Latent Class Transitions and Influencing Factors of Primary School Students' Learning Engagement Under the "Double Reduction" Policy

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Abstract

This study employed latent transition analysis to examine the transition categories of elementary school students' learning engagement and their influencing factors within the context of the "Double Reduction" policy. A total of 347 elementary school students were recruited as participants, and longitudinal tracking was conducted on their learning engagement levels, positive parenting styles, teacher-student relationships, and peer relationships before and after the implementation of the "Double Reduction" policy. The results indicated that: (1) elementary school students' learning engagement could be classified into four distinct categories: "low learning engagement group," "moderate learning engagement group," "high-focus low-vitality group," and "high learning engagement group"; (2) following the implementation of the "Double Reduction" policy, the "moderate learning engagement group" and "high learning engagement group" demonstrated strong stability, the "low learning engagement group" was more likely to transition to the "moderate learning engagement group," students in the "high-focus low-vitality group" were more prone to transition to the "moderate learning engagement group" half a year after policy implementation, while one year after implementation, these students had a higher probability of remaining in the "high-focus low-vitality group"; (3) the predictive effects of positive parenting styles, teacher-student relationships, and peer relationships on the transition categories of elementary school students' learning engagement differed before and after the "Double Reduction" policy. This study not only contributes to a deeper understanding of the developmental changes in and influencing factors of elementary school students' learning engagement, but also provides empirical evidence for the effectiveness of the "Double Reduction" policy.

Full Text

Preamble

Using standardized scores from the three dimensions of student learning engagement at T1, T2, and T3, we conducted latent profile analysis with gender included as a covariate. The model fit indices for different latent profile models at the three time points are presented in Table 3 . The study employed AIC, BIC, aBIC, Entropy, LMRT, and BLRT as model fit indices. Lower values of AIC, BIC, and aBIC indicate better model fit (Jung & Wickrama, 2008). When Entropy exceeds 0.80, it signifies that over 90% of cases are correctly classified (Côté et al., 2002). Significant p-values for LMRT and BLRT indicate that the k-class model differs significantly from the k-1 class model (Jung & Wickrama, 2008).

At T1, AIC, BIC, and aBIC decreased progressively as the number of classes increased. For the three-class model, Entropy was 0.77, indicating poor classification accuracy. When the model reached four classes, AIC, BIC, and aBIC showed substantial decreases, Entropy was 0.84, and the BLRT p-value was significant. For the five-class model, although AIC, BIC, and aBIC continued to decrease and both LMRT and BLRT p-values were significant, one class accounted for only 1.73% of cases (n = 6), suggesting potential issues with underrepresentation and limiting subsequent statistical analyses. Overall, the four-class model was optimal at T1. The model performance at T2 and T3 was largely consistent with T1. Considering model consistency, parsimony, and practical utility, this study selected the four-class latent profile model.

Drawing on naming conventions from previous research (Bae et al., 2020; Miller et al., 2021) and based on the standardized deviation differences between subgroups' scores on the three dimensions of vigor, motivation, and absorption relative to each dimension's mean (as shown in Figure 1 [Figure 1: see original paper]), this study named the learning engagement subgroups as "Low Engagement," "Moderate Engagement," "High Absorption with Low Vigor," and "High Engagement." The "Low Engagement" subgroup scored more than one standard deviation below the mean across all learning engagement dimensions. The "Moderate Engagement" subgroup scored near the average across all dimensions, with no dimension falling more than one standard deviation below the mean. For the "High Absorption with Low Vigor" subgroup, scores across all three dimensions at each time point were above the mean by less than 0.5 standard deviations. ANOVA results for the three dimension scores at T1 showed: $F(2, 519) = 2.30$, $p = 0.10$, $p = 0.01$, with absorption dimension scores ($M = 0.35$) higher than vigor dimension scores ($M = 0.24$). At T2, ANOVA showed: $F(2, 270) = 10.35$, $p < 0.001$, $p = 0.07$, with post-hoc tests indicating absorption scores ($M = 0.44$) were significantly higher than vigor scores ($M = 0.11$), $p < 0.001$. At T3, ANOVA showed: $F(2, 246) = 9.78$, $p < 0.001$, $p = 0.07$, with post-hoc tests indicating absorption scores ($M = 0.47$) were significantly higher than vigor scores ($M = 0.17$), $p < 0.001$. These results demonstrate that this subgroup's

absorption scores exceeded their vigor scores, hence the name "High Absorption with Low Vigor." The "High Engagement" subgroup scored approximately one standard deviation above the mean across all learning engagement dimensions. The proportions of participants in each subgroup at T1, T2, and T3 are shown in Table 3.

MANOVAs were used to examine differences in learning engagement dimension scores across subgroups. Results revealed significant main effects of learning engagement subgroup at all three time points, $Fs(3, 343) \geq 319.14$, $ps < 0.001$, $p \geq 0.74$. Table 4 presents score differences between learning engagement subgroups on each dimension, with Bonferroni post-hoc multiple comparisons. Results showed that at all three time points, the "Low Engagement" subgroup scored significantly lower than the "Moderate Engagement" subgroup on all three dimensions ($ps < 0.001$). The "Moderate Engagement" subgroup scored significantly lower than the "High Absorption with Low Vigor" subgroup on all dimensions ($ps < 0.001$). The "High Absorption with Low Vigor" subgroup scored significantly lower than the "High Engagement" subgroup on all dimensions ($ps < 0.001$).

3.4 Transition Patterns of the Four Learning Engagement Groups from T1 to T3

The transition patterns of the four learning engagement groups from T1 to T3 are presented in Table 5 and Figure 2 [Figure 2: see original paper]. The diagonal of the transition matrix in Table 5 represents the probability of participants remaining in their original latent class. Students in the "Low Engagement" group tended to transition toward the "Moderate Engagement" group after the "double reduction" policy. The probabilities of transitioning to the "Moderate Engagement" group were 55% from T1 to T2 (six months after policy implementation) and 44% from T2 to T3 (one year after implementation). Students in the "Moderate Engagement" group showed relatively high probabilities of remaining in their original group, with retention probabilities of 43% from T1 to T2 and 61% from T2 to T3. For the "High Absorption with Low Vigor" group, from T1 to T2, these students tended to transition to the "Moderate Engagement" group (39%). However, from T2 to T3, they were more likely to remain in the "High Absorption with Low Vigor" group (49%). Students in the "High Engagement" group tended to remain in their original group after the policy, with retention probabilities of 54% from T1 to T2 and 65% from T2 to T3.

3.6 Predictors of Learning Engagement Latent Class Transitions

To examine predictors of learning engagement latent class transitions, we developed a latent transition model including age and gender as covariates to investigate how positive parenting style, teacher-student relationships, and peer relationships influenced transitions in students' learning engagement classes over time under the "double reduction" context. Participants who maintained their

original latent status served as the reference group for multinomial logistic regression analysis, yielding odds ratios (OR) for transitions to other groups. OR > 1 indicates increased likelihood of a particular transition, while OR < 1 indicates decreased likelihood (Wang et al., 2015). Results are presented in Table 6 .

When using the "Low Engagement → Low Engagement" transition as the reference, from T1 to T2, positive parenting style increased the probability of "Low Engagement" students transitioning to the "High Absorption with Low Vigor" group (B = 1.97, SE = 0.77, p = 0.01, OR = 7.16) and to the "High Engagement" group (B = 2.08, SE = 0.90, p = 0.02, OR = 8.01). However, from T2 to T3, the predictive effect of positive parenting style was no longer significant, while the role of positive teacher-student relationships emerged: good teacher-student relationships increased the probability of "Low Engagement" students transitioning to the "High Absorption with Low Vigor" group (B = 2.43, SE = 1.00, p = 0.02, OR = 11.40).

When using the "Moderate Engagement → Moderate Engagement" transition as the reference, from T1 to T2, positive parenting style increased the probability of "Moderate Engagement" students transitioning to the "High Engagement" group (B = 0.99, SE = 0.50, p = 0.01, OR = 2.69), while good teacher-student relationships decreased the probability of transitioning to the "Low Engagement" group (B = –0.88, SE = 0.40, p = 0.03, OR = 0.42). From T2 to T3, the positive effects of both positive parenting style and good teacher-student relationships persisted, and the positive effect of good peer relationships also emerged: positive peer relationships increased the probability of "Moderate Engagement" students transitioning to the "High Absorption with Low Vigor" group (B = 0.60, SE = 0.31, p = 0.50, OR = 1.83).

When using the "High Absorption with Low Vigor → High Absorption with Low Vigor" transition as the reference, from T1 to T2, positive parenting style decreased the probability of students in this group transitioning to the "Low Engagement" group (B = –0.96, SE = 0.42, p = 0.02, OR = 0.38) and to the "Moderate Engagement" group (B = –0.62, SE = 0.23, p = 0.01, OR = 0.65), while increasing the probability of transitioning to the "High Engagement" group (B = 1.29, SE = 0.39, p < 0.001, OR = 3.65). Good teacher-student relationships decreased the probability of transitioning to the "Moderate Engagement" group (B = –0.53, SE = 0.24, p = 0.03, OR = 0.59). From T2 to T3, the effect of teacher-student relationships on learning engagement transitions was no longer significant.

When using the "High Engagement → High Engagement" transition as the reference, from T1 to T2, positive parenting style decreased the probability of "High Engagement" students transitioning to the "Low Engagement" group (B = –2.93, SE = 0.67, p < 0.001, OR = 0.05) and to the "Moderate Engagement" group (B = –1.59, SE = 0.65, p = 0.02, OR = 0.21). Good teacher-student relationships decreased the probability of transitioning to the "Low Engagement" group (B = –2.14, SE = 0.62, p < 0.001, OR = 0.12), to the "Moderate En-

gagement" group (B = –1.63, SE = 0.56, p = 0.004, OR = 0.20), and to the "High Absorption with Low Vigor" group (B = –1.12, SE = 0.54, p = 0.04, OR = 0.33). From T2 to T3, the effects of positive parenting style and teacher-student relationships on learning engagement transitions were similar to those from T1 to T2.

Overall, positive parenting style and good teacher-student relationships robustly influenced students' learning engagement transitions before and after the "double reduction" policy, with the predictive effects of teacher-student relationships varying across different subtypes of primary school students. Additionally, after the policy implementation, positive peer relationships played an active role in the learning engagement transitions of students in the "Moderate Engagement" group.

4 Discussion

4.1 Heterogeneity and Dynamic Changes in Primary School Students' Learning Engagement

Through latent transition analysis of primary school students' learning engagement, this study found that before and after the "double reduction" policy, the "Moderate Engagement" and "High Engagement" groups demonstrated relatively strong stability, while the "Low Engagement" and "High Absorption with Low Vigor" groups showed poorer stability. These findings indicate that learning engagement is both heterogeneous and dynamic, and that macro-level policies can influence its development, thereby validating and extending the integrative model of engagement (Wang et al., 2019). Before the "double reduction" policy, influenced by utilitarian value orientations, scores and rankings were prioritized by most teachers and parents, increasing student pressure and undermining autonomy and intrinsic motivation (Ryan & Deci, 2020). Following policy implementation, the expansion of technology and interest-based activities met students' individualized development needs (Huang & Zhou, 2022), and reduced academic burden coupled with increased autonomous development space triggered students' intrinsic motivation (Ryan & Deci, 2020; Ning & Yang, 2022). Consequently, students in the "Low Engagement" group tended to transition toward the "Moderate Engagement" group. For students who already demonstrated relatively high learning engagement before the policy, their intrinsic motivation remained persistent and intense, making it easier for them to maintain stable high-level engagement (Zhen et al., 2020).

Notably, six months after the "double reduction" policy implementation, students in the "High Absorption with Low Vigor" group were more likely to transition to the "Moderate Engagement" group, while one year after implementation, these students showed higher probabilities of remaining in the "High Absorption with Low Vigor" group. Based on Educational Effectiveness Theories, Kyriakides et al. (2015) propose that policy formulation should fully consider beneficiaries' capabilities and readiness for policies to exert positive effects. Af-

ter the rapid implementation of the "double reduction" policy, primary school students experienced reduced homework quantity and difficulty, and the nationwide after-school tutoring market contracted dramatically, exposing students to the "quality education" trend in a short period. However, some students had relatively weak self-management skills and lacked the ability to make full use of their leisure time, leaving them unprepared for the policy changes (Ning & Yang, 2022). Therefore, in the initial stage of policy implementation, students were in an "exploration mode," and the positive effects of the policy on the learning engagement of the "High Absorption with Low Vigor" group had not yet manifested. One year after implementation, as the intensity of environmental change relatively diminished and students adapted to the new context, their learning engagement levels stabilized, reflecting a positive social adaptation process.

4.3 The Influencing Mechanism of Environmental Factors on Learning Engagement Transitions

This study found that positive parenting style exerted positive effects on student learning engagement under the "double reduction" policy, consistent with previous research (Lan, 2022; Zhou et al., 2019). Additionally, the study revealed that the influence of positive parenting style on transitions among learning engagement subgroups showed minimal differences before and after policy implementation, because parents employing positive parenting consistently provide crucial support and environments needed for student growth (Teuber et al., 2022; Zhang et al., 2017). Thus, positive parenting style demonstrated robust positive effects across most learning engagement subtypes. Specifically, when students faced academic setbacks, parents using positive parenting consistently cultivated positive learning emotions through encouragement (Juvonen et al., 2012), infusing students with vigor and enthusiasm for learning. Moreover, rather than punishing poor learning discipline (Wang et al., 2018), parents with higher levels of positive parenting focused on cultivating students' learning skills and strategies (Hoover-Dempsey & Sandler, 1995), enhancing learning absorption. Therefore, strengthening parents' primary responsibility and guiding them toward scientific family education concepts proves essential under the "double reduction" policy (Bian & Zhang, 2022).

Consistent with previous research, this study found that teacher-student relationships positively influenced student learning engagement (Zhen et al., 2020). Good teacher-student relationships provide emotional support (Verschueren & Koomen, 2012), reduce negative emotions, help students feel cared for and understood, and promote positive emotional experiences in the classroom (Meyer & Turner, 2007), enabling students to actively explore their learning environment and increase engagement (Bergin & Bergin, 2009). Thus, positive teacher-student relationships can serve as a protective factor that reduces academic risk and enhances learning engagement.

Notably, the predictive effects of teacher-student relationships on learning engagement transitions differed before and after the "double reduction" policy.

For the "Low Engagement" group, before the policy, parents enrolled students in various after-school tutoring programs to improve academic performance, resulting in relatively weak school connections. The policy's requirements to regulate off-campus tutoring and expand diverse after-school services at school enlarged the educational space, and the provision of in-school academic tutoring and online teacher guidance reconnected students with teachers (Huang & Zhou, 2022), revealing the positive effects of good teacher-student relationships on transitions for the "Low Engagement" group after policy implementation. For the "High Absorption with Low Vigor" group, students demonstrating "absorption" received teacher encouragement, as high absorption in primary school often signifies good academic performance (Putwain et al., 2019). Consequently, good teacher-student relationships played a positive role in this group's learning engagement development before the policy. After policy implementation, as students entered "exploration mode" and focused more on whether their individualized development needs could be met through expanded after-school services and improved teaching quality (Huang & Zhou, 2022), macro-environmental factors exerted greater influence on learning engagement transitions than micro-environmental factors, and teacher-student relationships no longer showed significant effects. Meanwhile, good teacher-student relationships consistently influenced transitions for both the "Moderate Engagement" and "High Engagement" groups before and after the policy. In regular large-class teaching, teachers can typically only address common needs of most students (Yang & Zhang, 2022). As the largest subgroup, the needs of "Moderate Engagement" students were often well met. Additionally, influenced by educational competition, teachers provided more attention and support to top students, giving the "High Engagement" group greater teacher support (Deng et al., 2022). In the initial stage of the "double reduction" policy, the realities of large-class teaching and traditions of educational competition could not be immediately changed, so the influence of teacher-student relationships on these two subgroups remained unchanged.

Unlike Bear et al.'s (2018) finding that Chinese students' learning engagement was not associated with peer relationships, this study identified positive effects of peer relationships on primary school students' learning engagement, particularly in facilitating transitions from "Moderate Engagement" to "High Absorption with Low Vigor." This discrepancy arises because Bear et al. (2018) adopted a variable-centered approach, which diluted the effects of peer relationships on the "Moderate Engagement" group through their influence on other groups. This highlights the necessity of adopting a person-centered approach in this study to explore the heterogeneous effects of peer relationships on different learning engagement subgroups. For "Moderate Engagement" students, before the "double reduction" policy, cooperative learning in small groups with "inter-group homogeneity and intra-group heterogeneity" was widely implemented, allowing higher-engagement students to output accurate, high-quality knowledge from which "Moderate Engagement" students benefited (Law, 2014). However, this cooperative learning approach had a knowledge-oriented tendency, emphasizing knowledge and skill sharing while neglecting communication among group mem-

bers, disconnecting knowledge learning from interpersonal interaction. After the "double reduction" policy, the utilitarian education orientation was reversed (Li & Li, 2022), the knowledge-oriented learning atmosphere gradually shifted toward a student-oriented approach, and increased student autonomy at school (Huang & Zhou, 2022) led to more frequent peer interactions, reconnecting learning activities with interpersonal communication. Positive peer relationships make individuals feel safe, thereby promoting sharing and exchange and increasing vigor and enthusiasm for learning (Lee & Ha, 2022). Additionally, good peer relationships in the classroom often translate into learning engagement behaviors, such as management of learning time and attention, which increases absorption during learning (Lee & Ha, 2022), revealing the positive effects of peer relationships on transitions for "Moderate Engagement" students.

Overall, the "double reduction" policy both reaffirmed and expanded schools' educational authority while demanding "clear family-school educational responsibilities, close family-school communication, and innovative collaborative approaches," presenting new requirements for family-school collaborative education (Li & Li, 2022). This highlighted the distinct roles of teacher-student relationships and peer relationships (both school microsystems) and positive parenting style (family microsystem). These findings validate ecological systems theory, which posits that microsystem influences on individual development change as macrosystems change (Bronfenbrenner, 1979). The study reveals that microsystems including parents, teachers, and peers collectively influence individual learning engagement levels, and that these collective influences shift under policy implementation contexts: before the "double reduction" policy, only positive parenting style and teacher-student relationships influenced learning engagement transitions, indicating differential synergy among microsystems in individual development; after policy implementation, positive parenting style, teacher-student relationships, and peer relationships all influenced learning engagement transitions, indicating cumulative synergy among microsystems. Furthermore, this study's person-centered approach extends the application of differential synergy, demonstrating that it can manifest not only as different microsystems' differential effects on variables (e.g., learning engagement) but also as different microsystems' differential effects on different subgroups. Although positive parenting style, teacher-student relationships, and peer relationships showed cumulative synergy on learning engagement transitions overall after the "double reduction" policy, this cumulative synergy was only evident among "Moderate Engagement" students, expanding ecological systems theory (Skinner et al., 2022).

4.4 Limitations and Future Directions

First, although this study conducted three waves of longitudinal surveys, the intervals were relatively short, with a total survey period of 13 months and a relatively small sample size. Future research should extend the survey period and increase sample size to further explore the robustness of learning engagement

transition patterns among primary school students after the "double reduction" policy. Second, during the survey period, the "COVID-19" pandemic was in a recurring phase, which affected parenting style (Tao & Xu, 2020), teacher-student relationships (Lessard & Puhl, 2021; Tao & Xu, 2020), and peer relationships (Lessard & Puhl, 2021). Therefore, the effects of environmental factors such as parents and schools on students' learning engagement transitions may have been influenced by both the "double reduction" policy and the COVID-19 pandemic, requiring further investigation with additional evidence. Finally, future research could consider exploring the impact of the "double reduction" policy on student learning engagement using other policy-related factors (e.g., academic burden, homework completion time) and multiple perspectives (Zhang et al., 2020).

5 Conclusion

Chinese primary school students exhibit four distinct learning engagement classes: "Low Engagement," "Moderate Engagement," "High Absorption with Low Vigor," and "High Engagement." After the "double reduction" policy implementation, the "Moderate Engagement" and "High Engagement" groups showed strong stability. Students in the "Low Engagement" group were more likely to transition to the "Moderate Engagement" group. Six months after policy implementation, the "High Absorption with Low Vigor" group was more likely to transition to the "Moderate Engagement" group, while one year after implementation, these students showed higher probabilities of remaining in the "High Absorption with Low Vigor" group. Positive parenting style, positive teacher-student relationships, and positive peer relationships serve as promotive and protective factors for learning engagement class transitions. Positive parenting style and good teacher-student relationships robustly influenced learning engagement transitions before and after the "double reduction" policy, with teacher-student relationships showing varying predictive effects across different learning engagement subtypes. After the policy implementation, positive peer relationships played an active role in the learning engagement transitions of "Moderate Engagement" students.

Data Availability

The research data associated with this paper (DOI: 10.57760/sciencedb.06343) can be accessed in the Science Data Bank database (https://www.scidb.cn/surl/xlxb).

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Note: Figure translations are in progress. See original paper for figures.