Resilience for lifelong learning and well-being

Strengthening individual and community resilience has been prioritized by the World Health Organization to promote a global and sustainable approach to both individual and community health and well-being. Schools have the capacity to promote the resilience of children and adolescents through different strategies, enhancing cognitive abilities that contribute to overcoming adversity.

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Executive Summary

- Resilience is the ability to cope and thrive in the face of negative events, challenges or adversity.
- Neural circuitries within the brain appraise which experiences are stressful, taking into account experiences and emotional states, and consequently direct behavioural and physiological responses.
- Response to stress and trauma takes place in the context of interactions with other human beings, available resources, specific cultures and religions, organizations, communities and societies, meaning that each of these contexts may cause the same stressor to be experienced with more or less resilience in each person, in each particular environmental situation, and according to their developmental stage.
- Key attributes of resilience in children and adolescents include social competence, a sense of agency or responsibility, optimism, a sense of purpose or hope for the future, attachment to family, school and learning, problem–solving skills, effective coping mechanisms, pro–social values, a sense of self–efficacy, and positive self–regard.
- In a healthy environment, exposure to enriching environments or positive experiences contribute to the construction of resilience.
- Executive functions such as attention, problem solving and decision making contribute to greater resilience, being the most efficient means of overcoming adversity.
- Pedagogical strategies intended for promoting these cognitive and behavioural characteristics may contribute to strengthening resilience during schooling.

Introduction

The concept of resilience is increasingly invoked in academic discourse and among professional bodies, business institutions, human rights and civil society organizations, and a wide range of policy sectors. Since the endorsement of Horizon 2020, strengthening individual and community resilience has been prioritized by the World Health Organization to promote a global and sustainable approach to both individual and community health and well-being[1]. Resilience plays a prominent role in effectively all the Sustainable Development Goals[2]. Sustainable development requires sustainable societies, which in turn entail both individual and community health and well-being.

Available data suggest that approximately 16% of children and adolescents experience mental health problems, depression is one of the leading causes of illness and disability among adolescents, and suicide is the third leading cause of death in 15-19-year-olds worldwide[1]. The consequences of failing to address adolescent mental health conditions extend into adulthood, impairing both physical and mental health and limiting opportunities to lead fulfilling adult lives[3-5]. Despite the concurrence of multiple factors that determine mental health outcomes, one of the crucial aspects for individual and community health and well-being is resilience, which is related to the processes and skills that help in overcoming negative events, threats, hazards and traumas[6-9]. It is also instrumental in avoiding burnout; a state of emotional, physical, and mental exhaustion caused by excessive and prolonged stress which is often reported among students as well as teachers and educators[10], despite most studies focusing on health care professionals[11-13].

One of the first works that highlighted the importance of resilience in people's life trajectory dates back to 1971, when a longitudinal study of children from the Hawaiian island of Kauai was published[14]. The sample consisted of a cohort of children born in 1955 under particularly difficult or even traumatic environmental conditions. Nevertheless, about one third of children that grew up in those difficult and traumatic situations became adults considered by others to be competent, self-confident, autonomous and effective. This seminal study launched 50 years of study in this new field of research called "resilience", which was initially included in the field of positive psychology, a subfield of psychology that is usually defined as the study of positive emotion, positive character and positive institutions[15].

From the educational point of view, resilience is both a skill and a biological trait (see below for a discussion on this issue) that boils down to perseverance and grit, the emotional characteristics of successful learning, and it is essential for keeping learners engaged in learning. Perseverance can be defined as persisting in doing something despite difficulty or delay in achieving success. People who persevere face obstacles as hurdles to be overcome on the way to growing up. It is

an attitude that equates challenges to opportunities that make you better and stronger once you have dealt with them. In other words, it equates to growth mindset. Psychological relationships between these three characteristics (i.e. resilience, perseverance and grit) have been reported in young people recruited from a student population, in relation to pain thresholds and tolerance, as well as to optimism[16].

In this brief, the importance of resilience for learning as well as for lifelong learning will be examined, in relation to well-being. First, it will address definitions of resilience and the discussion about whether it is a personality trait or a skill. Then, neural correlates of resilience will be examined in relation to adversity management. Finally, prospects for cultivating resilience during childhood and adolescence will be advanced.

What are resilience and well-being?

The term *resilience* is used to describe and explain the complexities of individual and group responses to traumatic and challenging situations[17]. It was first used in the 1620s, meaning "the act of rebounding", and in the 1640s to mean "springing back"[18]. Resilience derives from the Latin word "resilire", which means "to recoil or rebound". By 1824, the term had developed to encompass the meaning of "elasticity", and by the mid-nineteenth century, *resilient* emerged as a technical term in the watchmaking industry, referring to flexible qualities of internal components that prevented excessive vibration. In the 1850s, the word resilient was used to describe being resistant or not susceptible to something. Since 1973, resilience has also been widely used in ecology[19] to describe the capacity of an ecosystem to respond and adapt to a perturbation or disturbance by resisting damage and recovering quickly.

Individual and social resilience and well-being

The American Psychological Association defines resilience at the individual level as the process of adapting well in the face of adversity, trauma, tragedy or threat. It also includes coping with significant stress caused by problematic and toxic relationships in the family or workplace and the capacity to bounce back from difficult experiences[20]. Similarly, community resilience is defined as the ability of social groups to withstand and recover from unfavourable circumstances. In the literature, community resilience is usually associated with social relationships and the activation of local resources that enable communities to cope with, counteract and anticipate unhealthy stressors[21,22]. The latter may include social and economic stressors such as poverty, natural disasters, isolation and other unfavourable circumstances. Community assets such as solidarity and mutual trust among members, strong social networks and other salutogenic resources have been proved to be factors that both protect and promote individual health and well-being[17].

While these definitions are broadly useful, they do not reflect the global and complex nature of resilience, as has been discussed by several authors[23,24]. Other, simpler definitions that may be useful to capture the complexity of resilience include, a stable trajectory of healthy functioning after a highly adverse event[25,26], a process of harnessing resources to sustain well-being[27] and a dynamic process allowing for positive adaptation in a context of significant adversity[28], among others[24].

However, some individuals, including children and young people, are more resilient than others. In this regard, it has been reported that a positive personality, including dispositional optimism, life satisfaction and a generalized self-efficacy belief, is a predictor of high resilience in adolescents[29]. From an educational perspective, those individuals with higher resilience are more likely to thrive in their learning, as they will have more facilities to overcome difficulties and learn from mistakes, and less likely to suffer from social or psychological health problems[30].

In this context, the term well-being[31] (or student well-being) is now frequently used in education circles, tending to replace terms such as "student welfare" or "student health". This term has been adopted because it encompasses more than the notion of physical and mental health, referring to the interconnected nature of social, relational, mental, physical and material health, as well as the experience of engagement in life and in learning[32]. In the educational context, well-being has been identified as both an outcome and a process which facilitates children's and adolescents' progress towards learning and development outcomes. Some studies have investigated what adolescents regard as influencing their overall sense of well-being[33]. A range of factors are perceived by adolescents to be important, including physical and emotional health and safety, confidence in their own capabilities, pleasure and joy in learning, satisfying relationships, inner strength and a sense of interconnection, and overall satisfaction with life. It is worth noting that, although individual resilience may be related to social resilience, there is not a straight link between them. An individual can be highly resilient in a non-resilient social environment, and vice versa.

Resilience as both a biological trait and an educational skill

Coming back to resilience, it has been considered important to specify whether it is being viewed as a trait, a process, or an outcome, and it is often tempting to take a binary approach in considering whether resilience is present or absent[34]. However, in reality, resilience is more likely to exist on a continuum that may be present to differing degrees across multiple domains of life[35] as a trait, a process and an outcome, and importantly, interlaced with everyday life[36]. Several reviews have explored resilience in various contexts, for example, in the workplace[37], in the mental health setting[38] or around family[39]. From the educational point of view, one crucial question is whether resilience is a personality trait or a skill, that is, if it is unchangeable or can be potentiated through educational intervention (and if so, also by therapeutic intervention)[40]. Several studies suggest that resilience is partially a trait related to the 5 factors of the Big Five personality traits model[41]. In this regard, it has been negatively related to neuroticism and positively related to openness, conscientiousness and extraversion[42], as well as to agreeableness[43,44].

Genetic, neuroendocrine and immune factors have also been related to the resilience of individuals[45]. In this regard, heritability of resilience has been quantified at 52% for males and 38% for females, and heritability of emotion-oriented coping as a strategy used to manage adversity at 14% and 11%, respectively[46]. It is worth noting that just because something is *heritable* does not necessarily mean that it is not changeable. Heritability, as a statistic, captures the proportion of variability associated with genetic variation among individuals in a population[47]. Thus, resilience and emotion-oriented coping may be considered, at least in part, biological traits based on genetic background. It is worth noting that there are sex differences in resilience, which are probably due to the interaction of sex hormones with other genetic networks[46]. This fact, that highlights the biological nature of resilience, should not be interpreted as meaning that males tend to be more resilient than females, but that, on average, environmental factors tend to be more influential in females than in males. It has been argued that self-acceptance is one of the most important aspects that may account for these differences[48].

However, other results suggest that resilience is also a dynamic skill. There are five main arguments: (1) resilience skills may degrade following accumulated trauma, which is called the sensitization mechanism[49]; (2) some individuals are better able to support accumulated traumatic episodes, suggesting an improvement in resilience skills, known as the immunization mechanism[25,50](see below for educational proposals to improve resilience, based on this mechanism); (3) resilience seems to be reinforced by some therapeutic approaches[51,52]; (4) empirical evidence shows neuronal plasticity, for example, thickness in the right temporal lobe, after some traumatic events such as the 2004 Indian Ocean tsunami[53], and (5) some empirical evidence shows effects of the family environment on the resilience of offspring through environmental transmission[54-56]. However, it is worth noting that in most cases the direction of causality may not be established with certainty[57]. Summarizing, despite resilience being partially a trait, it is also a skill that can be taught and enhanced through educational interventions. This has led to the so-called "three-hit concept of vulnerability and resilience"[58], including hit-1) genetic predisposition, hit-2) early-life environment and hit-3) later-life environment, which accommodates to cumulative stress, the hypothesis stating that in a given context vulnerability is enhanced when failure to cope with adversity accumulates.

Although the relatively high heritability of resilience as a trait, it is not a fixed value for each person, but a dynamic characteristic that may change over time as a function of development and one's interaction with the environment. For example, a high degree of maternal care and protection may be resilience-enhancing during infancy but may interfere with individuation during adolescence or young adulthood[59]. In addition, response to stress and trauma takes place in the context of interactions with other human beings, available resources, specific cultures and religions, organizations, communities, and societies[60,61], meaning that each of these contexts may cause the same stressor to be experienced with more or less resilience in each person and in each particular environmental situation, depending also on their developmental stage. For example, works on enhancing resilience behaviour among, let's say, Tanzanian primary-school students may be ineffective in other contexts[62]. Thus, works on resilience made in a specific cultural or socioeconomic context may not be directly extrapolatable to other contexts, although general strategies to enhance resilience focus on the same global issues (see discussion below). Moreover, there are vast individual differences in appraisals of stressors, which makes that the same thing that is extremely stressful to one person might be a minor nuisance to another.

Measuring resilience

It is also important to note that one of the major difficulties lies in the quantification of resilience. Reviews cover the use of six main scales[57,63], which include factors related to the individuals, their social and family environments, and the notion of acceptance: the Brief Resilient Coping Scale (BRCS) which describes resilience as a single-factor concept; the Resilience Scale for Adults (RSA) that includes 6 factors; the Resilience Scale (RS) which considers 2 factors; the Adolescent Resilience Scale

(ARS) describing a 3-factor concept; the Baruth Protective Factors Inventory (BPFI) that contains 4 factors, and the Connor-Davidson Resilience Scale (CD-RISC) which consists of 5 factors. It is not the aim of this brief to analyse the pros and cons of these scales but to highlight that this variety of measurement methods parallels the imprecision of the theoretical framework of this issue, which does not detract from the importance of resilience for the well-being and personal and educational progress of students.

Since the concept of resilience comes from studies of stress and trauma, all these scales describe the cognitive and behavioural strategies that individuals adopt to cope with trauma and stress. Similarly, when looking at the various measures of resilience, in most cases they evaluate the ability of individuals to build social networks, to lean on their family and friends, to find the capacity to plan their future, to have a better perception of themselves, to accept what has happened to them and to restructure their lives following a traumatic event, as these factors are considered central to resilient behaviours[64].

From adversity to neural networks for resilience

One of the main consequences of adversity, negative events and trauma, is stress. Stress, a physiological response to potential threat, may cause feelings of anxiety and frustration because of the threat to one's security or push one beyond the ability to successfully cope. Besides time pressures and daily hassles at school, at home and in other contexts (as well as in the workplace for adults), stressors have also been described in relation to economic insecurity, poor health, dangerous and noisy neighbourhoods, interpersonal conflicts such as bullying, etcetera. They also arise from situations that are life threatening, such as accidents, natural disasters and violence, and evoke the classic "fight-or-flight" response[65]. The fight-or-flight response is a physiological reaction that occurs in response to a perceived harmful event, attack, or threat to survival, preparing the body to either stay and deal with the threat or to run away to safety. When stressors are acute, or a traumatic situation has been experienced, they may lead to chronic stress and may also cause post-traumatic stress disorder in the aftermath of a tragic event[66]. Neural circuitries within the brain appraise which experiences are stressful, taking into account experiences and emotional states, and direct behavioural and physiological responses accordingly[67]. Concomitantly, the brain changes under acute and chronic stress due to neural plasticity, and directs many systems of the body—neuroendocrine, autonomic, metabolic, cardiovascular, and immune—that are involved in the short- and long-term consequences of the daily experiences of living[68]. This is not, however, and out-of-control process, as relatively simply techniques like reappraisal may contribute to redirecting responses.

The word, stress, may be somewhat ambiguous. One way to reduce ambiguity is by classifying stress in three categories, namely good stress, tolerable stress and toxic stress[69]. "Good (or positive) stress" refers to the experience of rising to a challenge, taking a risk, and feeling rewarded by an often-positive outcome. Even adverse outcomes can function as growth experiences for individuals with healthy self-esteem and good impulse control and decision-making capability, which are part of the so-called executive functions. "Tolerable stress" refers to situations where negative events occur, but the individual with healthy brain architecture is able to cope, often with the aid of family, friends and other individuals who provide support. Finally, "toxic stress" refers to situations in which negative events, adversity or trauma are experienced by an individual who typically has limited support and may also have brain architecture that reflects the effects of adverse early life events that have impaired the development of impulse control and adequate self-esteem[70].

The type, timing, intensity and duration of adversity influences the dynamic nature of resilience. The most well-researched types of adversity are childhood exposure to trauma and socioeconomic adversity. Exposure to childhood trauma, either physical, sexual and emotional abuse or physical and emotional neglect, has been shown to reduce resilience in a representative community sample spanning the ages from mid-adolescence to elderly, and resilient coping has been associated with reduced distress, mediating the relationship between adversity and distress[71]. Evidence from diverse studies indicates that adversity producing resilience is commonly either threat- or deprivation-related[64,72]. To counteract impact of adversity, adaptive shifts made across multiple systems to match internal functioning to external or environmental demands within both the brain and stress systems are produced, which are at the core of this adaptation[73].

One of the first early-life stresses comes from mother-baby interactions. Animal modelling has described different kinds of mother-pup interactions generating stress and affecting resilience, such as neonatal handling and maternal separation[74], naturally occurring variations of maternal care[75] and exposure to moderate postnatal stressors[76], among many others (see [58] for a comprehensive review).

In humans there is convincing evidence that traumatic stress, especially during early life, is a major risk factor for the development of almost all psychiatric disorders, including post-traumatic stress disorder[77], major depressive disorder[78] and

schizophrenia[79]. Despite decades of research, it is currently not known which combinations of stressful life events are the most etiologically relevant to predict the development of psychopathology nor how stressful events interact at different periods of life, although adversity related to the maternal environment can predict alterations in social behaviour, susceptibility to drug abuse, decreased capacity for learning and memory as well as decreasing resilience during later stages of life[58]. What is important to this review, however, is that resilient people are much less prone to suffering from these conditions[80], which fully justifies the importance of promoting an educational environment that fosters resilience.

Despite all the environmental influences, resilience clearly has neurobiological, cognitive-behavioural, emotion regulatory, social and physical underpinnings[34,81,82]. However, how neurobiological and psychosocial factors influence each other to produce resilience is not fully understood. There is evidence that specific subtypes of childhood adversity mechanistically produce differential dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis and inflammatory system[83], and specific genes may be independently or collectively associated with physical abuse or physical neglect[69,84,85]. We know that it involves the cortico-limbic circuitry, which is implicated in the regulation of many processes such as stress, emotion and cognitive processing, and social behaviour. There are several brain regions that are known to be involved in resilient behaviours, although relationships between them are complex and not fully understood. In brief, structural and functional brain circuitries involved in emotion, stress and behavioural regulation as well as cognitive processes and social behaviour have been identified as the most important in the development and maintenance of resilience[86,87], including the anterior corpus callosum and anterior cortical regions that are involved in cognitive processes and the reappraisal of negative information[88,89], the amygdala and the prefrontal cortex[90], related to emotion regulation, the hippocampus[91], that seems to be an important brain region for resilience, and the ventral striatum, which coordinates multiple aspects of cognition including action planning, decision making, motivation, reinforcement and reward perception, and the ventral tegmental area[92], which is also involved in the reward circuitry of the brain.

Promoting resilience through education

As stated above, from an educational perspective, those individuals with higher resilience are more likely to thrive in their learning, as they will have more facilities to overcome difficulties and learn from errors[30]. Resilience is also a crucial factor in individual and community health and well-being, and as a skill it can be influenced through education[93]. In this regard, a meta-analysis of 49 different trials suggest most promise for using universal resilience-focused interventions at least for short-term reductions in depressive and anxiety symptoms for children and adolescents[94]. As resilience is a characteristic that can be increased through specific training[93-97], interventions could be planned to strengthen individual resilience in terms of a preventive perspective[62,98-102] and a positive psychology perspective[103,104], in order to promote individuals' subjective and psychological well-being. This is considered to be particularly important in adolescence as it is a crucial period in an individual's development[105,106], and focusing on well-being in adolescence can also promote health and well-being in adulthood[107]. Programmes that focus on promoting resilience and coping skills have been shown to have positive impacts on students' ability to manage daily stressors[108].

A constellation of psychosocial factors that span cognitive and behavioural domains affecting resilience in response to stress or trauma has been identified, including cognitive flexibility, emotion regulation, active coping skills and maintenance of supportive social networks which enhance well-being[109,110]. Strong emotion regulation skills that at a neural level include the cortico-limbic network[111] and parietotemporal regions[112,113], are considered to be fundamental to resilience. In this regard, cognitive reappraisal, which can be defined as the ability to monitor and assess thoughts, and replace negative thoughts with positive ones, are associated with resilience[114,115]. Similarly, it has been suggested that executive functions such as attention, problem solving and decision making contribute to greater resilience[116]. These cognitive abilities are the most efficient means of overcoming adversity, allowing the individual to continue functioning at an optimal level. Thus, generally speaking, pedagogical strategies intended for promoting and enhancing these cognitive and behavioural characteristics may contribute to strengthening resilience during schooling[93-97].

More specifically, in a healthy environment, exposure to enriching environments or positive experiences contributes to the construction of resilience. In this regard, "enrichment" generally refers to increases in the variety and/or amount of multisensory stimulation, with the goal being to elicit exploratory behaviour[117]. Animal modelling has shown that natural enriched environments and optimal early-life experiences build resilience via neurobiological changes[118,119]. In humans, healthy lifestyles, including adequate diet, physical activity and sleep, and supportive environments that provide a sense of security and belonging, self-worth, realistic appraisal of mastery and control from an early age, contribute to building and promoting resilience through neurobiological and psychosocial mechanisms[109,1120]. The receiving of support provides security and safety via activation of cortical regions that potentially inhibit the sympathetic nervous system and inflammatory processes[121], having significant implications for health and resilience[121,122]. Interestingly, it has been suggested that the giving of support

may be more beneficial than the receiving of support, as it reduces physiological responses to stress[123,124]. However, when allostatic load increases in response to adversity, bringing about variable impairment ranging from minimal and moderate to severe stress, resilience strengthening may be needed. In this regard, allostatic load is defined as the physiological consequences of repeated or prolonged chronic stress, and may lead to exhaustion, burnout and overload. Resilience strengthening involves the use of several strategies that may operate together, namely tempering, fortification and stress inoculation.

Tempering is a process of strengthening systems that enhance resilience. In this context the term tempering means to make stronger and more resilient through hardship[125-127]. Activated by adversity, tempering involves the re-engagement and refinement of these skills that are then used to both repair and strengthen stress-responsive systems and to optimize their functioning. Regarding fortification, it implies the cultivation of new related skills. For instance, early-life exposure to intermittent stress that is mild to moderate, controllable but challenging, may induce the so-called stress inoculation, which is thought to strengthen existing structures promoting resilience across multiple domains of adaptive functioning after adversity[58,62,108,128-132]. Animal modelling has shown that stress inoculation through either experience or learning acts like a vaccine on stress systems and emotion regulation, including the cognitive and social processes and subserving neural networks[133-135]. Exposure to early-life stress inoculation diminishes subsequent indications of anxiety, increases exploration of novel situations, decreases stress levels of cortisol and enhances prefrontal-dependent cognitive control of behaviour[135]. In this regard, one of the key features of resiliency training for people working in conditions where performance in the face of adversity is required, e.g., medical and military personnel, aviators, police, firefighters, etcetera, is controlled exposure to stress-related cues[136,137]. This means that exposure to high stress may fragment resilience, while sheltering from adversity may cause weakened development[128]. Moderate exposure, as for example through trial and error in the classroom, may provide an opportunity to experience and practice the control of stress-responsive systems. It is important to highlight that inoculation is only viable up to a mild to moderate stress threshold[64].

Thus, it is suggested that pedagogical development of resilience-promoting methods, fostering executive functions such as attention, problem solving and decision making for overcoming adversity and based upon evidence, are needed.

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