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# No aspect of structure should be left behind in relation to student autonomous motivation

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**Background.** Provision of structure in classroom settings constitutes one of the pillars of conducive learning environments. However, little is known whether the particular elements of provided structure—namely, contingency, clear expectations, help and support, and monitoring—are equally important for student learning and motivation.

**Aims.** In this cross-sectional study, we aimed to investigate to what extent students' autonomous motivation is linearly and curvilinearly related to their perceptions of their teachers' contingency, clear expectations, help and support, and monitoring.

**Sample.** Participants were 12,036 Turkish adolescent students (age range: 15–19 years; 54.4% males) from 446 classes, nested into 24 public schools.

**Methods.** Cross-sectional, based on student ratings of their self-determined motivation and their teacher structure provision and autonomy support.

**Results.** Multilevel and ordinary least-squares polynomial regression analyses showed all the four perceived structure elements to predict autonomous motivation, with expectations and contingency (especially when coupled with monitoring) being even more important predictors than the other elements. Response surface analyses also showed strong positive relation between autonomous motivation and all the possible pairs of the four elements of perceived structure along the line of congruence, suggesting an additive effect when teachers are thought to be contingent and helpful and supportive (or monitor their students, or clearly communicate their expectations).

**Conclusions.** These findings imply the key role that teachers could play in enhancing their students' autonomous motivation by providing all the elements of structure.

To what extent do different instructional behaviors of teachers relate to students' quality of motivation? Are some elements more critical than some others, or are they all needed in concert? In our study, we relied on Self-Determination Theory (SDT; Ryan & Deci, 2017) to

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examine to what extent four key elements of instructional behaviors that constitute a well-structured learning environment – contingency, expectations communication, help and support, and monitoring – are all linked to student quality of motivation. Knowing whether some of the elements are more needed than the others may better inform theory and practice as to which instructional strategies are essential to enhance student quality of motivation and eventually their academic striving and success.

### *Perceived classroom structure and student motivation*

From the SDT perspective (Ryan & Deci, 2017), structure refers to social contexts that are stable and predictable where people can exercise their skills and develop a sense of mastery (Skinner, Zimmer-Gembeck, Connell, Eccles, & Wellborn, 1998). In educational settings, teachers set up a well-structured classroom is typically when they (a) set clear and well-justified rules by clarifying what they expect from their students (expectations), (b) behave in a contingent way (contingency), (c) interact with their students in a responsive, helpful, and supportive manner (help and support), and (d) oversee student understanding and progress by appropriately scaffolding learning activities (monitoring) (Reeve, 2006).

Research has shown that structure is associated with desired outcomes, most likely because it enhances competence perceptions (Vasconcellos et al., 2020). For instance, observational studies have shown a positive association between students' collective engagement and the degree to which teachers provided structure during the learning episodes – namely, clear and explicit directions, guidance during the lesson, and constructive feedback (e.g., Jang, Reeve, & Deci, 2010; Maulana, Helms-Lorenz, & Van De Grift, 2017). Also, correlational studies have shown that perceived structure is associated with cognitive and metacognitive strategies (Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009), behavioral engagement (Hospel & Galand, 2016), and intrinsic value (Maulana, Opdenakker, & Bosker, 2016). Building on these findings, a prospective study indicated perceived structure to predict increases in engagement, motivational resilience, and coping (Pitzer & Skinner, 2017).

#### *Autonomous motivation*

Structure predicts desired outcomes most likely because students tend to become autonomously motivated in well-structured learning environments, as several correlational and longitudinal studies have shown (e.g., Stroet, Opdenakker, & Minnaert, 2015). According to SDT (Ryan & Deci, 2017), autonomous motivation refers to behaviors that people carry out for activities that they find either challenging, joyful, or interesting (intrinsic motivation) or personally important (identified regulation). Such behaviors are termed autonomous because the person experiences personal volition and agency. Autonomously motivated behaviors stand in contrast to behaviors that are undertaken out of psychological pressure. When acting under psychological pressure, the person is motivated either by internal forces, such as to self-affirm self-worth or to avoid feelings of guilt (introjected regulation), or because of some external pressures, such as avoiding punishment or attaining a promised reward (external regulation). Research has shown that, unlike controlled motivation, autonomous motivation relates to a wide array of desired educational outcomes (Ryan, Ryan, Domenico, & Deci, 2019; Vansteenkiste, Niemiec, & Soenens, 2010; Vasconcellos et al., 2020). For instance, autonomous motivation has been positively related to desired outcomes such as study efforts and concentration (Ulstad, Halvari, Sorebo, & Deci, 2018), critical thinking and metacognition (Michou, Vansteenkiste, Mouratidis, & Lens, 2014), engagement (Michou, Altan, Mouratidis, Reeve, & Malmberg, 2021), and academic performance (Vansteenkiste, Sierens, Soenens, Luyckx, & Lens, 2009). Also, autonomous motivation has been found to negatively relate to undesired outcomes, such as anxiety (Cox, Ullrich-French, Madonia, & Witty, 2011), procrastination (Katz, Eilot, & Nevo, 2014), and cheating (Kanat-Maymon, Benjamin, Stavsky, Shoshani, & Roth, 2015).

In contrast, although controlled motivation may also act as an energizing force to address some internal or external psychological pressures, it cannot fully mobilize students' inner motivational resources. Even when it does so, it may deplete students' resources, given the internal conflict that students will most likely experience between what they genuinely want and what is expected from them (either by others or by themselves) (Ryan & Deci, 2017). Studies focusing on students' relative autonomous motivation (i.e., autonomous minus controlled motivation) have shown that relative autonomous motivation predicts more mindful attention (Elphinstone, Egan, & Whitehead, 2020), better conceptual learning (Vansteenkiste, Simons, Lens, Soenens, & Matos, 2005), and higher grades (Kusurkar, Ten Cate, Vos, Westers, & Croiset, 2013).

Given the vital role of autonomous motivation and its links to structure, an interesting question that deserves further scrutiny concerns which aspects of structure may foster student autonomous motivation. Are contingency, expectations, help and support, and monitoring equally important or are certain elements more crucial than others? This is an important question because teachers may endorse certain instructional practices that reflect some aspects of structure but not others. To address this question, however, a rigorous analytical approach is needed. An approach where testing should focus on the linear and the curvilinear relations of the four aspects of structure (and their two-way interactions) to autonomous motivation.

### The present study

In this study, we took a closer look at the four aspects of perceived structure as construed through SDT (Ryan & Deci, 2017) and examined whether each of them, that is, contingency, expectations, help and support, and monitoring—relate to relative autonomous motivation, either linearly or curvilinearly through polynomial (rather than linear) regression models. Linear regression models assume that a dependent variable (e.g., autonomous motivation) will increase or decrease when the motivational correlate (e.g., perceived structure) also increases (or decreases) at the same rate (linear relation assumption). A more relaxed – and perhaps more realistic – assumption presumes that autonomous motivation may increase when its correlate also increases (or decreases), though at a different rate (monotonic relation assumption). Such reasoning implies that the relation between a predictor and an outcome might be monotonic but not necessarily linear (Edwards, 2008).

Examining the presence of such curvilinear relations can provide us a more refined picture of when students are more likely to report higher levels of autonomous motivation. Specifically, examining the linear and the curvilinear relations (and the two-way interactions) of the four elements of perceived structure to autonomous motivation could help determine at what levels two aspects of perceived structure, (e.g., contingency combined with monitoring) will coincide with even higher levels of autonomous motivation.

We hypothesised that all the four elements – contingency, expectations, help and support, and monitoring – would positively relate to relative autonomous motivation after controlling for perceived autonomy support (Hypothesis 1). Autonomy support refers to classroom environments in which teachers show respect to their students, welcome their input, and acknowledge their negative feelings when they feel so (Reeve, 2006). Given that autonomy support is an essential element of conducive learning environments (Ryan & Deci, 2017), we statistically controlled for it before examining the unique predictive role that each of the four aspects of perceived structure could play in relation to autonomous motivation.

In addition, we explored to what degree some of these elements will be even stronger predictors (through their curvilinear relations) to relative autonomous motivation (RQ1), again, after controlling for perceived autonomy support. In the absence of prior empirical evidence, we could not make any concrete hypothesis regarding which of the four elements may predict higher levels of relative autonomous motivation when they surpass moderate levels. We anticipated, however, to observe more elevated levels of relative autonomous motivation along the line of congruence (when both aspects of structure would be increasing) than the line of incongruence (when one aspect would be increasing and the other would be decreasing) (Hypothesis 2). We presumed so because limited research toward this direction has shown that students benefit more when teachers provide both guidance and clarify their expectations toward their students (Aelterman et al., 2019).

To properly examine our hypotheses and explore our research question, we recruited a large number of adolescent students. This was important because the presence of quadratic or two-way interactions may pass unnoticed unless the sample size is large enough. Large samples can prevent researchers from committing a type II error (Nagengast et al., 2011) when testing two-way interactions and curvilinear relations.

## Method

### *Participants and procedures*

The sample is coming from a larger international project aiming to examine the quality of teacher instructional strategies across countries worldwide. The data of the present study had never been used before and involved 12,036 students (age range: 15–19 years; 54.4% males). The students belonged to 446 classes (mean class size $M$ = 26.29; $SD$ = 6.31 students), nested into 24 public schools in Turkey. The students came from families of various socioeconomic backgrounds. The majority of students attended the science track (39.7%), followed by language (35.4%), social sciences (21.3%), music and art (1.8%), and physical education (1.5%) track.

Ethical approval was granted by the host university and by the regional administrative authorities of the ministry of Turkish education. The schools were randomly selected and participated voluntarily on school principals' consent. All questionnaires were completed during class hours without the presence of teachers.

Data screening revealed 458 (3.8%) suspicious observations where students fully agreed with a pair of opposite items purporting to assess perceived autonomy support: "My teacher listens to my ideas" and "My teacher does not listen to my opinion". Hence, we dropped these observations, though supplementary analyses showed that the results would remain mostly the same if we retained these participants in our final sample.

Students answered to the scales on a 4-point Likert-type scale (1 = *Not true of me*; 4 = *Totally true of me*).

## Measures

### Perceived structure

Four pairs of items, taken from the Teacher as a Social Context Questionnaire (TASCQ; Belmont, Skinner, Wellborn, & Connell, 1988) that are presumed to reflect the four different dimensions of perceived structure, were used to assess to what extent students perceived their teacher in a particular subject matter (which differs from classroom to classroom) to (a) behave in a contingent way ("Every time I do something wrong, my teacher acts differently" and "My teacher keeps changing how he/she acts toward me"; both, reverse-worded); (b) openly communicate their expectations from their students ("My teacher does not make it clear what s/he expects of me in class" and "My teacher does not tell me what he/she expects of me in school"); (c) provide help and support ("My teacher shows me how to solve problems for myself" and "If I cannot solve a problem, my teacher shows me different way to try to"); and (d) adjust their pace by monitoring student progress ("My teacher makes sure I understand before he/she goes on" and "My teacher checks to see if I'm ready before he/she starts a new topic").

A Confirmatory Factor Analysis (CFA) in which each pair of items defined their respective latent factor (after imposing equality constraints to the loadings to locally identify each latent factor) which, in turn, defined the higher-order latent factor of perceived structure yielded acceptable fit: $S\text{-}B\chi^2$ (20, $N$ = 10,835) = 1275.87, $p < .001$, CFI = .960, SRMR = .088, RMSEA = .076 (90%-CI:.073, .079). Inspection of the loading of the first-order factors revealed unequal loading weights. Specifically, the loadings of contingency ($\lambda = .36$) and expectations ($\lambda = .32$) were much lower than the loadings of help and support ($\lambda = .92$) and monitoring ($\lambda = .85$). Expectedly, a four-factor model without a higher-order factor yielded an even better fit ($S\text{-}B\chi^2$ [18, $N$ = 10,835] = 169.34, $p < .001$, CFI = .995, SRMR = .017, RMSEA = .028 [90%-CI:.024, .031]) suggesting that the four constituent factors of perceived structure may not uniformly relate to one another. This difference in the strength of the correlations was also evident in the bivariate correlations (see Table 1).

### Perceived autonomy support

We retained four items from TASCQ (Belmont et al., 1988) to assess the degree to which students perceived that their teacher provided autonomy support to them. The four items were all reverse-worded and were as follows: "My teacher does not give me much choice about how I do"; ". . . is always getting on my case about schoolwork"; ". . . does not listen to my opinion"; and ". . . does not explain why what I do in school is important to me". A CFA testing a single-factor model yielded acceptable fit: $S\text{-}B\chi^2$ (2, $N$ = 10,982) = 11.37, $p$ = .003, CFI = .998, SRMR = .006, RMSEA = .025 (90%-CI:.012, .040).

### Relative autonomous motivation

We used the Self-Regulated Questionnaire (Ryan & Connell, 1989) to assess students' relative autonomous motivation for the subject matter they previously rated their teachers' structure provision. Students indicated through four items per subscale to what

**Table 1.** Means, standard deviations, cronbach alphas (on the diagonal) and bivariate correlations of the measured variables

| Variables | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Perceived autonomy-support | 3.29 | 0.69 | .71 | | | | | | | | | |
| Aspects of perceived structure | | | | | | | | | | | | |
| 2. Contingency | 3.41 | 0.80 | .55 | .79 | | | | | | | | |
| 3. Expectations | 2.93 | 0.93 | .40 | .39 | .86 | | | | | | | |
| 4. Help and support | 2.89 | 0.90 | .36 | .25 | .21 | .81 | | | | | | |
| 5. Monitoring | 2.78 | 0.91 | .32 | .22 | .21 | .64 | .83 | | | | | |
| Motivation | | | | | | | | | | | | |
| 6. Intrinsic motivation | 2.75 | 0.88 | .10 | .05 | .08 | .30 | .29 | .91 | | | | |
| 7. Identified regulation | 3.11 | 0.78 | .17 | .10 | .10 | .30 | .28 | .69 | .87 | | | |
| 8. Introjected regulation | 2.27 | 0.84 | −.13 | −.14 | −.11 | .05 | .05 | .20 | .24 | .77 | | |
| 9. External regulation | 2.43 | 0.78 | −.20 | −.20 | −.15 | −.03 | −.04 | .00 | .02 | .44 | .74 | |
| 10. Relative autonomous motivation | 1.48 | 2.99 | .26 | .21 | .19 | .25 | .24 | .66 | .62 | −.43 | −.60 | – |

*Note.* Values which are greater than |.02| are statistically significant at the.01 level (two-tailed).

extent they were studying because they found the subject matter interesting and enjoyable (i.e., intrinsic motivation; e.g., "Because it is fun.") or personally meaningful (i.e., identified regulation; e.g., "Because it is personally important to me."). Also, they rated whether they were studying to validate their self-worth or avoid feelings of guilt (i.e., introjected regulation; e.g., "Because I would feel guilty if I would not do so."). Likewise, they indicated the degree to which they were studying to get an external reward or avoid punishment (i.e., external regulation; e.g., "Because that is something others (parents, friends etc.) oblige me to do so."). Each subscale contained four items.

A four-factor CFA where the errors of two introjected regulation items were allowed to covary yielded the following fit: $S\text{-}B\chi^2$ (97, $N$ = 10,151) = 5806.24, $p < .001$, CFI = .928, SRMR = .083, RMSEA = .076 (90%-CI:.075, .078). As expected, intrinsic, identified, introjected, and external regulations formed a simplex pattern (see Table 1). In line with theoretical justification (Ryan & Deci, 2017) and prior empirical studies (e.g.., Soenens, Sierens, Vansteenkiste, Dochy, & Goossens, 2012), we computed a relative autonomous motivation index (RAI) using the formula RAI = 2 X intrinsic motivation + 1 X identified regulation – 1 X introjected regulation – 2 X external regulation. We opted for analyzing the relation of the four elements of perceived structure to RAI (instead of autonomous and controlled motivation) for reasons of parsimony.

### *Plan of analysis*

We set up a hierarchical regression model to test our hypotheses and research questions. After controlling for perceived autonomy support in Step 1, we regressed RAI on the four first-order predictors – contingency, help and support, expectations, and monitoring (first-order Model). We expected all the four first-order predictors to positively predict RAI (Hypothesis 1). In Step 2, we included all the possible two-way interactions (Interaction Model), and in Step 3, we added the four predictors squared (Polynomial Model). This building up approach enabled us to examine whether the interaction model significantly differed from the first-order model and whether the polynomial regression model would differ from the interaction model and which two-way interactions and curvilinear predictors were statistically significant (RQ1). In the next step, we examined in six separate regression models to what extent each possible pair of the four aspects of perceived structure, (e.g., contingency and monitoring) related linearly and curvilinearly to RAI. We statistically controlled for the other two aspects of structure (e.g., help and support and expectations) and perceived autonomy for each of these models.

To test the robustness of our findings and because students were nested into classrooms, we first tested our hypotheses under the multilevel framework to account for any shared variance due to classroom membership. With the aid of Mplus software (Muthén, & Muthén, 1998-2015), we regressed RAI on all the first-order, two-way interactions, and squared predictors at the within-classroom (i.e., between-student level) with fixed slopes. We opted for fixed slopes rather than random slopes for computational ease and ensure that all models converge. We entered no predictors at the between-classroom level as we had no particular hypothesis for any differences between classrooms.

All the four predictors were centered around their scale midpoints before computing the two-way interactions and squared predictors. Centering around the scale midpoint is preferred over centering around the mean for polynomial regression with response surface analysis (Cohen, Nahum-Shani, & Doveh, 2010) because such centering more realistically assumes that the scores of the one predictor may deviate from its mean to a different degree than the other predictor may do from its own mean (Barranti, Carlson, & Côté, 2017).

In the next step, we reran the same models through *R* software (*R*-core team, 2020) by ignoring the nested structure of the data. We did so because the available software package (rsm; Lenth, 2009) can analyze the surface only with ordinary least-squares (i.e., single-level) models. Providing the ordinary least-squares model reproduced the results obtained from the multilevel model, and the polynomial models statistically explained more variance than the first order or the interaction model; we proceeded with the response surface analysis to interpret the linear and curvilinear relations between the aspects of perceived structure and RAI. In that way, we could meaningfully address our RQ1 and Hypothesis 2. Response surface analysis can provide five pieces of information that are of interest in the present study. The first one concerns the *line of congruence* (x = y), which tests whether a pair of perceived structure components may additively predict students' RAI. The slope of the line of congruence, $\alpha_1$, represents the sum of the two first-order predictors (e.g., contingency and monitoring), and its curvature, $\alpha_2$, represents the sum of the two-way interaction with the two second-order predictors. According to Hypothesis 2, we expected the surface over the line of congruence to ascend. In practice, we anticipated the slope $\alpha_1$ and the curvature $\alpha_2$ (or their net effect) to be positive.

The second key feature concerns the *line of incongruence* (x = -y), which examines whether higher levels of one predictor combined with lower levels of the other predictor (or vice versa) predict higher levels of RAI. The slope of the line of incongruence, $\alpha_3$, represents the differences of the two first-order predictors, and the curvature, $\alpha_4$, represents the difference of the first squared predictor from the sum of the second squared predictor with the two-way interactions. As we expected that autonomous motivation would not increase along the line of incongruence, we hypothesised that its slope, $\alpha_3$, and its curvature, $\alpha_4$, (or their net effect) would be null.

The third piece of information concerns the surface along the line running parallel to the one predictor at 1 *SD* below and 1 *SD* above the midpoint of the other predictor. Given our congruence hypothesis (Hypothesis 2), we expected that the surface along the lines that run parallel at 1 *SD* above the midpoint of each predictor would be steeper than the surfaces along the lines that run parallel at 1 *SD* below the midpoint of the same predictor.

An additional piece of information that can help us understand the nature of the linear and curvilinear relation of structure predictors to autonomous motivation concerns the location of the *stationary point*, which represents the point in the surface where the slope of the estimated surface is null at all directions. Locating the stationary point can help us identify the two principal axes that run perpendicular to the stationary point (Edwards & Parry, 1993). The *first principal axis* reveals the direction toward which the upward curvature (for convex surfaces as the ones we expected in our models) is steepest. Given our congruence hypothesis (Hypothesis 2), we expected the first principal axis to run parallel to the line of congruence. The *second principal* axis, which crosses perpendicularly to the first principal axis at the stationary point, represents the direction where the upward curvature (for convex surfaces) is minimum. Given our congruence hypothesis, we anticipated the second principal axis to run parallel to the line of incongruence.

To examine our hypotheses and research question in a robust way, we bootstrapped with 10,000 samples the estimates from the polynomial regression model to get the 95% confidence interval for the slopes and curvatures along the lines of congruence and incongruence, the first and second principal axes, and the lines that run parallel to each pair of predictors for each model separately at moderately high (1 *SD* above the midscale), moderate (at the midscale), and moderately low (1 *SD* below the midscale) levels of RAI. As said, the software package we used (i.e., rsm; Length, 2009) to conduct response surface analysis through *R* (*R*-core team, 2020) is based on the typical (i.e., least-squares) and not on the multilevel regression models. Therefore, all the coefficients that correspond to the response surface analysis are derived from the least-squares models.

## Results

### *Preliminary analyses*

Means, standard deviations, Cronbach alphas, and bivariate correlations of the measured variables of the study are shown in Table 1. As can be noticed, the four components of perceived structure were only modestly correlated with one another; the highest relation concerned the pair help and support and monitoring. As expected, all the four aspects of perceived structure were positively related to both perceived autonomy support and RAI, which were also positively intercorrelated.

### *Main analyses*

#### *Polynomial regression analysis – full model*

To examine our hypotheses, we regressed the RAI on the four aspects of structure as predictors in Step 1, then on all their possible two-way interactions (Step 2), followed by the four predictors squared (Step 3). In all models, perceived autonomy support was included as a covariate. The results from the multilevel model are displayed in Table 2, left panel. As can be seen, all the four aspects of structure and autonomy-support positively predicted RAI, providing support to Hypothesis 1. Furthermore, the interaction model showed statistically significant two-way interactions between (a) contingency and expectations, (b) contingency and monitoring, and (c) help and support, and monitoring. These results address RQ1 and suggest that students tended to report even higher levels of RAI when they perceived that their teachers were concurrently more contingent and either communicated their expectations or monitored their students. Likewise, students appeared to report even more RAI when they perceived their teacher to provide help and support and at the same time monitor their progress.

Interestingly, when squared predictors were entered in Step 3, only the contingency by monitoring two-way interaction remained statistically significant, whereas the contingency by expectation interaction was marginally significant. As for the squared predictors, contingency and expectations (albeit marginally, the latter) emerged statistically significant (see Table 2 – Polynomial Model). These results suggest that the relation of RAI to contingency and expectations was nonlinear – students who perceived their teachers to be consistent and communicate their expectations tended to report even higher RAI. Taken together, the polynomial regression analysis implies that all the four components were positively associated with RAI, and perceived contingency combined either with monitoring or expectations were even stronger predictors of student RAI. The ordinary least squares model (i.e., the ones which ignored the nested structure of the data) yielded similar results (see Table 2 - Polynomial Model). The only two differences concerned the contingency by expectation interaction and expectations-squared predictor, which, from marginally statistically significant in the multilevel model, became statistically significant in the least-squares model.

**Table 2.** RAI as predicted by the aspects of perceived structure, controlling for autonomy support

| | Relative autonomous motivation (RAI) | | | | | |
|---|---|---|---|---|---|---|
| | Multilevel Model | | | Least-Squares Model | | |
| Predictors | *B* | (*SE*) | β | *B* | (*SE*) | β |
| First-order model | | | | | | |
| Intercept | .56 | (.06) | - | .56 | (.04) | - |
| Autonomy support | .48** | (.05) | .11 | .47** | (.05) | .11 |
| Contingency (C) | .22** | (.04) | .06 | .22** | (.04) | .06 |
| Expectations (E) | .20** | (.04) | .06 | .22** | (.03) | .07 |
| Help and support (H) | .40** | (.04) | .12 | .36** | (.04) | .11 |
| Monitoring (M) | .38** | (.05) | .12 | .38** | (.04) | .12 |
| *F*-change | - | | | (5, 11244) = 268.75** | | |
| Variance explained | .09 | | | .11 | | |
| Interaction model | | | | | | |
| Intercept | .45 | (.06) | - | .42 | (.05) | - |
| Autonomy support | .48** | (.05) | .11 | .48** | (.05) | .11 |
| Contingency (C) | .20** | (.04) | .06 | .21** | (.04) | .06 |
| Expectations (E) | .03 | (.05) | .01 | .04 | (.04) | .01 |
| Help and support (H) | .34** | (.06) | .10 | .29** | (.06) | .09 |
| Monitoring (M) | .16* | (.06) | .05 | .15** | (.06) | .05 |
| C X E | .14** | (.04) | .06 | .15** | (.04) | .03 |
| C X H | .04 | (.05) | .02 | .04 | (.05) | .01 |
| C X M | .17** | (.06) | .07 | .17** | (.05) | .05 |
| E X H | .02 | (.05) | .01 | .01 | (.04) | .00 |
| E X M | .06 | (.05) | .02 | .06 | (.04) | .02 |
| H X M | .15** | (.04) | .05 | .17** | (.03) | .04 |
| *F*-change | - | | | (6,11238) = 21.97** | | |
| Variance explained | .10 | | | .12 | | |
| Polynomial model | | | | | | |
| Intercept | .30 | (.07) | - | .26 | (.06) | - |
| Autonomy support | .48** | (.05) | .11 | .47** | (.05) | .11 |
| Contingency (C) | .14* | (.05) | .04 | .13* | (.05) | .03 |
| Expectations (E) | .05 | (.05) | .02 | .07 | (.05) | .02 |
| Help and support (H) | .35** | (.06) | .11 | .30** | (.06) | .09 |
| Monitoring (M) | .16* | (.06) | .05 | .15** | (.06) | .05 |
| C X E | .08† | (.04) | .03 | .08** | (.04) | .02 |
| C X H | .02 | (.05) | .01 | .02 | (.05) | .01 |
| C X M | .17** | (.06) | .07 | .17** | (.05) | .05 |
| E X H | .02 | (.05) | .01 | .02 | (.04) | .01 |
| E X M | .06 | (.05) | .02 | .06 | (.04) | .02 |
| H X M | .10 | (.06) | .03 | .10* | (.05) | .03 |
| Contingency$^2$ | .10* | (.04) | .03 | .12** | (.04) | .04 |
| Expectations$^2$ | .07† | (.04) | .02 | .07* | (.03) | .02 |
| Help and support$^2$ | .04 | (.05) | .01 | .04 | (.04) | .01 |
| Monitoring$^2$ | .01 | (.04) | .00 | .03 | (.04) | .01 |
| *F*-change | - | | | (4, 11234) = 4.28** | | |
| Variance explained | .10 | | | .11 | | |

*Note.* †$p$ = .05; *$p$ < .05; **$p$ < .01.

*Polynomial regression analysis – partial models*

To have a better understanding of the nature of relations between the four structure components (i.e., contingency [C], expectations [E], help and support [H], and monitoring [M)]) and RAI, we ran six sets of polynomial regressions where we regressed the RAI on each possible pair of the four structure components (e.g., contingency and expectations). For each pair, we controlled for the other two components (i.e., help and support and monitoring) and perceived autonomy-support (for example, see Model C & E). Table 3 illustrates the results of these six multilevel models with fixed slopes. In support of our hypotheses, they indicate that all the components were linearly and nonlinearly related to the RAI. The same was true for the two-way interaction and the two covariates. There were two exceptions, however. Specifically, expectations were not linearly related to the RAI in the model that referred to the pair of contingency and expectations (see Table 3, Model C & E). Likewise, the quadratic relations of help and support and monitoring to RAI were nonsignificant in the model that referred to the pair of help and support and monitoring (see Table 3, Model H & M). Similar results emerged when the same analyses were conducted after ignoring the nested structure of the data (see Table 4). The only two exceptions concerned the linear relation of contingency to RAI, which was nonsignificant in the model that referred to contingency and help and support (see Model C & H), and the model that referred to contingency and monitoring (see Model C & M).

*Response surface analyses for contingency and expectations*

To better capture the patterns of linear and nonlinear relations and the two-way interaction of each pair of structure components to RAI, we conducted separate response surface analysis for each partial model presented in Table 4. In each model, we were particularly interested in examining the slope and curvature of the surface along the lines of congruence and incongruence, the first and the second principal axes, and the lines at moderately low and high levels of RAI (respectively, 1 *SD* below and above the midpoint) of each pair of predictors. To examine the robustness of our results, we bootstrapped each model 10,000 times. Because the models yielded a similar picture, we describe only the model that concerned the linear and quadratic relations of contingency and expectations (and their interaction) to RAI. We then report in brief where the remaining models differed from that one. The reader can inspect the perspective and contour plot of each model in the online supplementary material. To reiterate, we ignored the nested structure of the data for the response surface analysis, as the available software package analyzes only ordinary least-square models. However, an inspection of the coefficients from the multilevel models (Table 3) and the respective ordinary least squares models (Table 4) shows that they differed slightly.

*Line of congruence.* Table 3 (Model C & E) showcases the results from the response surface analysis for the model that refers to contingency and expectations (after controlling for help & support, monitoring, and autonomy-support). Figures 1a (perspective plot) and 1b (contours plot) show a visual representation of the model in the three and the two dimensions, respectively. In line with our hypothesis 2, both the slope ($\alpha_1$) and the curvature ($\alpha_2$) (reflecting respectively, the linear and curvilinear relation) along the line of congruence were positive: $\alpha_1 = 0.20$, $SE = .06$, $t_{(11,577)} = 3.55$, $p < .001$ (95%-*CI*: 0.09, 0.32); $\alpha_2 = 0.38$ $SE = .05$, $t_{(11,577)} = 7.93$, $p < .001$ (95%-*CI*: 0.29,

**Table 3.** Relative autonomous motivation as predicted by the possible pairs of the four aspects of perceived structure at the within-classroom level, controlling for autonomy-support (multilevel model)

| | Relative autonomous motivation (RAI) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model C & E | | Model C & H | | Model C & M | | Model E & H | | Model E & M | | Model H & M | |
| Predictors | *B* | (*SE*) | *B* | (*SE*) | *B* | (*SE*) | *B* | (*SE*) | *B* | (*SE*) | *B* | (*SE*) |
| Intercept | .33 | (.06) | .34 | (.15) | .34 | (.06) | −.36 | (.06) | .34 | (.06) | .40 | (.06) |
| Linear | | | | | | | | | | | | |
| x | .14** | (.05) | .10* | (.05) | .10* | (.05) | .11** | (.05) | .12** | (.04) | .36** | (.05) |
| y | .06 | (.05) | .22** | (.05) | .14* | (.05) | .32** | (.03) | .29** | (.05) | .32** | (.05) |
| Interaction | | | | | | | | | | | | |
| x-y | .10* | (.04) | .16** | (.04) | .23** | (.04) | .11** | (.03) | .14** | (.03) | .15* | (.06) |
| Curvilinear | | | | | | | | | | | | |
| $x^2$ | .13** | (.04) | .15** | (.04) | .16** | (.04) | .11** | (.03) | .11** | (.03) | .07 | (.05) |
| $y^2$ | .12** | (.03) | .13** | (.03) | .11** | (.03) | .14** | (.04) | .12** | (.03) | .05 | (.04) |
| Covariates | | | | | | | | | | | | |
| Covariate 1 | .38** | (.04) | .17** | (.03) | .17** | (.04) | .21** | (.04) | .21** | (.04) | .22** | (.04) |
| Covariate 2 | .36** | (.05) | .37** | (.04) | .40** | (.04) | .36** | (.05) | .40** | (.04) | .18** | (.03) |
| Autonomy-S. | .48** | (.05) | .47** | (.05) | .47** | (.05) | .48** | (.05) | .49** | (.05) | .49** | (.05) |
| Variance expl | .09 | | .10 | | .10 | | .10 | | .10 | | .09 | |

*Note.* † $p = .05$. * $p < .05$. ** $p < .01$. Autonomy-S. = Autonomy-support
*Model C & E* = Contingency (x) and Expectations (y), controlling for linear relations of Help (covariate 1), Monitoring (covariate 2), and Autonomy-support.
*Model C & H* = Contingency (x) and Help (y), controlling for linear relations of Expectations (covariate 1), Monitoring (covariate 2), and Autonomy-support.
*Model C & M* = Contingency (x) and Monitoring (y), controlling for linear relations of Expectations (covariate 1), Help (covariate 2), and Autonomy-support.
*Model E & H* = Expectations (x) and Help (y), controlling for linear relations of Contingency (covariate 1), Monitoring (covariate 2), and Autonomy-support.
*Model E & M* = Expectations (x) and Monitoring (y), controlling for linear relations of Contingency (covariate 1), Help (covariate 2), and Autonomy-support.
*Model H & M* = Help (x) and Monitoring (y), controlling for linear relations of Contingency (covariate 1), Expectations (covariate 2), and Autonomy-support.

**Table 4.** Relative autonomous motivation as predicted by the possible pairs of the four aspects of perceived structure (ordinary least-squares model)

| | Relative autonomous motivation (RAI) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model C & H | | Model C & H | | Model C & M | | Model E & H | | Model E & M | | Model H &M | |
| Coefficients | *B* | (95%-*CI*) | *B* | (95%-*CI*) | *B* | (95%-*CI*) | *B* | (95%-*CI*) | *B* | (95%-*CI*) | *B* | (95%-*CI*) |
| Line of congruence | | | | | | | | | | | | |
| Slope ($\alpha_1$) | .20 | 0.09, 0.32 | .25 | 0.12, 0.38 | .21 | 0.08, 0.34 | .40 | 0.29, 0.51 | .42 | 0.32, 0.52 | .64 | 0.55, 0.71 |
| Curvature ($\alpha_2$) | .38 | 0.29, 0.47 | .49 | 0.39, 0.59 | .55 | 0.44, 0.65 | .38 | 0.30, 0.47 | .40 | 0.31, 0.48 | .29 | 0.22, 0.36 |
| Line of incongruence | | | | | | | | | | | | |
| Slope ($\alpha 3$) | .04 | −0.11, 0.18 | −.08 | −0.22, 0.05 | −.04 | −0.17, 0.09 | −.14 | −0.25, −0.03 | −.14 | −0.25, −0.04 | .01 | −0.13, 0.16 |
| Curvature ($\alpha 4$) | .19 | 0.04, 0.33 | .16 | 0.03, 0.29 | .08 | −0.04, 0.21 | .16 | 0.05, 0.27 | .12 | 0.01, 0.24 | −.01 | −0.22, 0.19 |
| Principal axes | | | | | | | | | | | | |
| Slope of 1st axis ($p_{11}$) | .81 | 0.15, 2.20 | .88 | 0.45, 1.59 | .87 | 0.55, 1.33 | 1.52 | 0.59, 3.20 | 1.37 | 0.64, 2.54 | 1.10 | 0.40, 2.37 |
| Slope of 2$^{nd}$ axis ($p_{21}$) | −1.86 | −5.95, −0.43 | −1.26 | −2.24, −0.63 | −1.22 | −1.83, −0.75 | −.79 | −1.70, −0.31 | −.83 | −1.56, −0.39 | −1.13 | −2.49, −0.42 |
| Slope of x when y is. . . | | | | | | | | | | | | |
| . . . moderately low (−1 *SD*) | .07 | −0.08, 0.21 | −.08 | −0.23, 0.06 | −.12 | −0.26, 0.02 | −.07 | −0.21, 0.06 | −.11 | −0.24, 0.02 | −.03 | −0.23, 0.16 |
| . . . moderate (~0 *SD*) | .12 | 0.02, 0.21 | .08 | −0.01, 0.18 | .08 | −0.01, 0.18 | .13 | 0.06, 0.20 | .14 | 0.07, 0.20 | .33 | 0.25, 0.41 |
| . . . moderately high (+1 *SD*) | .40 | 0.29, 0.51 | .51 | 0.39, 0.64 | .53 | 0.41, 0.66 | .61 | 0.51, 0.72 | .65 | 0.55, 0.76 | .81 | 0.71, 0.91 |

*Continued*

**Table 4.** (*Continued*)

| | Relative autonomous motivation (RAI) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model C & H | | Model C & H | | Model C & M | | Model E & H | | Model E & M | | Model H &M | |
| Coefficients | *B* | (95%-*CI*) | *B* | (95%-*CI*) | *B* | (95%-*CI*) | *B* | (95%-*CI*) | *B* | (95%-*CI*) | *B* | (95%-*CI*) |
| Slope of y when x is. . . | | | | | | | | | | | | |
| . . . moderately low (−1 *SD*) | .04 | −0.17, 0.25 | .11 | −0.08, 0.29 | −.01 | −0.17, 0.20 | .15 | −0.21, 0.06 | .13 | −0.02, 0.28 | −.05 | −0.27, 0.16 |
| . . . moderate (~0 *SD*) | .08 | −0.01, 0.17 | .17 | 0.07, 0.26 | .12 | 0.03, 0.22 | .27 | 0.06, 0.20 | .28 | 0.20, 0.36 | .31 | 0.23, 0.39 |
| . . . moderately high (+1 *SD*) | .39 | 0.30, 0.47 | .51 | 0.41, 0.61 | .52 | 0.42, 0.62 | .61 | 0.51, 0.72 | .64 | 0.44, 0.74 | .81 | 0.72, 0.89 |

*Note*. Based on n = 10,000 replications
*Model C & E* = Contingency (x) and Expectations (y). *Model C & H* = Contingency (x) and Help (y).
*Model C & M* = Contingency (x) and Monitoring (y). *Model E & H* = Expectations (x) and Help (y).
*Model E & M* = Expectations (x) and Monitoring (y). *Model H & M* = Help (x) and Monitoring (y).
For each model, the other two components of perceived structure as well as perceived autonomy support were also included as covariates.

0.47). This finding is in line with our congruence hypothesis (Hypothesis 2). A visual inspection of the surface along the line of congruence in Figure 1a confirms that higher and higher levels of RAI were reported among students who perceived their teacher to exceed moderate levels of both contingency and expectations.

*Line of incongruence.* In contrast to the line of congruence, the line of incongruence was less clear. Specifically, the slope (α3) was nonsignificant ($\alpha_3$ = 0.04, *SE* = .08, $t_{[11,577]}$ = 0.47, $p$ = .64 [95%-*CI*: −0.11, 0.18]), though the curvature was significant ($\alpha_4$ = 0.19, *SE* = .07, $t_{[11,577]}$ = 2.51, $p$ < .001 [95%-*CI*: 0.04, 0.33]). Inspection of the surface along the line of incongruence reveals that RAI was slightly higher when a teacher was perceived to be high in contingency and low in expectations (or the other way around). Instead, it appears that RAI was somewhat lower when a teacher was perceived to be at moderate levels of both contingency and expectations.

*First and second principal axes.* Bootstrap analyses indicated that the slope of the first principal axis ($p_{11}$), which shows the direction of the line of the steeper increase from the stationary point for convex surfaces (see Figures 1a and b), did not substantially differ from the line of congruence (the slope of which corresponds to the value of 1), $p_{11}$ = 0.81, (95%-*CI*: 0.15, 2.20). This result complements the findings that refer to the line of congruence: It suggests that the direction of the steepest increase of the estimated RAI took place along a line that did not differ from the statistical viewpoint from the line of congruence. Likewise, the slope of the second principal axis ($p_{21}$), which corresponds to the direction of the line with the least increase from the stationary point, did not differ from the line of incongruence. Specifically, the slope of the line of incongruence corresponds to the value of −1, whereas the slope of the second principal axis, $p_{21}$, was −1.86, and its confidence interval contained the unit of minus one (95%-*CI*: −5.95, −0.43).

*Relation of contingency to rai at different levels of expectations.* Next, we examined the linear relation of contingency at the surface that corresponds to lines at moderately low (1 *SD* below the midpoint), moderate (around the midpoint), and moderately high (1 *SD* above the midpoint) levels of expectations. Table 3 (see Model C&E, middle panel) shows the results of these analyses. As can be inspected, the slope was positive along the line that corresponded to moderately high ($b$ = .40, 95%-*CI*: 0.29, 0.51) or moderate levels of expectations ($b$ = .12, 95%-*CI*: 0.02, 0.21), whereas it was null at moderately low levels of expectations ($b$ = .07, 95%-*CI*: −0.08, 0.21). These results suggest that the linear relation of perceived contingency to the RAI was positive when perceived expectations passed moderate levels (see also the two long-dashed lines running parallel to the x-axis in Figure 1a and 1b).

*Relation of expectations to the rai at different levels of contingency.* Finally, we examined the linear relation of expectations at the surface that corresponds to lines at moderately low (1 *SD* below the midpoint), moderate (around the midpoint), and moderately high (1 *SD* above the midpoint) levels of contingency. Table 3 (see under Model C&E, lower panel) illustrates the results of these analyses. As can be inspected, the

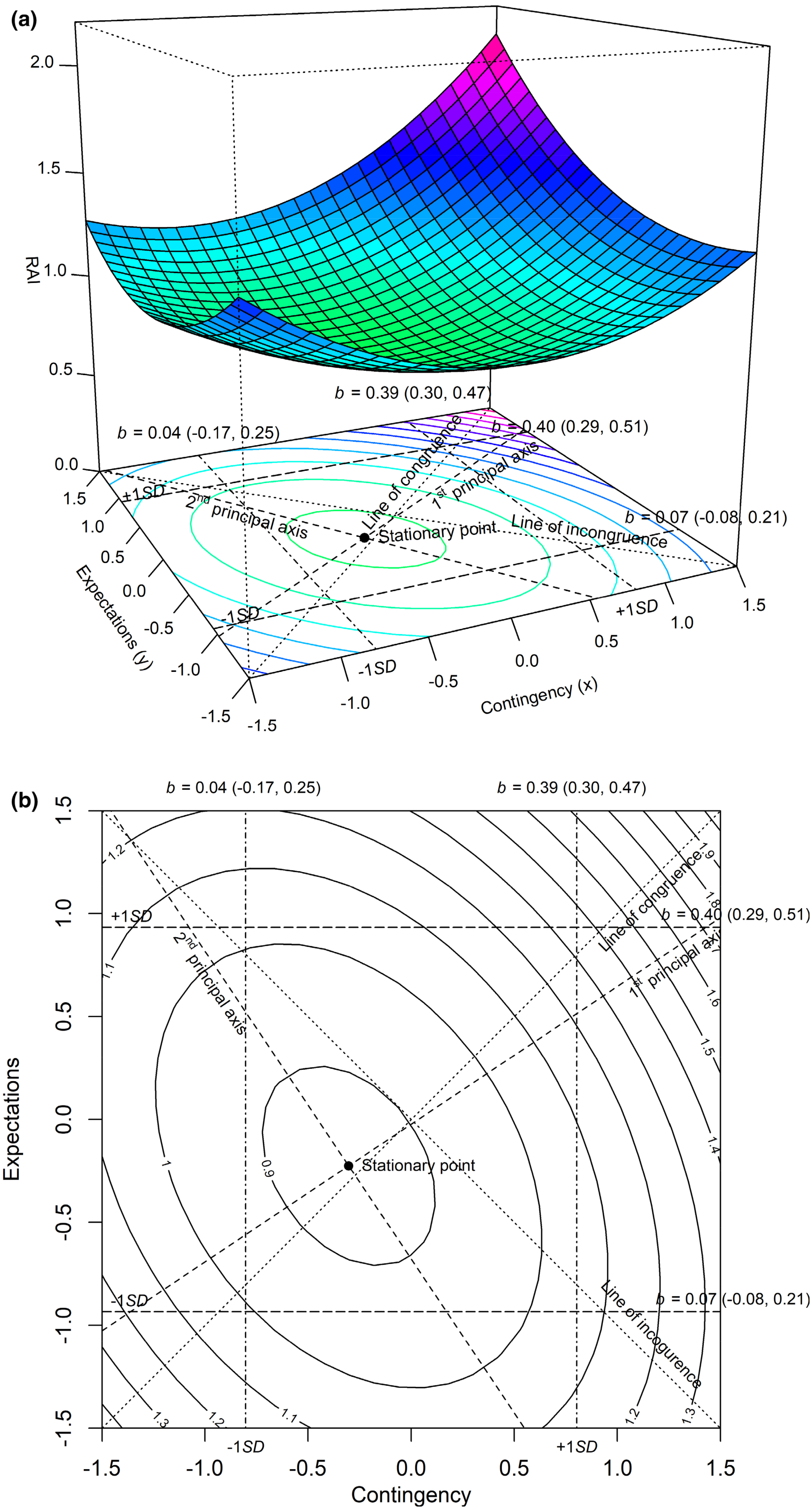
(a)
RAI
2.0
1.5
1.0
0.5
0.0
b = 0.39 (0.30, 0.47)
b = 0.04 (-0.17, 0.25)
b = 0.40 (0.29, 0.51)
b = 0.07 (-0.08, 0.21)
Line of congruence
1st principal axis
2nd principal axis
Stationary point
Line of incongruence
+1SD
-1SD
Expectations (y)
Contingency (x)
(b)
Expectations
Contingency
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5

**Figure 1.** (a) Response surface analysis of Relative Autonomous Motivation (RAI) as a function of Perceived Contingency (X) and Expectations (Y) after controlling for Help and Support, Monitoring, and autonomy support. In the X–Y plane, the dotted line running diagonally (a) from the near corner to the far corner and (b) from the left to right corner represent, respectively, the line of congruence and incongruence between contingency and expectations. The stationary point shows the location where the slope of the estimated surface is null in all directions. The two dashed lines that run perpendicular to each other at the stationary point represent the first and second principal axes that cross the X–Y plane within the contingency and expectations score range. The two dashed (and dot-dashed) lines running parallel to contingency (and expectations) represent the estimated (through bootstrap) linear relations of contingency (and expectations) to RAI at moderately high (+1 SD) and moderately low (−1 SD) scores of expectations (and contingency) with their 95% confidence intervals in parentheses. (b) Contour plot for contingency and expectations, the projection of which is also shown in (a). It exhibits the prediction of Relative Autonomous Motivation as a function of contingency and expectations after controlling for help and support, monitoring, and autonomy support.

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slope was null (as the 95%-CI after 10,000 bootstrap replications contained zero) along the line that corresponded to levels of contingency which were either moderately low ($b$ = .04, 95%-*CI*: −0.17, 0.25) or even moderate ($b$ = .08, 95%-*CI*: −0.01, 0.17). In contrast, that relation was positive at moderately high levels of expectations ($b$ = .39, 95%-*CI*: 0.30, 0.47). These findings suggest that the linear relation of perceived expectations to the RAI was positive when perceived contingency was moderate or low (see the two long-dashed lines running parallel to the y-axis in Figures 1a and 1b).

### *Response surface analyses for the other five models*

The model that focused on the pair of perceived contingency with help and support yielded a similar pattern (see Table 3, Model C & H). In that model, however, the relation of contingency to the RAI was also null when help and support was moderate (see Figures S1a and b). A similar pattern was found for the other four models with some slight differences. In particular, neither the slopes nor the curvature along the line of incongruence was significant along the line of incongruence in the models examining the pair of consistency with monitoring (see Table 3, Model C & M and Figures S2a and b). The same was true for the model testing the pair of help and support with monitoring (Model H & M; Figures S5a and b). Also, the slope along the line of incongruence was negative (rather than null) in the models that concerned expectations and help and support (Model E & H; Figures S3a and b) and expectations and monitoring (Model E & M; Figures S4a and b).

In summary, the results of polynomial regression analyses and the associated response surface analyses showed that students tended to more RAI when they rated their teachers high in all the four components of structure (i.e., consistency, expectations, help & support, and monitoring). These findings were in support of Hypothesis 2.

## Discussion

In line with our hypotheses, we found that all the four components – contingency, expectations, help and support, and monitoring – are linear predictors of relative autonomous motivation. To our knowledge, this is one of the first studies showing each of the four components comprising structure (Skinner et al., 1998) to relate to autonomous motivation. These results complement previous studies which indicated links between perceived structure and desired educational outcomes (e.g., Aelterman et al., 2019; Jang et al., 2010).

By relying on SDT as well, Aelterman et al. (2019) have conceptualised structure through vignettes as guiding and clarifying. Guiding refers to instructional practices that foster progress through scaffolding by providing proper and customised help and support and mutual and respectful interaction. Clarifying relates teachers' unambiguous communication of their expectations toward their students and monitoring of their progress. Although testing the interaction between these two subcomponents was out of the scope of their research, Aelterman et al. (2019) showed that guiding and clarifying are strongly related to each other and to desired outcomes, such as autonomous motivation and needs satisfaction.

Building on such findings, the present ones depict the positive role that each structure component can have for students' quality of motivation and can be used as a rubric regarding what teachers need to do in their classrooms to set up a conducive learning environment. Teachers need to be contingent, helpful, and responsive by explaining what they expect from their students while monitoring their learning efforts and progress.

Furthermore, the full polynomial regression model has shown that contingency and expectations, and contingency combined with monitoring, seem to be stronger predictors of autonomous motivation. Although it is prudent to suggest that providing help and support to students is a critical instructional practice that a teacher can use in everyday teaching, it appears that teachers' contingent behavior coincides with students' reporting autonomous motivation. The same holds for high expectations, as its curvilinear relation to autonomous motivation suggests. It seems that when students know what their teacher expects from them (either through her contingent behavior or the communication of clear expectations), they are more inclined to report volitional engagement in their learning activities. Over and above teacher's help and support, teacher's contingent behavior, clear expectations, and monitoring convey to students a message of respect and acknowledgment of their learning needs. This rapport seems to facilitate students focusing on their personal goals, values, and interests, a process that cannot but foster autonomous motivation.

Furthermore, a consistent synergistic effect emerged for any pair of the four structure elements, as suggested by the ascending surface of relative autonomous motivation along the line of congruence. Instead, the non-increasing surface along the line of incongruence across all the models implies that students reported less autonomous motivation when they perceived their teachers to emphasise one aspect of structure (e.g., contingency) but not another (e.g., monitoring).

Therefore, teachers need to ensure that they apply all the elements of the structure. Research has shown that when teachers believe that their students are motivated, they are less supportive toward them, probably because they devote their resources to less motivated students (Sarrazin, Tessier, Pelletier, Trouilloud, & Chanal, 2006). However, teachers need to support all their students and not take it for granted that most motivated or skilled students require less monitoring or help and support. However, this needed support should be tailored for each student accordingly as differentiated instruction seems to help teachers foster their students' autonomous learning (Smale-Jacobse, Meijer, Helms-Lorenz, & Maulana, 2019).

### Implications for research and practice

The present findings have considerable implications for teacher education and teacher professional development. They imply that teachers, especially novice ones, should practice and master the four structure skills altogether. As previous intervention studies in real-life classrooms showed, providing structure is possible, though challenging (Sebire et al., 2016), and can lead to desired educational outcomes (e.g., Tessier, Sarrazin, & Ntoumanis, 2010). Therefore, teacher education programs should provide special attention to equip preservice teachers with the mastery of structure skills. To continuously support novice teachers in their early professional practice, curricula of teacher induction should also focus on the structure.

But how could pre-service or in-service teachers practice themselves in providing all the components of structure? One way is to observe how other teachers apply (or fail to apply) the four components of a structure in the classroom. Another way is to raise teachers' self-awareness *via* structured observations of teachers' instructional behaviors through video recordings (Star & Strickland, 2008). Moreover, teacher educators and policymakers can encourage school-based interventions in improving teachers' balanced use of structure components. Whatever the likely method might be, it should be borne in mind that teachers need to be supported in the first place as the more teachers satisfy their own needs, the more likely they are to effectively implement structure to their classroom (Aelterman, Vansteenkiste, Van Keer, & Haerens, 2016).

### Limitations and future research

Several limitations should be acknowledged. First, the findings are based on cross-sectional, correlational data, which have been gathered from one source of information (i.e., students). Hence, we cannot claim causality as it is equally likely that autonomous motivated students rated more favorably their teachers. Also, our exclusive focus on the quality of motivation reminds us that future research needs to investigate the interplay between aspects of perceived structure and educational outcomes, preferably assessed by a third party. Such outcomes could include, but are not limited to, students' grades, students' individual and collective engagement as rated by their teachers (Michou et al., 2021), or by observers (Jang et al., 2010).

Second, we assessed each element of perceived structure using two out of the five or six items included in the original scale introduced by Belmont et al. (1988) However, each pair seems to have operated reasonably well and to sufficiently captured each underlying construct. Furthermore, some other key aspects constituting a competence supportive environment, such as providing constructive feedback, were not included. Third, we did not consider other essential elements of the classroom environment, such as perceived relatedness support and their interplay with structure and autonomy-support (which was included only as a covariate). However, we believe that the present study nicely builds on the limited prior work which examined the interplay between perceived autonomy support and only one aspect of structure – teachers' expectations (see Vansteenkiste et al., 2012). Future studies should determine to what extent each of the four elements of structure predicts higher levels of autonomous motivation when they coincide with perceived autonomy support and involvement. Another limitation concerns the generalisability of the present results to other educational and cultural contexts than those of Turkey, though prior research has shown the conducive role of structure across different educational settings (Vansteenkiste et al., 2010).

## Conflict of interest

All authors declare no conflict of interest.

## Author contribution

**Athanasios Mouratidis:** Conceptualization (equal); Data curation (equal); Formal analysis (equal); Investigation (equal); Writing – original draft (equal); Writing – review & editing (equal). **Aikaterini Michou:** Conceptualization (equal); Data curation (equal); Formal analysis (equal); Writing – original draft (equal). **Sibel Teli:** Data curation (equal); Investigation (equal); Methodology (equal); Resources (equal); Writing – review & editing (equal). **Ridwan Maulana:** Funding acquisition (equal); Project administration (equal); Resources (equal); Writing – original draft (equal). **Michelle Helms-Lorenz:** Funding acquisition (equal); Project administration (equal); Resources (equal); Writing – original draft (equal).

## Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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## Supporting Information

The following supporting information may be found in the online edition of the article:

**Figure S1**. (a) Response surface analysis of Relative Autonomous Motivation (RAI) as a function of perceived contingency (X) and help and support (Y), after controlling for expectations, monitoring, and autonomy-support. (b) The contour plot for contingency and help and support, the projection of which is also shown in Figure (a).

**Figure S2**. (a) Response surface analysis of Relative Autonomous Motivation (RAI) as a function of perceived contingency (X) and monitoring (Y), after controlling for help and support, expectations, and autonomous motivation. (b) The contour plot for contingency and monitoring, the projection of which is also shown in (a).

**Figure S3**. (a) Response surface analysis of Relative Autonomous Motivation (RAI) as a function of Expectations (X) and Help and Support (Y), after controlling for contingency, monitoring, and autonomy support. (b) The contour plot for expectations and help and support, the projection of which is also shown in Figure (a).

**Figure S4**. (a) Response surface analysis of Relative Autonomous Motivation (RAI) as a function of Expectations (X) and Monitoring (Y), after controlling for contingency, help and support, and autonomy support. (b) The contour plot for expectations and monitoring, the projection of which is also shown in (a).

**Figure S5**. (a) Response surface analysis of Relative Autonomous Motivation (RAI) as a function of Help and Support (X) and Monitoring (Y), after controlling for contingency, expectations, and autonomy support. (b) The contour plot for help and support and monitoring, the projection of which is also shown in (a).