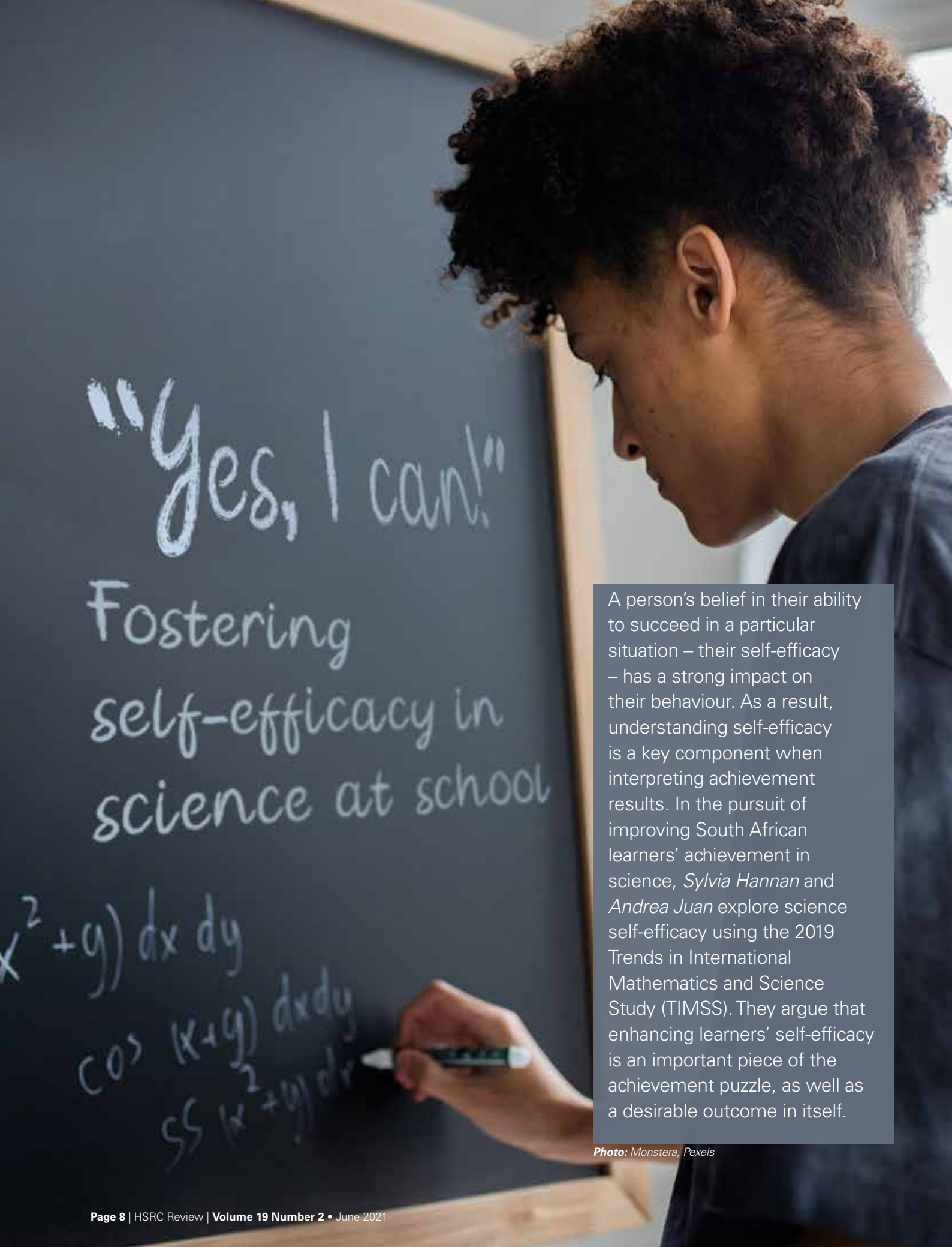


A person's belief in their ability to succeed in a particular situation – their self-efficacy – has a strong impact on their behaviour. As a result, understanding self-efficacy is a key component when interpreting achievement results. In the pursuit of improving South African learners' achievement in science, *Sylvia Hannan* and *Andrea Juan* explore science self-efficacy using the 2019 Trends in International Mathematics and Science Study (TIMSS). They argue that enhancing learners' self-efficacy is an important piece of the achievement puzzle, as well as a desirable outcome in itself.

Photo: *Monstera, Pexels*

Given the importance of science for the development of this country, it is concerning that limited numbers of South African learners are choosing to pursue science subjects in grades 10 to 12. In addition, the TIMSS 2019 results showed that South African learners performed poorly in science at the grade 9 level, which is the year before subject choices have to be made. A significant amount of research seeks ways to improve the quality of science education and increase science enrolments, by focusing on the cognitive determinants of science achievement. However, an area that is often missing in these studies is the role of non-cognitive psychosocial factors, such as self-efficacy. Science self-efficacy has an effect on learner motivation, thereby facilitating or hindering the learning process.

What is self-efficacy?

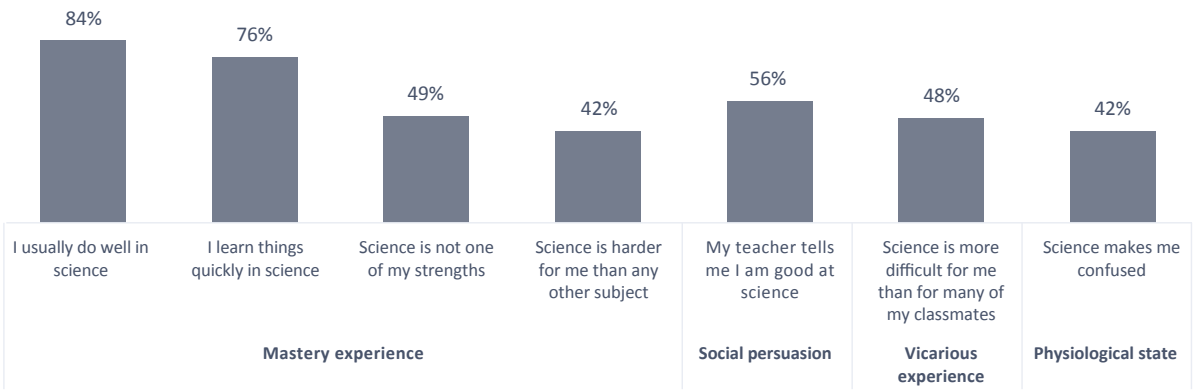
Self-efficacy relates to a person's belief in their ability to perform in order to reach specific goals. When applying this to school science, this belief affects learners' motivation, interest and performance in the subject. Efficacy beliefs therefore affect how much effort learners apply to an activity, how long they will persist when encountering obstacles, and how resilient they are when confronted with difficult problems. Individuals with high self-efficacy consider difficult tasks as challenges to be mastered, set themselves ambitious goals, maintain strong commitment, and increase or sustain their efforts when faced with failure.

Albert Bandura, the seminal writer on self-efficacy, offered some insight into the sources of self-efficacy, which he grouped into four categories: 1) mastery experiences – successful experiences boost self-efficacy, while failures corrode it; 2) vicarious experience – witnessing others similar to oneself succeed through sustained effort can translate to a belief that one has the ability to master similar activities; 3) social persuasion – persuading someone verbally that they have the capacity to master particular activities so that they are more likely to put in a sustained effort to succeed; and 4) physiological state – a positive mood can increase one's self-efficacy, while anxiety can reduce it. Mastery experience is the most robust source of self-efficacy. Using this theoretical framing, we used TIMSS 2019 data from 20 829 grade 9 learners to investigate their science self-efficacy and the relationship with achievement.

Science self-efficacy in TIMSS 2019

TIMSS learners completed a questionnaire that asked about their perceptions and attitudes towards science. Learners were scored according to their responses to eight statements that measured self-efficacy. The responses to the eight statements, categorised by the four sources of self-efficacy, appear in Figure 1.

Figure 1: Learners' agreement with science self-efficacy statements



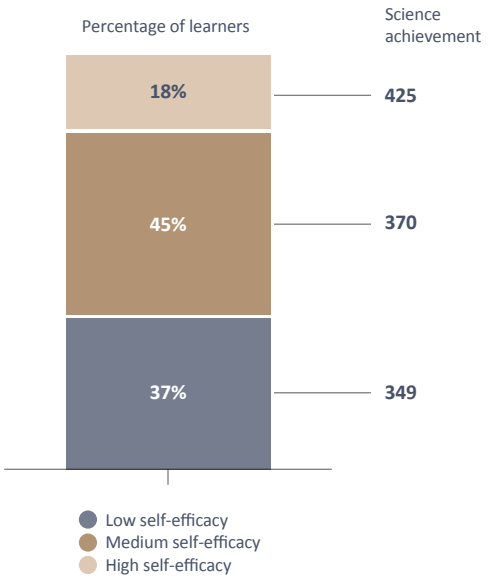
The statements that received the most positive responses were 'I usually do well in science' (84%) and 'I learn things quickly in science' (76%) and both relate to mastery experience. This is incongruent with the poor performance of the majority of learners in the TIMSS assessment. Only 36% of learners were categorised as 'proficient in science', suggesting a disconnect between perception and actual ability. However, the other five statements elicited more circumspect responses. Around half of the learners felt that science was harder for them than any other subject, and more difficult for them than for many of their classmates (vicarious experience), meaning that from observing peers performing tasks, they evaluated their own prospect of success as low. Understandably, 42% of learners experienced negative physiological states when doing science, having reported that science 'made them confused'. These findings are more consistent with performance – where 64% of learners were not proficient in the TIMSS science assessment.

The importance of educators as a source of social persuasion is also highlighted by the findings. Just more than half of learners (56%) received positive judgements from educators regarding their science capabilities. When many learners perform poorly, positive persuasion may be limited.

Self-efficacy and achievement

Learner responses to the self-efficacy items were combined to form a single self-efficacy scale – with categories of low, medium, or high self-efficacy. The percentage of learners in each category, as well as their average science achievement, are shown in Figure 2.

Figure 2: Self-efficacy and achievement



The average national TIMSS science score is **370 points**.

Almost one in five learners had high levels of self-efficacy, while about one in three were categorised as having low self-efficacy. Learners with high self-efficacy had higher average science achievement scores than those with lower self-efficacy. Grade 9 learners with the highest levels of self-efficacy performed 76 points above those with low levels, showing a positive and statistically significant difference. This suggests that generally, learners were able to honestly appraise their ability, which could be the first step towards identifying what is required to improve their achievement.

Fostering self-efficacy

Research has not determined the direction of association between self-efficacy and achievement. Does higher achievement lead to higher levels of self-efficacy, or is it the other way around? What the TIMSS results do show is that there is a positive, significant relationship between self-efficacy and achievement. The implication is that learners' science self-efficacy must be encouraged and nurtured and learners must be able to honestly reflect on their abilities. Beyond science achievement, self-efficacy should be a goal in and of itself as it influences an individual's effort, persistence and resilience, and therefore has a role to play in other aspects of life.

Based on Bandura's insights, we recommend that in order to improve self-efficacy, educators must promote repetitive problem solving activities until learners feel that they have mastered the subject matter (mastery experience); highlight the successes of learners in science tasks and emphasise how others could achieve the same success (vicarious experience); provide constructive feedback, guide learners through tasks and motivate them to try harder (social persuasion); and attempt to limit learners' anxiety around science tasks, such as exams and presentations, by minimising performance pressure (physiological states). Developing the necessary skills to encourage learners' self-efficacy, and their accurate self-reflection on their abilities, should form a core component of educator training programmes.

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