;
2. monitoring;
3. evaluating; and
4. reflecting (Flavell, 1979; Brown, 1987).

Zulkiply (2009) and an OECD report (Zemira & Bracha, 2014) suggest that metacognitive students may compensate for cognitive disadvantages as they become more reflexive about their own learning process. They are better able to predict their scores, which are higher than students who are not as metacognitive, and they are also more efficient learners who can problem-solve and find more adequate strategies and solutions to their study challenges. These students can organise themselves to achieve their goals and adapt their strategies when necessary, which is related to the concept of self-efficacy.

2.1.3 Growth Mindset

In the 1980s, Gardner's (1983) idea of multiple intelligences and the new discussion of implicit theories about the intellect (Sternberg, 1985; Dweck & Leggett, 1988) put the notion of a fixed intellect, mostly related to academic abilities, in check. It is important to contrast that implicit theories refer to the internalised assumptions that teachers, students, parents, and society, in general, have about intelligence and creativity, as opposed to explicit theories, which are externalised by the scientific community through the scientific method (Dweck & Leggett, 1988). These developments laid the foundation for Yaeger and Dweck's (2012) fixed versus growth mindset duality by proposing that there were two types of mindsets about intelligence:

1. entity (fixed): the belief that intelligence is fixed and immutable; and
2. incremental (growth): the belief that intelligence is fluid and can be increased (Sternberg 1985, Dweck & Leggett, 1988).

These new theories have become quite popular globally and are used in lectures, teacher training programs, and educational interventions. However, despite the shift from the concept of a more fixed type of intelligence to a more fluid one, the prior remained important in the scientific literature with new studies emerging claiming that IQ might still be the best predictor of academic (Gagné & St. Pere, 2001) and professional success (Schmidt & Hunter, 2004). Another study by Cury et al. (2008) suggests that having a more fixed (entity) mindset may prevent students from engaging in habitual practice (homework), which, in turn, might explain why scores are lower for these students.

In spite of the aforementioned studies, interventions based on the concept of growth mindset have in general produced positive results. Several studies' interventions basically consisted of lessons that were meant to raise students' awareness of their implicit theories and the concept of growth mindset versus a control group that either received lessons about other topics or simply some materials but no lesson (Aronson et al., 2002; Blackwell et al., 2007; Paunesku et al., 2012; Yeager et al., 2013; Paunesku et al., 2015; Hochanadel et al., 2015). These studies were carried out in different settings with different age groups and subject areas and varying sample sizes. Overall, the studies suggest that interventions based on the concept of growth mindset have shown to be effective in improving students' academic outcomes.

Aronson et al. (2002) verified significant race and condition effects on the outcomes when matching Black (African American) and White students. On average, Black students had a lower SAT score and the intervention had a more visible impact on them when compared to Whites, which might suggest that students who come from a more socially vulnerable background already have a growth mindset and may benefit more from the intervention. On the long term, Blacks maintained the idea that we have a more "malleable intelligence" more than Whites and had better achievement scores. The only study that presented evidence of a weak correlation between a growth mindset intervention and improved academic achievement was the one by Mills & Mills (2018), which did not find a statistically significant correlation between mindset and retention, and between high mindset scores and enrollment for the next semester.

The fact that there are only a few studies (see Mills & Mills, 2018) suggesting that mindsets are not a good predictor of academic success may suggest that incremental interventions are a reliable way to help schools achieve higher performance. The Education Endowment Foundation suggests, in its 2017 report (Higgins et al., 2016), that metacognitive skills and growth mindset interventions are effective ways to promote higher academic achievement.

2.1.4 Neuroplasticity

Finally, the last concept is *neuroplasticity* or *brain plasticity*. This development of cognitive neuroscience posits that the brain has the ability to change its structure when learning occurs (Berlucchi & Buchtel, 2009). That means that the brain can not only create new synapses, but it can also eliminate ones which are not frequently used and change pre-existing ones. This property is directly related to one's ability to learn, self-correct, and improve skills (Kania, Wrońska, & Zięba, 2017). Therefore, students who are made aware of this property of the brain

will likely become more successful learners in the classroom and, consequently, achieve better outcomes (Blackwell et al., 2007; Paunesku et al. 2015 Myers et al., 2016).

Blackwell et al. (2007) have found that an intervention based on neuroplasticity was able to increase at-risk 7th graders' motivation and had a positive influence on their maths marks. On the other hand, it is worth mentioning that Paunesku et al. (2015) tested nearly 800 students (aged 14 to 18yo) who were divided into two groups and received a 45-minute session each (one on how neuroplasticity positively impacts achievement, and the other on general neurobiology) and found no statistically significant differences between the groups (although the control group had lower marks).

A meta-analysis of 10 peer-reviewed articles conducted by Sarrasin et al. (2018) suggests that teaching the notion of neuroplasticity leads to significant gains in motivation, brain activity, and ultimately to the development of a growth mindset. The study concludes that interventions based on the concept of neuroplasticity can generally have a positive impact on academic achievement and that inconsistent findings may have something to do with the length of the intervention, the type of task or subject analysed, and whether students are at-risk or not.

3. Conclusion

This article has attempted to elucidate some theories and empirical evidence related to how students can learn more effectively which are not directly under the umbrella of their cognitive abilities. First, a literature review within the MBE area was conducted. Two major references with 97 influences on academic achievement were found and coded. These 97 codes went through a thematic analysis and were narrowed down to 16 codes which were related to non-cognitive skills within the domain of beliefs and attitudes. Then I conducted a theme search by grouping these 16 codes according to similarities. Four themes emerged (*self-efficacy, metacognition, growth mindset,* and *neuroplasticity*) and four codes were discarded because they did not fit. Finally, another review was done focusing on the generated themes.

These attitudes and beliefs about learning and intelligence seem to be strongly interconnected and give support to the results of successful interventions based on the concept of malleable intelligence. A possible illustration of this link would be a student who understands that the brain is always capable of change and will more likely have a more positive relationship toward learning and effort. In that sense, this student might be more open to metacognitive strategies taught by the teacher and understand the value of self-organised study and goal-setting, which means this student would be potentially more self-efficacious and display more of a growth mindset in the classroom.

This study has looked at how implicit theories of intelligence, particularly the dichotomy between growth (incremental) mindset and fixed (entity) mindset, impact academic achievement. The literature suggests that there is a strong and positive correlation between attitudes and beliefs toward intelligence and learning. Only one study has been able to challenge the previous findings that a growth mindset is strongly correlated with academic performance (see Mill & Mills, 2018).

Taken together with the new developments of cognitive neuroscience and other psychological theories in the MBE literature, the results of multiple studies in diverse settings suggest that

interventions based on identifying students' most frequent mindsets, developing a more growth mindset, teaching metacognitive strategies, talking about brain plasticity, and promoting self-efficacy might be effective in improving their academic outcomes and potentially their job prospects (as discussed in Dweck, 2007). However, it is argued by Carol Dweck herself that the application of this theory might have been misplaced as it assumes, oftentimes, that there is a complete divide between growth and fixed mindsets (Dweck, 2016), since, as she explains in her book (Dweck, 2007) and more recent papers, individuals have mixed mindsets for different things at different times.

It is worth mentioning that the disruptive effect of the COVID-19 pandemic has challenged educators around the world to rethink their practices and shift their own mindsets about the teaching/learning process. The findings of this study might help educators, policymakers, and families shed light on the complexity of learning and how it forms a cosmos with different spheres that impact student achievement (Hedlund, 2021).

Future research will benefit from investigating interventions based on all of the four concepts discussed in this article and the impact they have not only on students' academic performance, but also on their career choices and success. I believe longitudinal studies can help understand how these beliefs and attitudes might carry on in individuals' lives and influence learning in the workplace. This review might also serve as a source of inspiration to teachers, school managers, teacher trainers, and policymakers to rethink teacher development programs and the role of skills and competencies which are not directly related to cognitive skills.

I must say, however, that beliefs and attitudes form only one aspect that influences learning. I believe anyone involved in education should understand – at least at a basic level – how different aspects can impact academic achievement and what are the main theories, principles, and empirical evidence relating to these aspects. There are emotional, motivational, learning design, and environmental elements interfering with and being affected by both cognitive processes and students' beliefs and attitudes. It was the desire to help educators and the entire school ecosystem reflect on this complex scenario that led me to the creation of a new conceptual framework that brings together many of these elements into a single illustration: the Learning Cosmos (Hedlund, 2021). I end this study with an invitation to explore the intricate universe that surrounds learners in the hope that this reflection will help impact achievement.

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APPENDIX 1. LIST OF INFLUENCES ON ACHIEVEMENT FROM MBE LITERATURE

Tokuhama-Espinosa (2014)	Hattie (2012)
1. Plan activities to grab attention	1. Self-reported grades, self-expectations, self-efficacy
2. Plan activities that stimulate memory	2. Piagetian (constructivist) programs
3. Plan to use spaced versus massed learning	3. Response to intervention (attitude)
4. Plan to incorporate repetition	4. Teacher credibility
5. Take advantage of variation and transdisciplinarity	5. Formative evaluation
6. Plan authentic lessons	6. Microteaching
7. Implement formative evaluation	7. Classroom discussion
8. Use product, process, and progress evaluations	8. Teacher clarity
9. Test to improve memory	9. Feedback
10. Develop shared, explicit learning objectives	10. Reciprocal teaching
11. Strive for clarity and immediacy	11. Teacher-student relationships
12. Provide feedback for mastery learning	12. Spaced vs mass learning
13. Nurture teacher-student relationships	13. Metacognitive practices
14. Believe in the role of plasticity and in your students	14. Acceleration
15. Foster metacognition and mindfulness	15. Classroom behaviour
16. Employ Zemelman and Colleagues' best filter when selecting activities	16. Self-verbalization and self-questioning
17. Develop students' ability to identify similarities and differences	17. Study skills
18. Develop students' summarizing and note taking ability	18. Teaching strategies (explanation, elaboration, modelling, demonstration, reminders of procedures
19. Reinforce effort and provide recognition	19. Problem-solving teaching
20. Provide purposeful homework and practice	20. Not labelling students
21. Prepare students to set personal objectives and give themselves feedback	21. Concept mapping
22. Teach students to generate and test hypotheses	22. Cooperative vs individualist learning
23. Use cues and triggers	23. Direct instruction

24. Use the Socratic method	24. Mastery learning
25. Cultivate the art of questioning	25. Worked examples
26. Incorporate problem-based learning	26. Peer tutoring
27. Incorporate cooperative learning	27. Cooperative vs competitive learning
28. Incorporate reciprocal teaching	28. Student-centred teaching
29. Incorporate case studies	29. Classroom cohesion and climate
30. Harness the power of analogies	30. Peer influence
31. Implement the 5Es: Engage, Explore, Explain, Elaborate, and Evaluate	31. Classroom management
32. Improve student self-efficacy	32. Professional development
33. Maintain high expectations	33. Goals
34. See learning as fluid	34. Second/third-chance programs
35. Appreciate the role of affect in learning	35. Small-group learning
36. Take the lead in social contagion	36. Questioning
37. Award perseverance and celebrate error	37. Concentration, persistence, engagement
38. Motivate	38. Motivation
39. Never work harder than your students	39. Quality of teaching as rated by students
40. Be passionate	40. Early intervention
41. Design engaging classrooms	41. Self-concept (cognitive appraisals: descriptions of pride, worth, confidence)*
42. Manage	42. Writing programs
43. Use thinking routines	43. Teacher expectations
44. Keep abreast of technology and flip the classroom	44. Cooperative learning
45. Adjust for ages and stages	45. Exposure to reading
46. Improve nutrition	46. Behavioural organizers, adjunct question
47. Get students out of rows	47. Reducing anxiety
48. Begin year-round schooling	
49. Change the school day	
50. Stop using tests as indicators of higher thinking	

*Codes highlighted in blue are related to non-cognitive skills

Source: own compilation based on Hattie (2012) and Tokuhama-Espinosa (2014)