**Electronic supplementary material**

Table 1. Scales for self-efficacy in mathematics and basic needs

| Scale | Item |
|---|---|
| Self-efficacy | In math, I am sure to be able to understand even the most difficult topic.<br>I am convinced that I can understand even the most difficult content presented by our math teacher.<br>I am convinced that I can perform well in my math homework and on math tests.<br>I am convinced that I am able to master the skills taught in my math classes. |
| Experience of autonomy | During unit [number of the unit], ...<br>• ... I felt free to make my own decisions.<br>• ... I could decide how I wanted to work.<br>• ... I was able to work as I see fit. |
| Experience of competence | During unit [number of the unit], ...<br>• ... I learned a lot.<br>• ... I felt able to master the work<br>• ... I had the feeling that I could develop further. |
| Experience of relatedness | During unit [number of the unit], ...<br>• ... I felt comfortable in the class community.<br>• ... I had the feeling that others in the class would help me.<br>• ... I felt a sense of belonging. |

The scales were adapted from Berger and Karabenick (2011), Rakoczy et al. (2022), Schukajlow et al. (2022), and Schukajlow and Krug (2014)

Table 2. Confirmatory factor analysis (CFA) results for autonomy, competence, relatedness (Lessons 1–4) and self-efficacy (pre/posttest)

| Constructs | Measurement occasion | $\chi^2$ (*df*) | RMSEA | CFI | TLI | Standardized factor loadings (range) | Latent correlations (min–max) |
|---|---|---|---|---|---|---|---|
| Basic needs (autonomy, competence, relatedness) | Lesson 1 | 73.78 (24) | .11 | .95 | .93 | .62–.92 | .31–.57 |
| | Lesson 2 | 119.48 (24) | .15 | .95 | .93 | .70–.93 | .49–.73 |
| | Lesson 3 | 98.90 (24) | .14 | .98 | .97 | .79–.94 | .55–.71 |
| | Lesson 4 | 94.28 (24) | .14 | .96 | .94 | .79–.93 | .51–.60 |
| Self-efficacy | Pretest | 5.72 (2) | .10 | 1.00 | .99 | .71–.88 | – |
| | Posttest | 1.11 (2) | .00 | 1.00 | 1.00 | .71–.91 | – |

*Note*. All items were treated as ordered categorical and estimated with WLSMV and THETA parameterization in Mplus. For autonomy, competence, and relatedness, separate three-factor models were estimated for each lesson (Lessons 1–4). For self-efficacy, a one-factor model was estimated at pretest and posttest. In the three-factor CFAs for autonomy, competence, and relatedness, latent factor correlations were below .85, supporting discriminant validity.

Table 3. Means, standard deviations, and correlations for the study variables of Models 2a, 2b, 2c

| | PSOM | | SGM | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. Self-efficacy (pretest) | 3.00 | 0.95 | 2.81 | 1.02 | 1 | .69** | .18* | .32** | .23** | .09 |
| 2. Self-efficacy (posttest) | 2.86 | 0.95 | 2.76 | 0.89 | | 1 | .25** | .41** | .27** | .03 |
| 3. Autonomy | 3.25 | 0.53 | 2.79 | 0.67 | | | 1 | .43** | .35** | .33** |
| 4. Competence | 2.51 | 0.35 | 2.39 | 0.45 | | | | 1 | .50** | .10 |
| 5. Relatedness | 2.69 | 0.33 | 2.47 | 0.46 | | | | | 1 | .15* |
| 6. PSOM vs. SM | - | - | - | - | | | | | | 1 |

Table 4. Means, standard deviations, and correlations for the study variables of Models 3a, 3b, 3c

| | PSOM | | SGM | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. Self-efficacy (pretest) | 3.00 | 0.95 | 2.81 | 1.02 | 1 | .69** | .18* | .32** | .17* | .09 |
| 2. Self-efficacy (posttest) | 2.86 | 0.95 | 2.76 | 0.89 | | 1 | .21** | .37** | .22** | .03 |
| 3. Autonomy | 2.87 | 0.53 | 2.96 | 0.65 | | | 1 | .52** | .45** | -.07 |
| 4. Competence | 2.53 | 0,45 | 2.50 | 0.47 | | | | 1 | .47** | .02 |
| 5. Relatedness | 2.61 | 0.39 | 2.43 | 0.55 | | | | | 1 | .11 |
| 6. PSOM vs. SM | - | - | - | - | | | | | | 1 |

Table 5. Regression coefficients for all path models (Model 1a, 1b, 1c; Model 2a, 2b, 2c, Model 3a, 3b, 3c)

| | Models 1 (PSOM vs. SGM) | | | Models 2 (POM vs. SGM) | | | Models 3 (SOM vs. SGM) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Models a (via autonomy)** | β | $b_Y$ | *p* | β | $b_Y$ | *p* | β | $b_Y$ | *p* |
| Direct effects | | | | | | | | | |
| PSOM vs. SGM → autonomy | | 0.34$^{*}$ | .01 | | 0.61$^{**}$ | <.01 | | -0.17 | .11 |
| PSOM vs. SGM → self-efficacy (posttest) | | -0.09 | .22 | | -0.14 | .11 | | -0.02 | .42 |
| Autonomy → self-efficacy (posttest) | 0.14$^{*}$ | | .02 | .17$^{**}$ | | .01 | 0.09$^{\dagger}$ | | .09 |
| self-efficacy (pretest)→ autonomy | 0.25$^{*}$ | | .01 | .18$^{\dagger}$ | | .06 | 0.28$^{**}$ | | <.01 |
| self-efficacy (pretest)→ self-efficacy (posttest) | 0.66$^{**}$ | | <.01 | .63$^{**}$ | | <.01 | 0.67$^{**}$ | | <.01 |
| (PSOM vs. SGM)X(self-efficacy pretest) → autonomy | -0.09 | | .16 | -.05 | | .30 | -0.14$^{\dagger}$ | | .08 |
| Total effects | | | | | | | | | |
| PSOM vs. SGM → self-efficacy (posttest) | | -0.03 | .38 | | -0.02 | .38 | | -0.04 | .37 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Indirect | | | | | | | | | |
| PSOM vs. SGM → autonomy → self-efficacy (posttest) | | 0.05** | <.01 | | 0.10* | .02 | | -0.02 | .18 |
| **Models b (via competence)** | | | | | | | | | |
| Direct effects | | | | | | | | | |
| PSOM vs. SGM → competence | | 0.05 | .36 | | 0.14 | .17 | | -0.05 | .36 |
| PSOM vs. SGM → self-efficacy (posttest) | | -0.05 | .30 | | -0.07 | .24 | | -0.03 | .39 |
| Competence → self-efficacy (posttest) | 0.23** | | <.01 | .22** | | <.01 | 0.17** | | <.01 |
| self-efficacy (pretest)→ competence | 0.39** | | <.01 | .36** | | <.01 | 0.36** | | <.01 |
| self-efficacy (pretest)→ self-efficacy (posttest) | 0.62** | | <.01 | .62** | | <.01 | 0.64** | | <.01 |
| (PSOM vs. SGM)X(self-efficacy pretest) → competence | -.07 | | .24 | -.07 | | .23 | -.05 | | .30 |
| Total effects | | | | | | | | | |
| PSOM vs. SGM → self-efficacy (posttest) | | -.04 | .35 | | -.04 | .35 | | -.04 | .36 |
| Indirect | | | | | | | | | |
| PSOM vs. SGM → competence → self-efficacy (posttest) | | .01 | .36 | | .03 | .18 | | -.01 | .36 |
| **Models c (via relatedness)** | | | | | | | | | |
| Direct effects | | | | | | | | | |
| PSOM vs. SGM → relatedness | | .28* | .03 | | .30 | .02 | | .22 | .06 |
| PSOM vs. SGM → self-efficacy (posttest) | | -.08 | .23 | | -.08 | .24 | | -.07 | .28 |
| Relatedness → self-efficacy (posttest) | .14* | | .01 | .12 | | .03 | .11 | | .08 |
| self-efficacy (pretest)→ relatedness | .25* | | .01 | .26 | | <.01 | .23 | | .02 |
| self-efficacy (pretest)→ self-efficacy (posttest) | .66** | | <.01 | .66 | | <.01 | .67 | | <.01 |
| (PSOM vs. SGM)X(self-efficacy pretest) → relatedness | -.09 | | .19 | -.07 | | .25 | -.10 | | .15 |
| Total effects | | | | | | | | | |
| PSOM vs. SGM → self-efficacy (posttest) | | -.04 | .36 | | -.04 | .37 | | -.04 | .36 |
| Indirect | | | | | | | | | |
| PSOM vs. SGM → relatedness → self-efficacy (posttest) | | .04† | .08 | | .04 | .08 | | .03 | .14 |

*Note.* PSOM = Posing and Solving Own Modelling Problems; SGM = Solving Given Modelling Problems. β = standardized regression coefficient (STDYX), $b_Y$ = standardized regression coefficient (STDY). † $p < .10$, * $p < .05$, ** $p < .01$.

# References


Berger, J.-L., & Karabenick, S. A. (2011). Motivation and students' use of learning strategies: Evidence of unidirectional effects in mathematics classrooms. *Learning and Instruction*, *21*(3), 416–428. https://doi.org/10.1016/j.learninstruc.2010.06.002

Rakoczy, K., Frick, U., Weiß-Wittstadt, S., Tallon, M., & Wagner, E. (2022). Einmal begeistert, immer begeistert? Eine Experience-Sampling Studie zur wahrgenommen Unterrichtsqualität und Motivation von Schülerinnen und Schülern im Kunstunterricht [Once enthusiastic, always enthusiastic? An experience-sampling study]. *Unterrichtswissenschaft*, *50*(2), 211–236. https://doi.org/10.1007/s42010-022-00147-w

Schukajlow, S., Blomberg, J., Rellensmann, J., & Leopold, C. (2022). The role of strategy-based motivation in mathematical problem solving: The case of learner-generated drawings. *Learning and Instruction*, Article 101561. Advance online publication. https://doi.org/10.1016/j.learninstruc.2021.101561

Schukajlow, S., & Krug, A. (2014). Do multiple solutions matter? Prompting multiple solutions, interest, competence, and autonomy. *Journal for Research in Mathematics Education*, *45*(4), 497–533. https://doi.org/10.5951/jresematheduc.45.4.0497