Infographic Posters to Empower Growth Mindset in Mathematics Learning

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Abstract

A growth mindset is a way of thinking that emphasises the belief that one's abilities, intelligence, and talents can be developed through effort and learning. This study examines the use of growth-mindset infographic posters in mathematics instruction to enhance students' motivation. The study applies the Analysis, Design, and Development (ADD) method to integrate growth-mindset principles into mathematics worksheets. The analysis phase identifies key aspects, including neuroplasticity, learning from mistakes, and feedback, within mathematics topics. The design phase focuses on planning the poster's elements, including visuals, messages, purpose, and context. The development phase involves producing the posters and validating them through expert review. The theoretical review identifies six themes: an introduction to growth mindset principles; learning; challenges; failures; effort; and success in mathematics learning. The poster messages are designed to transform fixed-mindset perspectives into growth-oriented thinking, supported by directional arrows and appropriate characters to strengthen message delivery.

Keywords: growth mindset, mathematics learning, infographic posters, learning motivation, instructional design

Introduction

It is generally accepted by educators and social psychologists that non-cognitive factors influence mathematics learning (Mohamoud, 2024). Rhew et al. (2018) also stated that non-cognitive factors can also predict which learners are inclined to achieve academically and persistently. Non-cognitive factors include students' beliefs about themselves, attitudes, goals, motivation, perseverance and how students deal with failure. Students' ability to manage learning strategies and learning experiences constructively is also an important non-cognitive factor (Chatterji & Lin, 2018; Wanzer et al., 2019). This is why research on non-cognitive factors in mathematics learning needs to be conducted continually.

Learners' motivation in the classroom varies due to many aspects of the learning environment that influence it (Özcan, 2016; Xu et al., 2021). Individual learners need motivation to develop their interest, especially in learning mathematics (Keller, 2012). Pemberian motivasi ini diperlukan oleh peserta didik secara individu untuk mengembangkan minat mereka, terutama dalam belajar matematika (Keller, 2012). Failure makes students give up before learning math, so they do not have a foundation for learning it. (Van Hoeve et al., 2023). Dweck (1999, 2006) mentioned two orientations that influence how an individual acts and ultimately influence one's achievements. One who believes that individuals oriented towards growth are easy to form and able to learn from experiences is said to have a growth mindset; meanwhile, one who relates an individual's characteristics to fixed traits is said to have a *fixed mindset*.

Learners with a growth mindset tend to put in more effort, show greater persistence, and achieve higher academic outcomes than learners with a fixed mindset. Moreover, the growth mindset in mathematics learning can increase learners' motivation (Van Hoeve et al., 2023). Students with a growth mindset can focus more on the learning process rather than just grades or exams. The growth mindset can also have positive effects on learners' behaviours (Masters, 2014), elevate academic achievement (Claro et al., 2016), and help learners pull through when they experience a decline in academic achievement (Dweck, 1999). The growth mindset is perceived to have the potential to bring positive changes in mathematics learning, thereby helping teachers reduce feelings of frustration towards mathematics (Canning et al., 2022; Claro et al., 2016).

The growth mindset theory provides a framework for analysing mathematics learning (Baldwin, 2019; Simpson & Haltiwanger, 2017; Vestad & Bru, 2023). Van Hoeve et al. (2023) highlight the importance of promoting a growth mindset to make math less daunting for students. This awareness, combined with psychological and social interventions, can enable teachers to encourage learners to adopt a growth mindset (Yeager & Walton, 2011). Learners think they will never be able to improve their mathematics skills or succeed. Alternatively, they think that they can never be "mathematics people". This mindset can impair learners' motivation and cause them to feel incompetent in mathematics (Boaler, 2019). Developing a growth mindset can change the way they think about their confidence and attitude towards math (Boaler, 2019). As shown by Bostwick et al. (2019), using various constructions of the growth mindset significantly increases learners' mathematics scores. Besides, minor changes in mathematics tasks related to mindset theories have increased motivation, especially persistence in the face of failure (Baldwin, 2019; Masters, 2014; Porter et al., 2022; Vestad & Bru, 2023). It is therefore true that developing a growth mindset through mathematics learning is needed to improve learners' motivation to learn.

Although previous research has emphasised the importance of providing growth mindset messages to help students build confidence in their abilities, these interventions are generally delivered in a general way, without being contextualised to mathematics learning. Mindset messages are usually delivered as verbal sentences or short texts, rather than through visual media, which are more interesting and easier for students to understand. In fact, Dweck et al. (2015) and Cheng et al. (2021) have shown that consistent delivery of mindset messages can influence how students build confidence, view effort, and deal with failure. However, a research gap remains regarding how the core messages of mindset theory, such as neuroplasticity, learning from mistakes, and the importance of perseverance, can be conveyed through visual formats, such as infographic posters. The development of growth-mindset theory-based posters is important because visual media can provide repeated exposure in the classroom and help students internalise positive thinking when faced with mathematical challenges (Baldwin, 2019; Van Hoeve et al., 2023; Bostwick et al., 2019).

The growth mindset infographic poster is designed to help students shift from a fixed to a growth mindset. This poster is expected to be used later to improve student performance and help students see failure as a learning opportunity, especially in mathematics. Growth mindset motivation needs to be presented visually, such as through infographic posters, as this approach is not only instructive but also challenging, emotional, and engaging for learners (Cheng et al., 2021). Infographic posters can motivate learners to develop growth-mindset behaviours by prompting them to reflect on their learning styles, affirm their efforts, and shift their attention from learning outcomes to learning processes (Cheng et al., 2021; Rhew et al., 2018; Sheffler & Cheung, 2024). Besides, infographic posters can facilitate self-understanding and provide new frameworks for understanding learning processes by using growth-mindset concepts (Cheng et al.,

2021). Therefore, this research focuses on the process of developing posters designed to change a fixed mindset to a growth mindset in mathematics learning.

Research Method

The product in this study was developed using the three-step 'Analysis, Design, and Develop' (ADD) method (Branch, 2010). These were conducted by planning the growth mindset to be integrated in mathematics learning work sheets in the following phases: 1) Analysis; conducted by mapping the growth-mindset aspects: neuroplasticity, learning from mistakes; and feedbacks, in topics of mathematics learning; 2) Planning the poster design, i.e. determining the aspects such as visual, message, purpose, and contexts; and 3) Develop, i.e. producing the posters in line with the determined design to produce the six themes of introduction to the growth mindset principles, learning, challenges, failures, efforts, and successes in the contexts of mathematics learning. Subsequently, experts validated whether the narration and visuals of the growth mindset intervention in mathematics learning topics were expected to improve motivation.

Results

Analysis

It has the potential to bring about PoPositive changes in mathematics learning, enabling teachers to reduce feelings of frustration toward mathematics and simultaneously improve learners' achievement (Boaler, 2019; Canning et al., 2022). (Baldwin, 2019; Porter et al., 2022; van Hoeve et al., 2023) showed how the mindset influences learners' motivation to continue learning. This is supported by Samuel & Warner (2021) and Van Hoeve et al. (2023), who stated that, with a growth mindset, it is possible to maintain strong motivation to learn, resulting in learners achieving better learning outcomes than those with a fixed mindset. Learners who see intelligence as something that can be developed tend to be more involved in their learning activities and highly challenging mathematics tasks. The message that can shift a fixed mindset to a growth mindset can motivate learners to see challenges as opportunities and failures as starting points for growth, helping them appreciate processes and effort (Cheng et al., 2021; Lee et al., 2022; Mills & Mills, 2018).

In the present study, the growth-mindset intervention was delivered through infographic posters that emphasised visual aspects (Cheng et al., 2021). Planning was carried out by designing motivation in the form of a growth mindset in mathematics learning. The message in the motivation-based infographics, according to Van Hoeve, Doorman, and Veldhuis (2023), included the three aspects, namely: (1) neuroplasticity, (2) learning from mistakes, and (3) feedback. The posters presented themes based on the study by Cheng et al. (2021). The message in the poster aimed to shift the fixed mindset toward the growth mindset, as it was expected to influence learning achievements (Bostwick & Becker-Blease, 2018). Meanwhile, the presented contexts were related to mathematics learning. Cheng et al. (2021) stated that the infographic poster served to prompt learners to reflect on their motivation to learn and to introduce fixed and growth mindsets.

Design

A set of infographics was developed on topics such as “learning”, “challenges”, “failures”, and “efforts”. The narration and visual pictures were developed based on, and as modifications of, existing growth mindset theories and interventions (for example, Dweck, 2000, 2015; Paunesku et al., 2015; Yeager et al., 2016) to ensure that the infographics can communicate abstract ideas clearly (H. Bicen & Beheshti, 2017). For instance, the quotation on the theme “learning” was derived from a mindset intervention experiment by Blackwell and colleagues (2007) that compared the brains and muscles that could be trained through sports exercises. For the theme “challenges,” Dweck's (2015) quotation was selected to prompt mindset development. For the theme “failures”, the theory by Hymer, B. & Gershon, M.(2014) was quoted concerning failures as parts and experiences in one’s learning.

Table 1

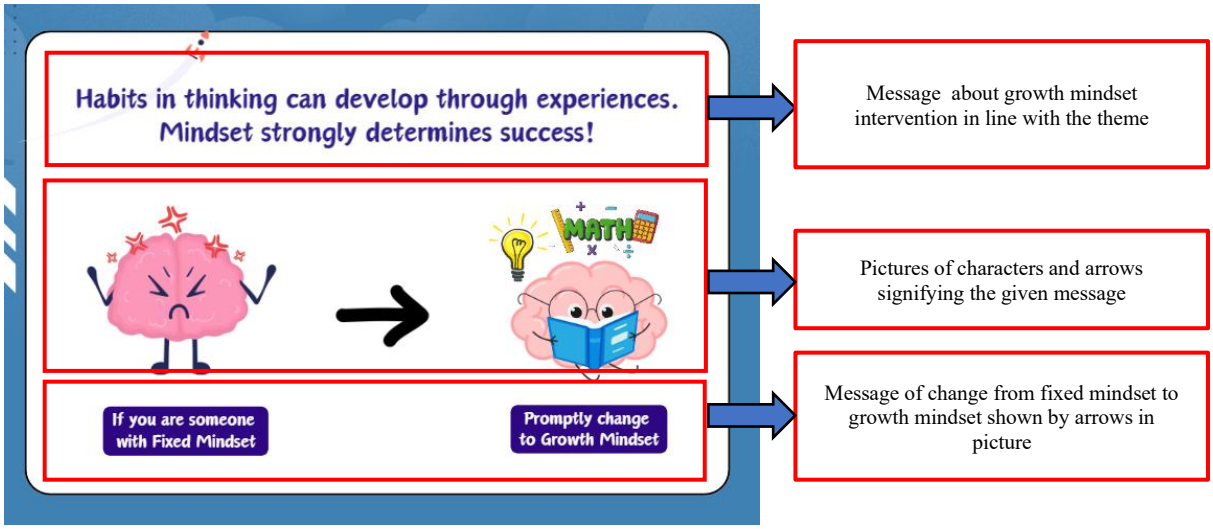
Aspects of Designing Growth Mindset Posters in Mathematics Learning

No	Design	Aspect	Contents
1.	Developing visuals that convey messages in posters.	Visual	Pictures of characters and arrows.
2.	Developing growth-mindset intervention messages in line with the identified themes.	Message	Persuasive sentences with a growth mindset intervention.
3.	The presented messages contain existing mindset themes.	Theme	Messages containing growth-mindset themes from previous research.
4.	Ensuring the developed messages incite learners to change from fixed mindsets to growth mindsets.	Purpose	It contains a narration of the flow of the change from fixed mindsets to growth mindsets.
5.	The presented messages relate to mathematics learning.	Context	Mathematics learning.

Finally, the developed poster design must meet the specified aspects.

Figure 1

Mindset Introduction poster.

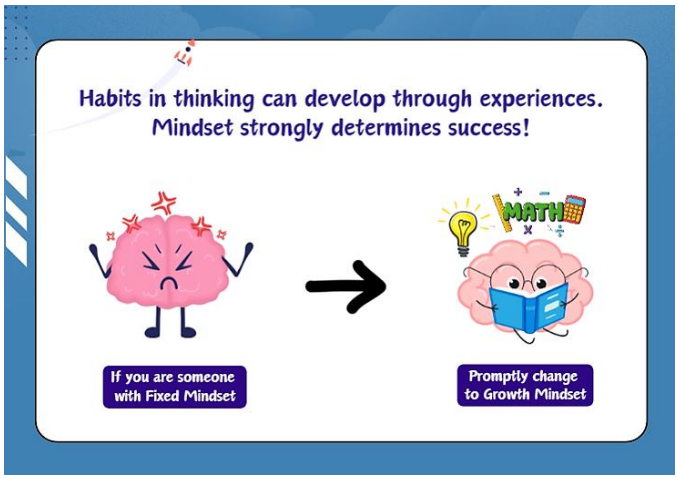


Results

Prior to the presentation of the growth mindset posters, it is important to introduce the principles of the mindset, as in Figure I. Introduction to the concepts of the mindset is done by describing thinking habits and a new conviction resulting from understanding that the growth mindset is superior to the fixed mindset in terms of meaning and values. Hoeve et al. (2023) stated that growth mindset principles can lead learners to put more effort into learning, reduce frustration, and increase learning achievement.

Figure 2

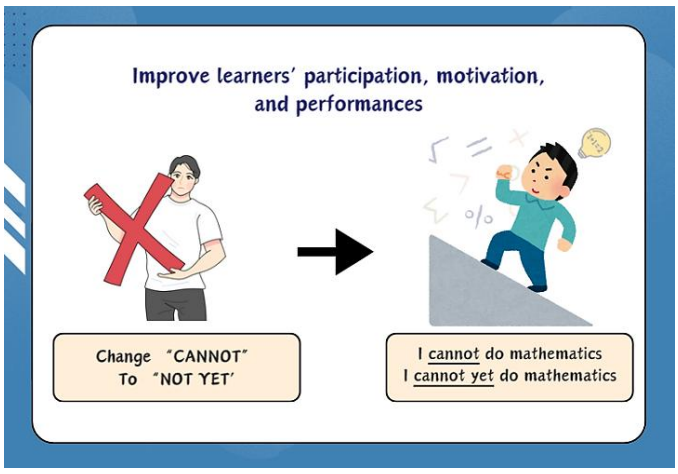
Learning poster



The info: an infographic poster in the “learning” theme can be interpreted as a trial-and-error process, i.e., learning by trying and revising in response to errors until success is achieved. In addition, learning can be obtained from: 1) individual growth and learning from experience, which shows that everybody can grow and learn from their experiences; 2) changing thinking habits for better learning, i.e. prior experiences form thinking habits, which can be changed to support better learning. This means that skills can be stronger if they are continually practised. Subsequently, the poster with the theme “challenge” is presented, showing how learners can face challenges as opportunities to learn and grow mentally stronger.

Figure 3

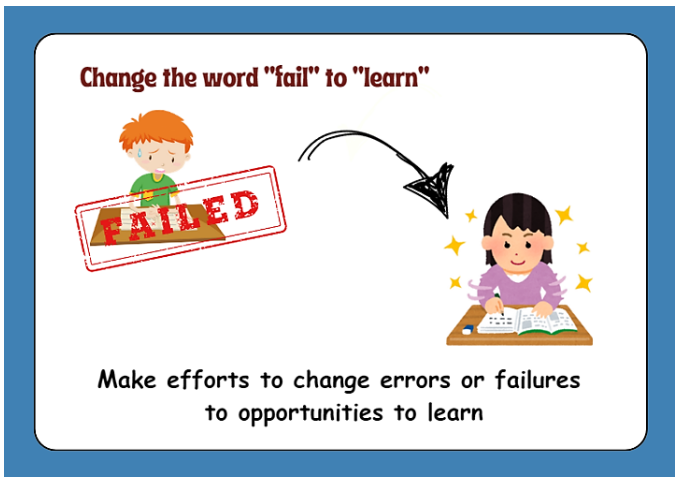
Challenge poster



The challenge poster emphasises the importance of persistence and the potential it offers. Learners are encouraged to add “not yet” when they are doubtful about their abilities, in order to help them know their potential to grow and achieve logical purposes. Within the context of mathematics learning, this intervention can improve learners’ participation, motivation, and performance. For example, mindset-oriented teaching interventions can influence the learners’ mindset, performance, and motivation in mathematics learning. Besides, this technique can also help learners see challenges as exercises or practices that test and broaden their experience, preparing them to be successful in the future. With that, this intervention aims to foster learners’ persistence and positive attitudes towards challenges, which ultimately increase their motivation and achievement.

Figure 4

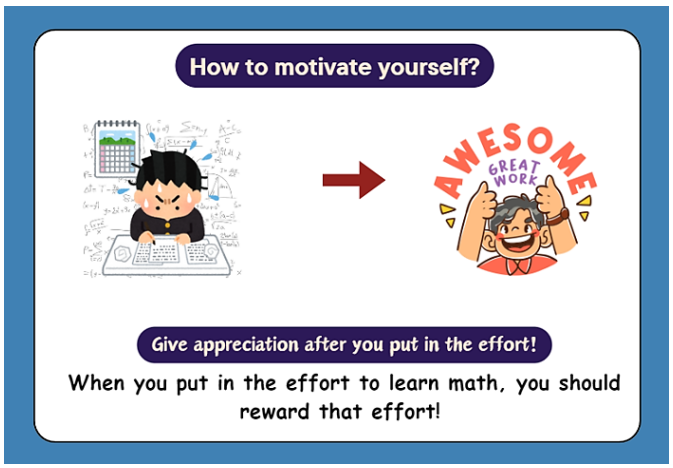
Failure poster



The failure theme needs to be posted because failures are often seen as negative, whereas in growth-mindset contexts, they should be regarded as opportunities to learn and grow. The messages that must be conveyed in the poster must show that failures must not be taken as inabilities or doubts, but, on the other hand, as important parts of one’s personal growth. Failures and learning must be seen as interrelated; failures must not be seen as ‘ugly words” in life, but as inevitable and important parts of life. The growth mindset intervention, which focuses on failures in mathematics learning, must include instruction that errors and failures are part of the learning process and can become opportunities for learners to improve and deepen their understanding. In this context, learners must be told that intelligence can grow and that failures are a means of improving performance, not a mark of weakness. Besides, this intervention can increase learners’ participation, motivation, and performance in mathematics learning by changing their attitudes to challenges as opportunities to learn and grow (Boaler, 2019; Bostwick & Becker-Blease, 2018; C. S. Dweck, 2006; van Hoeve et al., 2023).

Figure 5

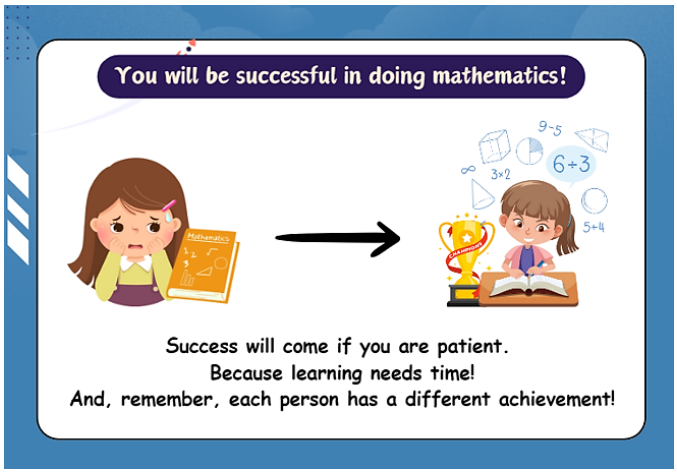
Effort poster



The poster with the effort theme emphasises the importance of consistent effort as a key component of success. The poster also emphasises that without motivation and adherence to punctuality, persistent effort can lead to burnout and, ultimately, a fixed mindset in an individual. Therefore, the presented material must warn learners to acknowledge and appreciate their own efforts, regardless of the outcome. Appreciation not only provides psychological satisfaction to learners but can also be seen as validation of one's efforts. Learners are told that with their effort and persistence, they can overcome challenges and improve their mathematical competencies. Besides, when learners understand that intelligence can grow, they learn that effort is a way to improve performance and abilities in mathematics. (Dweck, 2000; Hoeve et al., 2023).

Figure 6

Success poster



Moreover, successes are interrelated in the context of the growth mindset. Success must not be seen as a result of competition with others, but it must be seen as a result of one's own efforts and persistence to achieve the determined objectives. Success is supported by one's intention to realise a determined objective and not to defeat others. In this way, success in the growth mindset is interrelated with one's self-awareness of learning interests and styles, and with the conviction that success will come as time passes. Success must not be seen as competition to defeat others, but rather as the result of following the curve of one's patient learning. Success is driven by the intention to achieve desired results,

not by the wish to beat others. To understand this, learners need to develop the self-awareness that success will ultimately come to them (Cheng et al., 2021).

Discussion

Developing growth mindset infographic posters in learning is important because they can be designed to improve learners' motivation and positive attitudes toward mathematics learning. The present study produced a set of growth-mindset infographic posters designed to communicate key principles, including effort, learning from errors, and the brain's ability to grow. The Results section showed that the posters were designed to counter fixed-mindset beliefs by presenting messages aligned with the core values of the growth mindset. This output becomes the basis for discussing how such posters can support mathematics learning. The growth mindset is also related to the development of important competencies such as resilience and persistence in mathematics learning. By telling learners that intelligence can grow and that effort is a way to improve performance, learners will be more open to challenges and learn from errors (Vestad et al., 2023). Cheng et al. (2021) showed that infographics can motivate learners and help them overcome frustration in mathematics learning. Learners shift their focus to the learning processes rather than merely on results and scores. The messages on the developed posters change learners' perception of failure as hopeless. Learners can see challenges as opportunities to grow and develop. The poster developed is designed to help students understand that failure is not inherently negative but part of the learning process that must be overcome to achieve success. This infographic poster includes images and a short message for students to read before completing the math task assigned by the teacher. This media provides a new frame of mind for students when interpreting mistakes, encouraging more positive attitude changes and supporting the learning process in mathematics.

Mills et al. (2018) showed that a brief intervention may produce positive changes and that teachers must convey to learners that errors and effort are part of learning and that intelligence can grow from effort. Blackwell et al. (2007) conducted an intervention to improve learners' growth mindsets and found that learners in the experimental group showed higher intrinsic motivation than those in the control group. This finding has been supported by other intervention studies, which have shown that a growth mindset helps maintain learners' high motivation in mathematics learning (Priess-Groben & Hyde, 2017). Van Hoeve et.al. (2023) mentioned the three spect of the growth mindset, namely: (1) neuroplasticity, (2) learning from mistakes, and (3) feedback. Neuroplasticity is the brain's capacity that enables dynamic growth and opportunities to learn new things. Facilitating students to reverse from fixed mindsets to growth mindsets by conveying messages that human brains are identical with human muscles in that they grow stronger with continual exercises and practices can ultimately improve self-efficacy (Lee et al., 2022; Samuel & Warner, 2021).

The second aspect is learning from mistakes. When learners face mathematical problems and make errors, learners with a growth mindset will show more active brain processes than those with a fixed mindset (Van Hoeve et al., 2023). Learners with a fixed mindset, however, when they face a difficult task, tend to think they are not smart and that maybe their friends and teacher know this. This may cause anxiety, which can consume working memory resources and, subsequently, slow the process of solving mathematical problems (Szczygieł, 2021). In the end, this problem is fixed in the learners' brains, and they will not try to solve it optimally. This is different from learners with a growth mindset in that they will use errors as learning opportunities to improve their learning and achievements.

The third aspect is feedback. This relates to responses teachers give to learners, usually during or at the end of the lesson. Teachers need to consider techniques for giving feedback to learners, not only on language choices but also on how feedback is delivered, especially when learners make mistakes (Van Hoeve et al., 2023). Teachers' mindsets and attitudes certainly influence how they deliver feedback to learners. Teachers with a growth mindset tend to focus on the processes learners use when doing mathematics tasks, since they believe learners' performance can be developed (Dweck, 2006). Meanwhile, teachers with a fixed mindset will tend to see learners' intelligence and talents as fixed, so their performance and abilities do not develop (Dweck, 2006). Teachers must adopt the position that learners can give their own feedback, since appreciating their achievements will improve their tenacity and motivation to learn mathematics. During class activities, when there is a negative comment from a student with the fixed mindset "I give up; this is too difficult", the teacher must respond like "Let us focus on the first item and do it step by step according to the procedure", so that self-efficacy can occur (Hoeve et al., 2023). As a whole, growth mindset interventions, such as infographic posters, can improve learners' motivation and encourage them to work harder, as they know that mathematical abilities can be developed through persistent effort and practice. It is therefore understood that a growth mindset intervention, such as infographic posters, is appropriately needed in mathematics learning.

Although this study has fulfilled the research purposes pre-determined in the earlier section, some limitations can be observed and reported. The study has focused on the development of infographic posters or growth-mindset interventions that have not been tested on students for construct validity and reliability. Further studies are needed to assess construct validity and reliability, examine the long-term impacts of the intervention, and investigate the cause-and-effect relationships of delivering infographic posters for the growth-mindset intervention, in order to accrue results with more empirical data.

Conclusion

Developing infographic posters that promote a growth mindset in mathematics learning is very important because it has the potential to increase student motivation and perseverance. Infographic posters that convey a shift from a fixed to a growth mindset can influence students' mindsets during the learning process. The resulting poster is based on mindset theory, which emphasises that strengthening a growth mindset can increase students' learning resilience. This study produced a growth mindset poster media developed using the ADD (Analysis-Design-Development) model. Unlike previous studies that were general in nature, the poster development in this study was specifically aimed at learning mathematics, so that the messages displayed were relevant to the challenges that students often face when solving math problems.

The development results show that the growth mindset posters produced are easy to understand and feasible to use as learning support media. This poster serves as a priming mindset that helps students develop a positive perception of difficulties, encouraging effort, appropriate strategies, and perseverance when solving math problems. Thus, this research contributes to the development of theory-based visual media that teachers can use to develop students' growth mindsets in mathematics classes

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Disclosure statement

The authors declare no conflicts of interest.

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