

Changes in General Self-Efficacy Among Middle School Students Learning Physics Following a Problem-Solving Strategy Program

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djharoun13@gmail.com**Abstract:**

Background. Self-efficacy beliefs are among the strongest motivational predictors of academic engagement and achievement, yet they are often fragile in physics, a domain dominated by multi-step problem solving. **Purpose.** This study examined whether an explicit problem-solving strategy program delivered within physics lessons was associated with higher general self-efficacy among third-year middle school students in Algeria. **Method.** A single-group pretest–posttest design was used with 35 volunteer students (third year of middle school; 20 girls and 15 boys) from a public school in Skikda Province. The program (20 sessions of 45 minutes over 8 weeks) taught a four-phase strategy (understanding and representing the problem, planning, solving, and evaluating) through worked examples, graded practice, and cooperative problem solving. General self-efficacy was measured before and after the program with the 30-item General Self-Efficacy Inventory (Maamriya, 2012; score range 0–90). **Results.** Scores rose from $M = 44.17$ ($SD = 6.79$) at pretest to $M = 66.11$ ($SD = 8.05$) at posttest, $t(34) = 11.87$, $p < .001$, $d_z = 2.01$, 95% CI of the effect size [1.42, 2.58]. Twenty-eight of 35 students moved to a higher self-efficacy level, and none moved to a lower level. **Conclusions.** The findings suggest that a structured problem-solving strategy program merits controlled evaluation as a way to support adolescents' self-efficacy in physics. Because the design has no control group, the results describe change rather than establish causation, and controlled studies are needed.

Keywords: problem-solving strategy; self-efficacy; physics education; middle school; social cognitive theory; pretest–posttest design; Algeria

Changes in General Self-Efficacy Among Middle School Students Learning Physics Following a Problem-Solving Strategy Program: A Single-Group Pretest–Posttest Study

1. Introduction:

Self-efficacy refers to individuals' beliefs about their capability to organize and carry out the actions needed to reach particular goals (Bandura, 1997). In educational settings, these beliefs influence the tasks students choose, the effort they invest, how long they persist when work becomes difficult, and how they interpret failure (Pajares, 1996; Zimmerman, 2000). Meta-analytic evidence links self-efficacy to academic performance and persistence (Multon et al., 1991), and reviews of the sources from which adolescents build these beliefs show that they are shaped largely by what happens in the classroom (Usher & Pajares, 2008). Self-efficacy is therefore not only an outcome worth valuing in itself but also a lever through which instruction can affect later learning.

Physics is a demanding context for the development of self-efficacy. Success in school physics depends on integrating concepts, mathematical operations, and multiple representations within tasks that rarely announce

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which principle applies. Research on expertise shows that novices tend to work from the surface features of a problem and to search for equations, whereas experts organize problems around underlying principles (Chi et al., 1981; Larkin et al., 1980). When students lack a dependable way to approach such tasks, repeated unsuccessful attempts deprive them of what Bandura (1997) identified as the most influential source of self-efficacy, namely mastery experiences.

One instructional response is to teach problem solving explicitly. Since Pólya's (1945) heuristic of understanding the problem, devising a plan, carrying it out, and looking back, a substantial literature has examined how structured strategies support novices (Gick, 1986; Mayer & Wittrock, 2006). In physics, strategy-based frameworks that require learners to build a qualitative representation before manipulating equations, and that are practiced in cooperative groups, have been shown to improve problem-solving performance (Heller & Hollabaugh, 1992; Heller et al., 1992; Reif & Heller, 1982), and syntheses of physics education research identify problem solving as one of the field's central areas of inquiry (Docktor & Mestre, 2014). By comparison, the affective consequences of strategy instruction, and self-efficacy in particular, have received less attention, especially with younger adolescents.

The Algerian context gives this question additional relevance. The competency-based approach adopted in Algerian schooling places the resolution of problem-situations at the center of learning, asking students to mobilize knowledge and skills to deal with tasks that are new to them (Roegiers, 2000). A strategy that makes the solution process visible and repeatable is congruent with this orientation. To the best of our knowledge, however, few empirical studies have examined whether such instruction is associated with changes in students' self-efficacy in middle school physics.

The present study addresses this gap. It examines whether the general self-efficacy of third-year middle school students differs before and after a problem-solving strategy program delivered in physics lessons, and whether any difference is practically meaningful.

2. Theoretical Framework and Literature Review:

2.1 Self-efficacy in social cognitive theory:

Bandura (1977) introduced self-efficacy as a determinant of the initiation and maintenance of coping behavior, and later embedded it in social cognitive theory, in which personal factors, behavior, and the environment influence one another reciprocally (Bandura, 1986, 1997). Four sources of efficacy information are distinguished: mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states. Mastery experiences are considered the most powerful because they provide direct evidence of capability, while observing similar others succeed, credible encouragement, and the interpretation of one's own arousal supply additional information (Bandura, 1997; Usher & Pajares, 2008). Recent reviews confirm the continuing centrality of the construct in research on motivation and learning (Schunk & DiBenedetto, 2020).

Self-efficacy is typically conceptualized as domain- and task-specific, and Bandura (2006) recommends that scales be tailored to the activity of interest. Broader dispositional measures of general self-efficacy have nevertheless been developed and used as indicators of overall confidence in one's ability to deal with demanding situations (Tipton & Worthington, 1984). The present study uses such a general measure, an issue we return to in the Limitations section.

2.2 Self-efficacy and achievement in science learning;

A meta-analysis of studies conducted between 1977 and 1988 found positive relations between self-efficacy beliefs and both academic performance and persistence (Multon et al., 1991). Pajares (1996) reviewed evidence that efficacy beliefs contribute to achievement independently of ability, and Zimmerman et al. (1992) showed that self-efficacy and personal goal setting were associated with students' academic attainment. Zimmerman (2000) further argued that self-efficacy operates as an essential motive to learn through its effects on goal choice, effort, and self-regulation. Because these relations are reciprocal, instruction that raises self-efficacy may create conditions for better performance, and improved performance may in turn raise self-efficacy.

2.3 Problem solving in physics

Problem solving is commonly defined as cognitive processing directed at achieving a goal when no obvious solution method is available to the solver (Mayer & Wittrock, 2006). Jonassen (2000) argued that problems differ in structure, ranging from well-structured tasks with a convergent answer, which characterize much of school physics, to ill-structured tasks that require judgment about goals and constraints. The origins of problem-

solving training as an applied approach lie in the model proposed by D’Zurilla and Goldfried (1971), which specified a sequence of orientation, problem definition, generation of alternatives, decision making, and verification. Pólya (1945) offered a more compact heuristic that has been widely adapted to school subjects.

In physics, expert–novice studies established why explicit strategy instruction is needed. Experts spend effort on a qualitative analysis of the situation and select principles before writing equations, whereas novices tend to begin with formulas and to classify problems by literal features (Chi et al., 1981; Larkin et al., 1980). Reif and Heller (1982) argued that effective problem solving depends on organized knowledge that is linked to explicit procedures for using it. Instructional models derived from this work, such as the cooperative-group problem-solving approach of Heller and colleagues, require students to visualize the situation, describe it in physical terms, plan a solution, execute it, and evaluate the result, and they compared favorably with unstructured individual work (Heller & Hollabaugh, 1992; Heller et al., 1992). Docktor and Mestre (2014), in a synthesis focused on undergraduate physics, likewise treat the design of problem-solving instruction as a major research domain.

Two theoretical arguments support explicit guidance for novice learners. First, unguided means–ends search during problem solving imposes a heavy cognitive load that can leave few resources for learning (Sweller, 1988). Second, reviews of instructional research conclude that minimally guided instruction is less effective and less efficient for novices than approaches that provide structure and support (Kirschner et al., 2006). The program examined here should be distinguished from problem-based learning, a broader pedagogical model in which students use complex, ill-structured problems to drive self-directed inquiry (Hmelo-Silver, 2004). It is a strategy-focused program that teaches a repeatable solution procedure for school physics tasks.

2.4 How strategy instruction may influence self-efficacy:

Social cognitive theory suggests several routes through which a problem-solving strategy could raise self-efficacy. First, a strategy that divides a task into manageable phases increases the likelihood of success, and graded practice supplies the accumulating mastery experiences that build efficacy (Bandura, 1997). Second, worked examples and cognitive modeling allow students to observe the solution process, and modeling of solution operations has been shown to increase children’s self-efficacy and skill (Schunk, 1981). Observing peers who are similar to oneself succeed can raise observers’ self-efficacy and achievement (Schunk & Hanson, 1985), which is relevant when students solve problems in groups. Third, the phases of a strategy operate as proximal subgoals, and attainment of proximal goals fosters perceived competence (Bandura & Schunk, 1981). Fourth, feedback that focuses on the process and on the use of the strategy directs attention to controllable causes of success and failure (Hattie & Timperley, 2007). Finally, a predictable procedure may reduce uncertainty and the negative arousal that unfamiliar physics tasks provoke, although this route is the least documented (Bandura, 1997).

Empirical work also indicates that self-efficacy and problem solving are closely tied. In a path analysis with middle school students, self-efficacy in mathematics was a strong direct predictor of problem-solving performance, even after accounting for prior achievement and other beliefs (Pajares & Miller, 1994). Although that study was correlational and concerned mathematics, it supports the plausibility of a reciprocal relation between the two constructs in the sciences.

2.5 The present study

The study addressed one research question and tested two hypotheses. The research question was: What were the levels of general self-efficacy of the participating students before and after the problem-solving strategy program? The hypotheses were:

H_1 : The mean general self-efficacy score at posttest will be significantly higher than the mean score at pretest among the participating third-year middle school students.

H_2 : The change in general self-efficacy will be practically meaningful, corresponding to a large standardized effect (Cohen’s $d_z \geq 0.80$).

3. Method

3.1 Design

A single-group pretest–posttest (repeated-measures) design was used. The within-subject factor was measurement occasion (pretest vs. posttest), and the dependent variable was general self-efficacy. This design

allows the magnitude of change to be estimated, but it does not include a comparison group and is therefore classified as pre-experimental (Campbell & Stanley, 1963). The report follows the TREND guidelines for nonrandomized evaluations of behavioral interventions (Des Jarlais et al., 2004).

3.2 Setting and participants

The study was conducted during the 2023/2024 school year in a public middle school in the municipality of Bin El Ouiden, Skikda Province, north-eastern Algeria. Participants were selected in stages. The school level (third year of middle school) was drawn at random from the four levels, two of the four third-year classes were then drawn at random, and, from the 68 students enrolled in these classes, 35 volunteered to take part, within the target range of 30–40 participants. The final sample comprised 35 students (20 girls and 15 boys). All 35 participants completed both measurements. Two isolated item responses were outside the permissible range and were handled as described in Section 3.6.

The program was implemented in physics lessons only, and the pretest was administered immediately before the first session so that it reflected students' self-efficacy at the start of the program.

A sensitivity analysis based on the noncentral t distribution indicated that, with $N = 35$, a two-tailed α of .05, and power of .80, the design could detect a standardized within-person change of $d_z \approx 0.49$ or larger. Smaller effects could not be detected reliably.

3.3 Measure;

General self-efficacy was measured with the General Self-Efficacy Inventory developed by Maamriya (2012, 2013). The inventory was constructed after consulting the self-efficacy list of Tipton and Worthington (1984) in its Arabic translation, and consists of 30 first-person statements (for example, "I like accomplishing difficult tasks"). Respondents choose one of four options: not at all (0), a little (1), moderately (2), and a lot (3). Total scores range from 0 to 90 with a theoretical midpoint of 45, and scores are classified as low (0–30), medium (31–60), or high (61–90). Higher scores indicate higher general self-efficacy.

The psychometric properties reported for the inventory come from a standardization sample of 578 secondary school students (381 males and 197 females) from Batna Province, tested between November 2010 and May 2011 (Maamriya, 2012). Item scores correlated significantly with the total score ($p < .01$). Discriminant validity, tested by comparing extreme groups, was supported for males ($t = 7.69, p < .01$) and females ($t = 14.42, p < .01$). Convergent validity was supported by significant correlations with measures of optimism, well-being, hope, and achievement motivation, and divergent validity by significant correlations with measures of pessimism. Test-retest coefficients over a two-week interval ranged from .69 to .74, and Cronbach's α coefficients ranged from .77 to .87 across subsamples (Maamriya, 2012, 2013).

Because the inventory was standardized on older students, its internal consistency was re-examined in the present sample (Cronbach's $\alpha = .70$ at pretest and .69 at posttest). These values are acceptable for group-level comparisons but lower than the coefficients of .77 to .87 reported for the standardization sample. The inventory was administered in Arabic under the same conditions on both occasions.

3.4 Intervention: the problem-solving strategy program:

The program was delivered by the researcher during regular physics lessons. It comprised 20 sessions of 45 minutes over 8 weeks (15 instructional hours in total) and covered the fourth unit of the third-year physics curriculum. The content taught was that prescribed by the official curriculum, so that the program altered how problems were approached rather than what was taught.

The program taught a four-phase strategy adapted from Pólya (1945) and from the physics-specific frameworks of Heller and colleagues (Heller & Hollabaugh, 1992; Heller et al., 1992). In the first phase, understanding and representing the problem, students read the statement, list the known and unknown quantities with their symbols and units, and draw a diagram of the physical situation. In the second phase, planning, they identify the relevant law or principle, write the relation that links the quantities, and divide the task into subgoals. In the third phase, solving, they manipulate the relation symbolically before substituting values, keep units consistent, and carry out the computation. In the fourth phase, evaluating, they check units and the order of magnitude, judge whether the result is physically plausible, consider an alternative route, and reflect on which steps of the strategy proved useful. A strategy card listing these phases and their guiding questions was available to students throughout.

Each session followed a common structure: (a) a brief review of the previous session, (b) explicit modeling of the strategy by the instructor on a worked example with a think-aloud commentary, (c) guided practice with progressively reduced support, (d) cooperative solution of a new problem in groups of four students, and (e) a whole-class reflection on the use of the strategy. Tasks were sequenced from routine well-structured problems to multi-step problem-situations embedded in everyday contexts, so that every student could experience success at an appropriate level of difficulty before moving on. Feedback concentrated on the use of the strategy rather than on ability.

Before implementation, the program materials were reviewed by university professors and by the physics subject inspector. Mean attendance across the 20 sessions was 90%.

3.5 Procedure:

Administrative authorization was obtained from the school administration. Parents or legal guardians gave written informed consent, and students gave assent after the aims and procedures were explained, with the assurance that participation was voluntary and that responses would be kept confidential and used for research purposes only. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The inventory was administered collectively in the classroom before the first session (pretest) and again one week after the final session (posttest). Participants received identical instructions on both occasions and were not given feedback on their scores. Questionnaires were matched across occasions by anonymous codes.

3.6 Data analysis:

Analyses were conducted with IBM SPSS Statistics. Item responses were first screened against the permissible range of 0–3. Two out-of-range values were found: a 9 on Item 9 at pretest (participant 3) and a 20 on Item 5 at posttest (participant 23). Because the intended responses could not be recovered, both were treated as missing and replaced with the respondent's mean on the remaining 29 items of the same occasion, rounded to the nearest integer (2 in both cases). The robustness of the results to this decision was checked by substituting the item mean instead and by deleting both participants listwise. Descriptive statistics and Cronbach's α were computed for each occasion. Because the paired-samples t test assumes approximately normal difference scores, the distribution of the pretest–posttest differences was examined with the Shapiro–Wilk test (Shapiro & Wilk, 1965) and inspection of boxplots for outliers (values beyond 1.5 times the interquartile range). The hypothesis of no change was tested with a two-tailed paired-samples t test at $\alpha = .05$. The standardized effect was expressed as Cohen's d_z (the mean difference divided by the standard deviation of the differences), with the conventional benchmarks of 0.20, 0.50, and 0.80 for small, medium, and large effects (Cohen, 1988), together with its bias-corrected version, Hedges' g_z (Hedges, 1981), and 95% confidence intervals based on the noncentral t distribution (Lakens, 2013). Changes in classification across the three self-efficacy levels were tabulated, and a Wilcoxon signed-rank test on the ordinal levels served as a supplementary nonparametric analysis that does not depend on the normality assumption (normal approximation with tie correction; effect size $r = |Z|/\sqrt{N}$).

4. Results

4.1 Preliminary analyses:

All 35 participants completed both measurements. Two isolated out-of-range item responses (a 9 at pretest and a 20 at posttest) were replaced as described in Section 3.6. The differences between posttest and pretest scores did not depart significantly from normality (Shapiro–Wilk $W = .99$, $p = .94$), and no outliers were identified by the $1.5 \times \text{IQR}$ rule. Internal consistency was acceptable but modest on both occasions (Table 1). The pretest and posttest total scores were essentially uncorrelated ($r = -.08$), meaning that students' rank order was not preserved across the two occasions; this point is taken up in the Limitations.

4.2 Descriptive statistics:

Table 1 presents descriptive statistics for the two occasions. The mean general self-efficacy score was 44.17 at pretest and 66.11 at posttest, an increase of 21.94 points on the 0–90 scale.

Table 1*Descriptive Statistics for General Self-Efficacy Scores at Pretest and Posttest (N = 35)*

Occasion	<i>M</i>	<i>SD</i>	95% CI for <i>M</i>	Min	Max	Cronbach's α
Pretest	44.17	6.79	[41.84, 46.50]	28	58	.70
Posttest	66.11	8.05	[63.35, 68.88]	49	89	.69

Note. Scores range from 0 to 90. *M* = mean; *SD* = standard deviation; CI = confidence interval based on the *t* distribution (*df* = 34); Min and Max = observed minimum and maximum; α = Cronbach's alpha. Two out-of-range item responses were replaced as described in Section 3.6.

4.3 Test of H1: differences between pretest and posttest

The paired-samples *t* test showed that posttest scores were significantly higher than pretest scores, $t(34) = 11.87$, $p < .001$, with a mean difference of 21.94 points (95% CI [18.18, 25.70]; Table 2). H_1 was therefore supported. The result was unchanged when the two out-of-range responses were handled by item-mean substitution, $t(34) = 11.89$, or by listwise deletion of the two participants, $t(32) = 11.78$ (both $p < .001$).

4.4 Test of H2: practical significance:

The standardized effect was $d_z = 2.01$ (95% CI [1.42, 2.58]), with a bias-corrected estimate of $g_z = 1.96$. Following Cohen's (1988) benchmarks, this is a large effect; the lower bound of the confidence interval also lies above the 0.80 threshold, and H_2 was supported. Under listwise deletion the effect was virtually identical ($d_z = 2.05$).

Table 2*Paired-Samples *t* Test and Effect Sizes for the Change in General Self-Efficacy (Posttest – Pretest), N = 35*

Statistic	Value
Meandifference	21.94
<i>SD</i> of differences	10.94
Standard error of the mean difference	1.85
95% CI of the mean difference	[18.18, 25.70]
$t(34)$	11.87
p (two-tailed)	< .001
Cohen's d_z [95% CI]	2.01 [1.42, 2.58]
Hedges' g_z	1.96

Note. CI = confidence interval; *SD* = standard deviation. Cohen's d_z = mean difference divided by the *SD* of the paired differences; Hedges' $g_z = d_z \times [1 - 3/(4df - 1)]$. Confidence intervals for d_z are based on the noncentral *t* distribution.

4.5 Self-efficacy levels before and after the program:

Table 3 shows how students were distributed across the three self-efficacy levels. At pretest, 1 student (2.9%) was classified as low, 34 (97.1%) as medium, and none (0.0%) as high. At posttest, the corresponding figures were 0 (0.0%), 7 (20.0%), and 28 (80.0%). In total, 28 students (80.0%) moved to a higher level, 7 (20.0%) remained at the same level, and none (0.0%) moved to a lower level. The Wilcoxon signed-rank test on the ordinal levels was consistent with the *t*-test result, $Z = -5.21$, $p < .001$, $r = .88$. Because the three levels are coarse and heavily tied (7 of 35 pairs were ties, and all 28 nonzero differences were positive), this test mainly

confirms the direction of the level changes and adds little information beyond the cross-tabulation; r was computed as $|Z|/\sqrt{35}$ (number of pairs).

Table 3

Cross-Tabulation of Self-Efficacy Levels at Pretest and Posttest (N = 35)

Pretestlevel	Posttest:Low (0–30)	Posttest: Medium (31–60)	Posttest: High (61–90)	Total
Low (0–30)	0	0	1	1
Medium (31–60)	0	7	27	34
High (61–90)	0	0	0	0
Total	0	7	28	35

Note. Cell entries are numbers of students. Diagonal cells indicate students who remained at the same level ($n = 7$); cells above the diagonal indicate students who moved to a higher level ($n = 28$); no student moved to a lower level.

5. Discussion

5.1 Summary of findings:

This study examined whether a problem-solving strategy program delivered in physics lessons was associated with higher general self-efficacy among third-year middle school students. General self-efficacy scores were significantly higher after the program than before it, and the standardized change was large ($d_z = 2.01$). Twenty-eight of 35 students moved to a higher self-efficacy level. Both hypotheses were supported. Given the design, these results describe a pattern of change that is consistent with a beneficial effect of the program but that cannot be attributed to it with certainty.

5.2 Interpretation:

The pattern is consistent with the mechanisms proposed by social cognitive theory. A strategy that structures the solution process may have increased the proportion of problems that students solved successfully, and graded practice may thereby have supplied repeated mastery experiences, the strongest source of self-efficacy (Bandura, 1997; Usher & Pajares, 2008). Instructor modeling with worked examples and cooperative solution with peers provided vicarious experiences of success (Schunk, 1981; Schunk & Hanson, 1985), while the successive phases of the strategy functioned as proximal subgoals whose attainment can foster perceived competence (Bandura & Schunk, 1981). Process-oriented feedback may have helped students attribute outcomes to their use of the strategy rather than to fixed ability (Hattie & Timperley, 2007). We did not measure these sources directly, so they should be regarded as plausible explanations to be tested rather than as demonstrated mediators.

The findings also fit the literature on expert–novice differences in physics. The first phase of the strategy asks students to represent the situation and identify the governing principle before manipulating equations, which is the behavior that distinguishes experts from novices (Chi et al., 1981; Larkin et al., 1980). By replacing equation search with a guided procedure, the program may have reduced the cognitive load imposed by physics tasks and left students better able to experience them as manageable (Kirschner et al., 2006; Sweller, 1988). This interpretation agrees with the view that self-efficacy and problem solving are reciprocally related (Pajares & Miller, 1994) and with the observation that successful performance and stronger efficacy beliefs support each other over time (Zimmerman, 2000).

The study also resonates with the competency-based orientation of the Algerian curriculum, in which learners are expected to mobilize resources to resolve problem-situations (Roegiers, 2000). Teaching students how to approach such situations, rather than expecting the approach to emerge spontaneously, may be an important condition for their confidence in doing so.

5.3 Implications for practice:

For physics teachers, the results suggest that making the solution process explicit is worth the instructional time, particularly when accompanied by a strategy card, graded task sequences, and feedback on the use of the strategy. For curriculum designers and inspectors, the strategy provides a concrete way to operationalize the resolution of problem-situations in the competency-based approach. For teacher education, training should include modeling of expert reasoning aloud and the design of tasks that progress from routine to multi-step problems. For school counselors and educational psychologists, brief measures of self-efficacy may help identify students who would benefit from additional scaffolding in demanding subjects.

5.4 Limitations:

Several limitations qualify the conclusions. First, the absence of a control group means that history, maturation, testing effects, regression to the mean, and simple exposure to the researcher may account for part of the observed change (Campbell & Stanley, 1963). Second, the students continued to receive regular schooling and to have other classroom experiences during the eight weeks of the program, and the design cannot separate these from the effect of the program itself. Third, the sample was small, voluntary, and drawn from one school, which limits statistical power for small effects and external validity. Fourth, the outcome was measured with a general self-efficacy inventory standardized on older students, whereas the intervention targeted physics; a domain-specific measure constructed according to Bandura's (2006) guidelines would be more sensitive to the change the program was designed to produce. Fifth, the data were self-reported and were collected by the researcher, who also delivered the program, which may have introduced demand characteristics. Sixth, no follow-up measurement was taken, so the durability of the change is unknown. In addition, internal consistency in the present sample was modest ($\alpha = .70$ and $.69$), two out-of-range item responses had to be replaced, and the pretest and posttest totals were essentially uncorrelated ($r = -.08$), which limits the precision of the individual-level change estimates. Finally, problem-solving performance and the sources of self-efficacy were not assessed, so the proposed mechanisms remain untested.

5.5 Directions for future research:

Future studies should use randomized or well-matched quasi-experimental designs with an active comparison condition, such as instruction in which students practice the same problems without an explicit strategy. They should measure physics-specific self-efficacy, problem-solving performance, and the sources of self-efficacy in order to test mediation, include delayed follow-up assessments, and examine whether effects differ by gender, prior achievement, and initial level of self-efficacy. Replications with larger and more diverse samples across Algerian regions would establish how far the findings generalize.

6. Conclusion:

In a single-group pretest–posttest study of 35 third-year middle school students, general self-efficacy was significantly higher after a problem-solving strategy program in physics than before it, with a large standardized change ($d_z = 2.01$). The findings are consistent with social cognitive theory and with research on expert–novice differences in physics, and they suggest that teaching students an explicit, repeatable approach to problems may be associated with greater confidence in their own capability. Because the design does not permit causal inference, the results should be treated as preliminary evidence that justifies controlled evaluations.

Declarations:

Ethics approval and consent to participate. The study was authorized by the school administration. Parents or legal guardians gave written informed consent, and the students gave assent before taking part.

Data availability. The anonymized dataset is available from the corresponding author on reasonable request.

Conflict of interest. The author(s) declare no conflict of interest.

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Author contributions (CRediT). Conceptualization, methodology, investigation, formal analysis, writing – original draft, writing – review and editing.

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