

Original Article



Dynamic Modeling for Influencing Factors of Pupils' Learning Behavior

Baorong Xiao¹, Tengfei Wang²

¹School of Marxism, Weinan Normal University, Weinan 714099, China

²School of Intelligent Manufacturing & Information Engineering, Shaanxi Energy Institute, Xianyang 712000, China

*Corresponding Author: Tengfei Wang

Abstract:

Pupils' learning behavior is an important predictor of their academic success and a hot spot in elementary education research at home and abroad. However, in the academic circle, there is no consensus on the learning behavior influence mechanism. To analyze the main factors affecting pupils' learning behavior, the educational subjects of family, school and society are introduced, and the system dynamics (SD) model for influencing factors of pupils' learning behavior is constructed using Vensim simulation software. The model is dynamically simulated and analyzed. The results showed that education intensity has the greatest impact on pupils' learning behavior, and the joint strategy of family, school and society more benefits the cultivation of pupils' good learning behavior. Therefore, schools need to actively carry out learning behavior publicity and education activities and strengthen the supervision of pupils' learning behavior to improve their attention to learning, which will be more conducive to the cultivation and maintenance of their learning behavior.

Keywords: Learning behavior; System dynamics; Influencing factors; Dynamic modeling; Educational subjects

Introduction

From behavior to learning behavior, psychology to education, learners' learning behavior has been the focus of researchers to find problems and explore ways to solve them. Learning behavior results from the interaction between the learning subject and the surrounding social environment, and it is the sum of activities carried out by learners to obtain learning results (Wilson, 1993; Liu, Li, & Qiao, 2022). It is an important aspect to measure pupils' comprehensive performance in school and their academic success. Research shows that the better learning behavior of pupils indicates greater learning achievement in all aspects, and negative emotions and behaviors decrease accordingly (Guo, Liu, & Yang, 2021). With the rapid rise and application of educational cloud services, big educational data and mobile learning, pupils' learning scenes and learning mentality have changed, and the factors affecting pupils' learning behavior are becoming increasingly complex. Studying the influencing factors of pupils' learning behavior and its

improvement path has become an urgent issue in China's elementary education circles.

However, a unified understanding of the connotation of learning behavior is not formed. Since learning behavior is related to almost all aspects of pupils' learning, it is complex and multidimensional. The earliest research on learning behavior is behaviorism theory summarized by Thomas: most behaviors depend on specific stimuli and can be taught, changed and shaped, which means they can be generated by adjusting stimuli and changing the environment (Yao, Mi, & Wang, 2009). By studying instructional design theory, Chen and Xu (2019) defined teaching and learning behaviors and pointed out that learning behavior is the sum of activities carried out by learners to obtain certain learning results under the guidance of certain motivations. Yang and Xu (2022) summarized learning behavior from result form, content form, activity form and shape form and concluded that it is the sum of two-way interactive

activities between learners and the learning environment to obtain a certain learning result promoted by a certain motivation.

There are different views on the meaning of learning behavior. The existing literature on learning behavior mainly focuses on the influencing factors of learning behavior, especially learning motivation and specific discipline psychology (Cao, 2014; Qin, 2022; Wei, 2012; Li, Yao, Hou, & Wang, 2012; Peng, 2014). At the same time, in the research process, questionnaires are mainly adopted to conduct research, and the problem is explained based on the frequency of some learning behaviors. The action mechanism of internal and external factors of learning behavior is not comprehensively investigated. Most research is limited to exploring the relationship between some variables, resulting in research deficiencies. To analyze the main factors affecting pupils' learning behavior, an SD model for influencing factors of pupils' learning behavior was constructed, and the relationship between learning behavior and the educational subjects of family, school and society was systematically investigated. The research results will help clarify the connotation and mechanism of pupils' learning behavior and explore the ways to improve pupils' learning behavior and effectiveness in China.

2. Analysis of the Influencing Factors of Pupils' Learning Behavior

Finding ways to better construct the future learning environment, understand the learning subject and implement the future teaching are the major challenges for the realization of personalized learning (Yang, 2019). This section will focus on the domestic and foreign-related research on the family, school and social factors affecting learning behavior.

2.1 Family Factors

Family parenting style influences all aspects of children's learning and life, which is reflected in the development of their cognitive and non-cognitive abilities, mental health level and problem behavior. Although the conclusions of different studies are not completely consistent, most studies have found that whether in western countries such as Britain and the United States or in Asian countries such as China and Japan, positive parenting styles positively impact

children's learning behavior, while negative ones exert a negative impact. The main reason is that a good parenting style can provide children with emotional support, action explanation and equal communication, which helps develop their sense of security, autonomy and social ability (Baumrind, 1989; Durkin, 1995). The research on learning behavior showed that positive parenting styles (such as parents' democracy, tolerance, appreciation and encouragement) could improve pupils' learning interest and learning engagement; The negative ones (such as scolding, autocracy, harshness and interference) are easy to cause pupils' bad emotions and learning burnout (Luo, Chen, & Wang, 2016; Dai, & Jia, 2024; Zhi, Yu & Liu, 2024).

2.2 School Factors

According to the field theory of Lewin, school factors can be used to reflect the characteristics of the individual's "living space". It effectively affects the individual's psychology and behavior through group motivation. However, there is still a lack of empirical research on the school factors affecting pupils' learning behavior. Previous studies have found that the school factors influencing learning behavior include: school scale, learning atmosphere, school belonging and academic burden. The study found that pupils in relatively small schools have higher learning behavior (Finn, & Voelkl, 1993). Lee and Smith (1995) studied a nationally representative random sample of pupils in the United States and found that pupils' participation in school policies and management will also positively affect their learning behavior. The research of Voelkl (1997) showed a significant positive correlation between pupils' school identity, school belonging and learning engagement. Some domestic researchers believe that the main school factors affecting pupils' behavior include: high pressure of entrance examination, heavy academic burden, boring and difficult teaching content, high work pressure on teachers and low teaching quality (Zhang, & Chai, 2024). Thus, the cultivation of learning behavior can be influenced by factors such as teachers' teaching organization and school management policies. Therefore, Li *et al.* (2021) developed a goal-oriented active learning system to study how pupils' cognition of self-directed learning ability affects their reading

input, self-directed learning behavior and extensive reading motivation. Lai et al. (2020) proposed the enhanced extended nearest neighbor algorithm to help teachers better understand the personality characteristics of pupils and then teach them accordingly. Hwang et al. (2012) put forward a network-based programming-assisted cooperative system and explored the relationship between pupils' cooperative programming learning behavior and their academic achievement. Jovanovic et al. (2012) applied a classification model (including data preprocessing, parameter optimization and attribute selection) to predict pupils' academic performance and explore the relationship between learning field and learning behavior. Shieh et al. (2014) used the Delphi method to determine the factors affecting learning motivation and then studied the learning styles and learning motivation adjustment strategies of pupils.

2.3 Social Factors

The social environment covers many areas, such as social relations, social atmosphere, customary forces, cultural facilities, family conditions, relatives and friends(Wu, 2016). With the development of society, the composition of the social environment is becoming increasingly complex, and so does its impact on human activities. The social environment provides conditions for pupils' learning and exerts various influences on them. Correspondingly, they also make various responses to the social environment, including the performance of their learning behavior.

2.3.1 The Influence of Social Trends on Pupils' Learning Behavior

Social trends refer to mass social activities formed based on the wishes of the majority(She, 2015). In such social activities, everyone will use this trend to realize their personal wishes. By following the

trend, people can express themselves, and their personalities will also be changed. It is characterized by the polarized development of all activities related to the trend, which means the characteristics fitting the trend will be developed, and the violations will be severely restrained.

2.3.2 The Influence of Social Change Factors on Pupils' Learning Behavior

There are various changes during social development, with some being unilateral or multifaceted, gradual or sharp, positive or negative. However, no matter what kind of change, it will greatly influence pupils' learning behavior(Kang, & Liu, 2022).

2.3.3 The Influence of Political Education on Pupils' Learning Behavior

Political education, the necessity for human society, also affects pupils' learning behavior(Xin, Yu, & Yao, 2019). It cannot be changed subjectively, whether people like it or not. It plays an important role in the growth of talents and the corresponding development of morality and talent.

To sum up, the current research on pupils' learning behavior is immature. The research on the impact of family, school and society on pupils' learning behavior is separated. Based on the big data of pupils' daily life and learning activities, this paper introduces the educational subjects of family, school and society, explores the influence of school, family and social factors on pupils' learning behavior to help them cultivate good learning behavior (see Figure 1 for the research framework), and constructs the simulation model for factors influencing pupils' learning behavior using SD. Through causality analysis and dynamic simulation analysis, the action mechanism between various factors is explored to provide theoretical suggestions and a decision-making basis for cultivating pupils' good learning behavior.

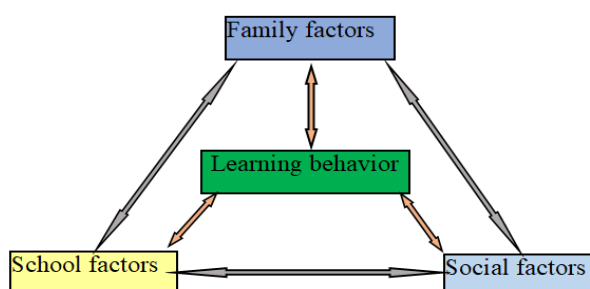


Figure 1. The research framework for factors influencing pupils' learning behavior

3. System dynamics study on the influencing factors of pupils' learning behavior

System dynamics, as a systematic, comprehensive reasoning method combining qualitative and quantitative, is widely used in industry, agriculture, economy, society, ecology and other fields (Wang, & Ye, 2023). It can be used to reflect the relationship between the internal and external factors of the system and emphasize the mutual connection and interaction between the system and the environment; Its behavior mode and characteristics are mainly determined by the internal dynamic structure and feedback mechanism of the system and are not disturbed by external factors. The variable contained in the system changes with time, so it can be used to simulate long-term and periodic system problems. Process of SD dealing with problems:

- 1) Put forward questions: clarify the problems to be studied and solved and the purpose of establishing the model;
- 2) Analyze reference behavior patterns: analyze the system events and actual behavior patterns, and put forward the envisaged and desired system behavior patterns that are used as the goal of improving and adjusting the system structure;
- 3) Put forward the hypothesis and establish the model: start from the behavior mode, put forward the structural hypothesis of the system, and start from the hypothesis, design the causal-loop diagram and stock-flow diagram of the system, define the parameters and list the equations. Thus, a series of SD hypothesis are expressed by clear mathematical relations;
- 4) Model simulation: adjust parameters, run the model and generate behavior patterns. The established model is like a laboratory, which can understand the relationship between structure and system behavior mode through the changes of test parameters and structure.

At present, many scholars at home and abroad use the SD method to study pupils' learning-related problems. Zhang and Guo (2020) explored the

influence trend and sensitivity of the richness of practical experience on the learning achievement of science and engineering pupils based on SD and the simulation model. Wang and Niu (2017) used it to construct the evolutionary game model of innovation behavior between innovation demanders and pupils and studied the dynamic decision-making process of both sides of the game. Taking learners' personalized learning needs as the research content, Mou et al. (2018) established a personalized learning demand prediction model using SD and explored the changes in learning needs in all aspects. Fan and Zong (2016) used the human dynamics method to quantitatively analyze user learning data and study the behavior patterns and characteristics of user online learning. Using SD to study the learning behavior of pupils is conducive to timely understanding the development trend of the problem and providing a reference for policy implementation.

3.1 Data Collection and Variable Determination

Pupils from Middle and Primary Schools in Shaanxi Province were randomly selected for the questionnaire survey. According to the stratified sampling method of elementary, middle and high-school students, 3500 questionnaires were distributed, with a recovery rate of 96.5%. There was little difference in the number of people at all educational levels. The proportion of elementary, middle and high-school students was 30%, 33% and 27%, respectively, with male pupils occupying 47% and females 53%. Therefore, the questionnaire used to study the learning behavior of pupils has certain randomness and representativeness.

After testing the authenticity and validity of the questionnaire data, we found that there are many factors affecting pupils' learning behavior. To simplify the modeling process and further identify the logical relationship between these factors, the principal component analysis method was used to reduce the dimension of these influencing factors. The names and weights of each influencing factor are shown in Table 1.

Table 1. The weights of influencing factor

Serial numbers	Principal component	Weight
D1	Family factors	0.1301

D2	Social factors	0.1063
D3	School factors	0.1124
D4	Learning values	0.1092
D5	Willingness to learn	0.1054
D6	Knowledge learned	0.0972
D7	Learning cost perception	0.0877
D8	Learning norms	0.0885
D9	Learning conditions	0.0831
D10	Learning perception	0.0801

3.2 Constructing the SD Model of Pupils' Learning Behavior

3.2.1 Determining Hypothetical Variables and System Boundaries

The extracted 10 main influencing factors were taken as the key variables of the model, and the SD model was established. The relevant hypothesis of the model are as follows:

Hypothesis 1: Given the particularity of pupils and complex interpersonal relationships, we comprehensively consider the impact of family, school and society factors on pupils' learning behavior.

Hypothesis 2: when family, school and social factors are compared, school and social factors mainly include the supervision, education, publicity and the perfection of learning facilities. Family factors mainly embrace the impact of family members' learning behavior on that of pupils.

To compare and analyze the changing trend of pupils' learning behavior under different influencing factors, it is necessary to simulate the model by changing the assignment of variables. Combined with the actual investigation, the definition of some variables is shown in Table 2.

Table 2. The definition of variables

Variable name	Definition
Family learning behavior	How often the pupil's family members study.
Supervision strength	The frequency of social and school checks on pupils' learning behavior.
Publicity efforts	pupils' emphasis on learning.
perfection of learning facilities	The proportion of learning facilities provided by society and schools.
Education intensity	The proportion of social lectures, school learning and education courses.

3.2.2 Causal-Loop Diagram

A high cognitive level of learning is the basis for cultivating a good learning attitude and behavior. Environmental education plays an important guiding role. The knowledge acquisition of pupils mainly comes from family, school and social education. Therefore, the influence of the three

factors on pupils' learning behavior is huge. Combined with the investigation outcomes and the analysis results of the factors influencing pupils' learning behavior, this paper constructs a causal relationship model of the factors influencing pupils' learning behavior, which mainly includes family, school and social factors, as shown in Figure 2.

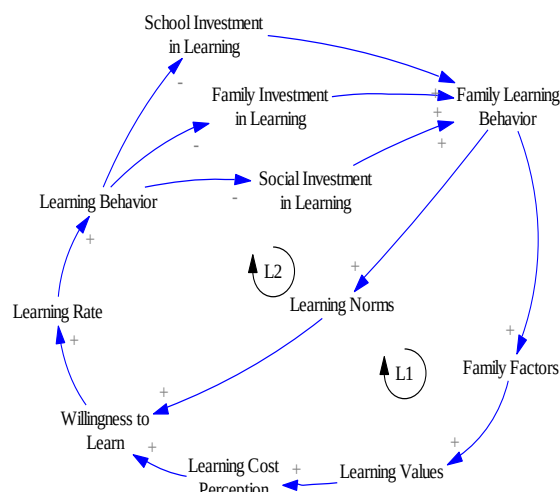


Figure 2. The causal-loop diagram of the impact of family factors

Figure 2 shows the causal-loop diagram of the impact of family factors on pupils' learning behavior, including two feedback loops:

L1: *Learning Behavior* ↓ → *Family Investment in Learning* ↑ → *Family Learning Behavior* ↑ → *Family Factors* ↑ → *Learning Values* ↑ → *Learning Cost Perception* ↑ → *Willingness to Learn* ↑ → *Learning Rate* ↑ → *Learning Behavior* ↑

L2: *Learning Behavior* ↓ → *Family Investment in Learning* ↑ → *Family Learning Behavior* ↑ →

Learning Norms ↑ → *Willingness to Learn* ↑ → *Learning Rate* ↑ → *Learning Behavior* ↑

Among them, increasing the learning investment of family, school, and society will arouse the attention of family to learning, further promote the impact of family learning behavior on pupils' learning intention, to promote their learning behavior. At the same time, changes in pupils' learning behavior will also affect the further implementation of family learning behavior, school and social work.

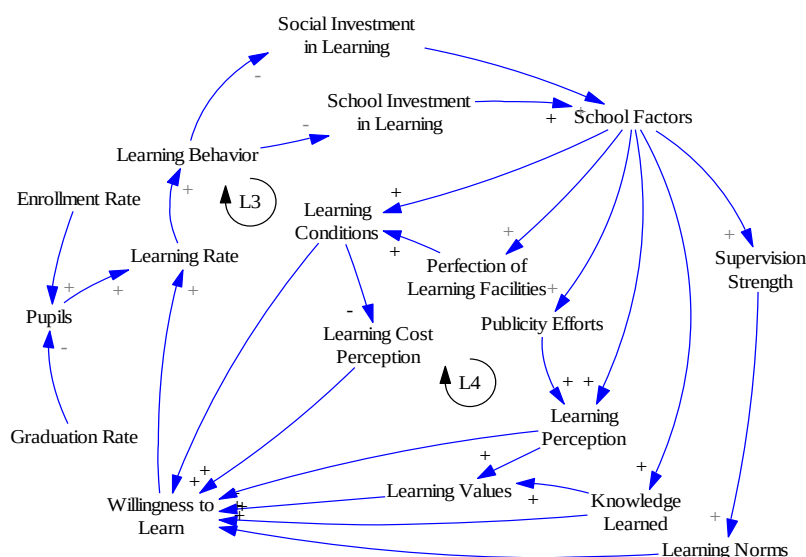


Figure 3. The causal-loop diagram of the impact of school factors

Figure 3 shows the causal-loop diagram of the impact of school factors on pupils' learning behavior, including two feedback loops:

L3: *Learning Behavior* ↓ → *School Investment in*

Learning ↑ → *School Factors* ↑ → *Knowledge Learned* ↑ → *Willingness to Learn* ↑ → *Learning Rate* ↑ → *Learning Behavior* ↑

L4: *Learning Behavior* ↓ → *School Investment in*

Learning $\uparrow \rightarrow$ School Factors $\uparrow \rightarrow$ Perfection of Learning Facilities $\uparrow \rightarrow$ Learning Conditions $\uparrow \rightarrow$ Learning Cost Perception $\downarrow \rightarrow$ Willingness to Learn $\uparrow \rightarrow$ Learning Rate $\uparrow \rightarrow$ Learning Behavior $\uparrow$
 More investment in school learning promotes the

influence of school factors on pupils' learning behavior. Improved school learning facilities make it easier for pupils to carry out learning activities, which reduces pupils' perception of learning costs and improves their willingness to learn.

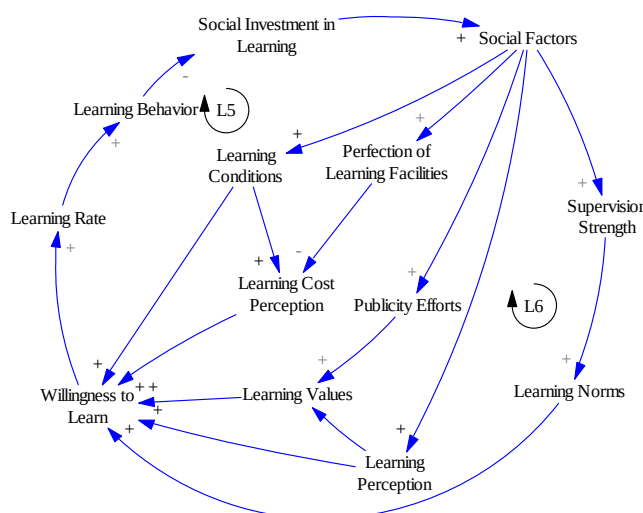


Figure 4. The causal-loop diagram of the impact of social factors

Figure 4 shows the causal-loop diagram of the impact of social factors on pupils' learning behavior, including two feedback loops:

L5: Learning Behavior $\downarrow \rightarrow$ Social Investment in Learning $\uparrow \rightarrow$ Social Factors $\uparrow \rightarrow$ Learning Conditions $\uparrow \rightarrow$ Willingness to Learn $\uparrow \rightarrow$ Learning Rate $\uparrow \rightarrow$ Learning Behavior $\uparrow$

L6: Learning Behavior $\downarrow \rightarrow$ Social Investment in Learning $\uparrow \rightarrow$ Social Factors $\uparrow \rightarrow$ Supervision Strength $\uparrow \rightarrow$ Learning Norms $\uparrow \rightarrow$ Willingness to Learn $\uparrow \rightarrow$ Learning Rate $\uparrow \rightarrow$ Learning Behavior $\uparrow$

Increased investment in social learning boosts the influence of social factors on pupils' learning behavior. Upgraded social supervision makes pupils more willing to standardize their learning behavior and improve their learning willingness.

To sum up, pupils' learning intention mainly comes from the influence of family, school and society. Family, school and society have created

learning conditions for pupils, standardized their learning behavior, popularized learning values, and had a positive impact on their learning intention, which also directly determines their learning behavior. At the same time, family, school and society can also continue to cultivate pupils' good learning behavior according to the feedback.

3.2.3 Stock-flow Diagram

According to the theory of planned behavior, willingness is the best predictor of behavior (Lin, & Bai, 2014). Pupils' learning behavior will be affected by their learning intention. A higher learning intention means a greater possibility of learning behavior. According to the results of causal-loop diagram analysis, this study used Vensim software to construct a stock-flow diagram of the model, as shown in figure 5. The simulation cycle is 24 months, and the simulation step is 1 month.

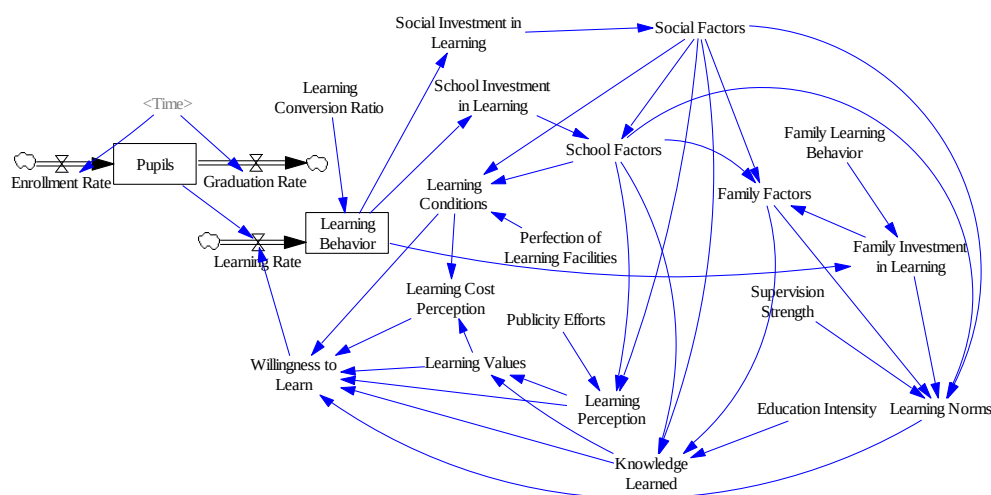


Figure 5. The stock-flow diagram for factors influencing pupils' learning behavior

3.2.4 Determination of Variables and Equations

The key variables of the model include school, family, social factors and learning behavior. The learning conversion ratio in the model refers to the influence weight of pupils' learning intention on learning behavior. The perfection degree of learning facilities (hereinafter referred to as facilities), publicity efforts (publicity), education intensity (education), supervision strength (supervision) and family learning behavior (family) was studied. Data analysis showed that at present, the standardization of pupils' learning

behavior by families is insufficient, and the construction of learning facilities in schools and society and the implementation of learning behavior education and supervision for pupils are unoptimistic. Therefore, the initial value of family, facilities, education and supervision was 0.1, and the variation range was [0,1]. In addition, according to the survey results, pupils attached great importance to learning. Therefore, the publicity was assumed at a medium level in this case, with an initial value of 0.5 and a variation range of [0,1]. Based on the mathematical derivation and regression analysis, the system simulation equation was established as follows:

$$\text{Learning Rate} = \text{pupils} * \text{Willingness to Learn} \quad (3-1)$$

$$\text{pupils} = \int_{t_0}^t (\text{Enrollment Rate} - \text{Graduation Rate}) dt \quad (3-2)$$

$$\text{Learning Behavior} = \int_{t_0}^t (\text{Learning Conversion Ratio} * \text{College Students}) dt \quad (3-3)$$

$$\text{Social Factors} = \text{Social Investment in Learning} \quad (3-4)$$

$$\text{Social Investment in Learning} = (1 - \text{Learning Behavior}) * 0.2 \quad (3-5)$$

$$\text{School Factors} = \text{Social Factors} + \text{School Investment in Learning} \quad (3-6)$$

$$\text{School Investment in Learning} = (1 - \text{Learning Behavior}) * 0.4 \quad (3-7)$$

$$\begin{aligned} \text{Family Factors} = & \text{School Factors} + \text{Family Investment in Learning} \\ & + \text{Social Factors} \end{aligned} \quad (3-8)$$

$$\text{Family Investment in Learning} = (1 - \text{Learning Behavior}) * 0.4 \quad (3-9)$$

$$\begin{aligned} \text{Learning Norms} = & \text{Family Factors} * \text{Family Investment in Learning} \\ & + (\text{Social Factors} + \text{School Factors}) * \text{Supervision Strength} \end{aligned} \quad (3-10)$$

$$\text{Learning Conditions} = (\text{Social Factors} + \text{School Factors})$$

$$* \text{Perfection of Learning Facilities} \quad (3-11)$$

$$\text{Learning Perception} = (\text{Social Factors} + \text{School Factors})$$

$$* \text{Publicity Efforts} \quad (3-12)$$

$$\text{Knowledge Learned} = (\text{Family Factors} + \text{Social Factors} + \text{School Factors})$$

$$* \text{Education Intensity} \quad (3-13)$$

$$\text{Learning Values} = \text{Knowledge Learned} + \text{Learning Perception} \quad (3-14)$$

$$\text{Learning Cost Perception} = \text{Learning Conditions} + \text{Learning Values} \quad (3-15)$$

$$\text{Willingness to Learn} = 0.09 * \text{Learning Norms} + 0.096 * \text{Learning Cost Perception}$$

$$+ 0.13 * \text{Learning Values} + 0.1 * \text{Knowledge Learned} + 0.086$$

$$* \text{Learning Conditions} + 0.08 * \text{Learning Perception} \quad (3-16)$$

4. Results and Discussion

Different factors have different effects on pupils' learning behavior. Therefore, to promote pupils' learning behavior, the assignment of each influencing factor was set to 0.6, and the

simulation was carried out after a random combination. Finally, according to the simulation results, the action mechanism of each factor on pupils' learning behavior was analyzed to find the best combination strategy. See Table 3 for a specific combination scheme and strategy.

Table 3 Combination scheme and strategy

Scheme 1		Scheme 2		Scheme 3		Scheme 4	
Strategy	Combination	Strategy	Combination	Strategy	Combination	Strategy	Combination
1	facilities	1	facilities +family	1	facilities+family +education	1	facilities +family +education +supervision
		2	facilities +education	2	facilities+family +supervision		
2	family	3	Facilities +supervision	3	facilities+family +publicity	2	facilities +family +education +publicity
		4	facilities +publicity	4	facilities +education +supervision		
3	education	5	family +education	5	facilities +education +publicity	3	family +education +supervision +publicity
		6	family +supervision	6	facilities +supervision +publicity		
4	supervision	7	family +publicity	7	family+educatio n+supervision	4	facilities +education +supervision +publicity
		8	education +supervision	8	family+educatio n+publicity		
5	publicity	9	education +publicity	9	family +supervision +publicity	5	facilities +family +education +supervision +publicity
		A	supervision +publicity	A	education +supervision +publicity		

4.1 Single Factor Strategy Simulation Analysis (Scheme 1)

To find the key factors affecting pupils' learning

behavior, the five strategies in scheme 1 are simulated and analyzed respectively, and the results of the impact of each strategy on pupils' learning behavior are shown in figure 6.

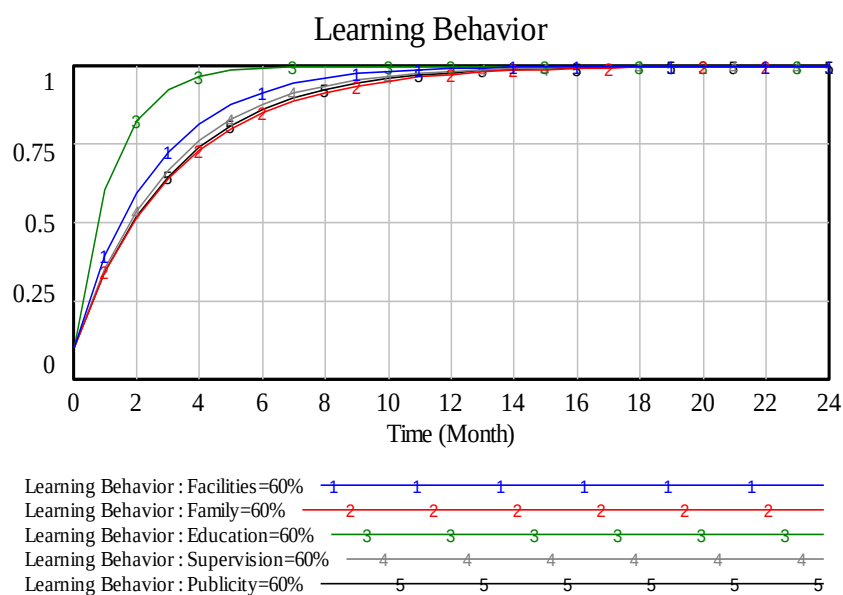


Figure 6. Comparison of learning behavior (Single factor strategy)

The impact effects are as follows:

strategy 3 > strategy 1 > strategy 4 > strategy 5 > strategy 2

Among them, the effect of strategy 3 on learning behavior is significantly higher than that of other strategies, indicating that increasing education intensity can arouse pupils' attention to learning. With the passage of time, the effect of strategies 1, 4, 5 and 2 on pupils' learning behavior tends to be consistent with that of strategy 3. Thus, the

implementation of five strategies can improve pupils' learning behavior.

4.2 Simulation Analysis of Two-Factor Combination strategy (Scheme 2)

Since pupils' learning environment is complex, to further explore the influence mechanism of various factors on learning behavior, 10 two-factor combination strategies were set in scheme 2, with the results shown in figure 7.

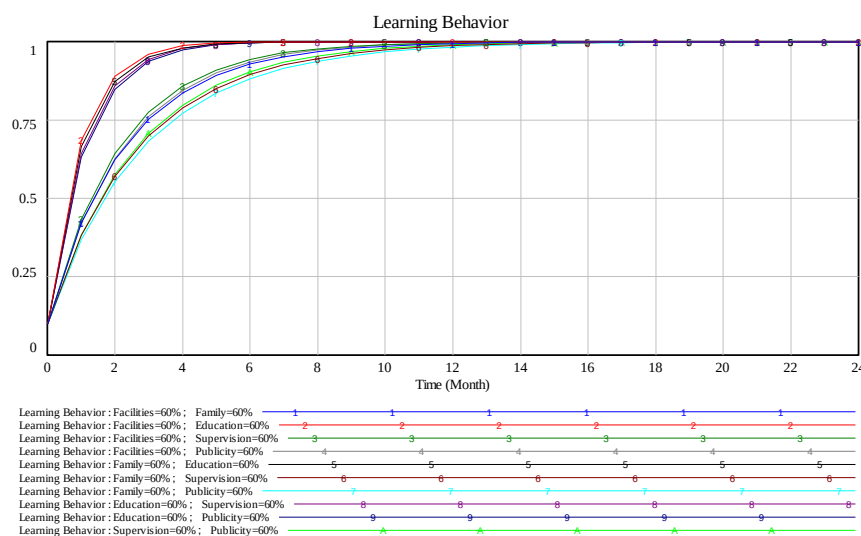


Figure 7. Comparison of learning behavior (two-factor combination strategy)

The influence effects are as follows:

Strategy 2 > strategy 5 > strategy 8 > strategy 9 > strategy 3 > strategy 4 > strategy 1 > strategy A > strategy 6 > strategy 7

The comparison of the effects of various strategies on learning behavior showed that strategy 5 has a better effect on pupils' learning behavior than strategy 8 (family + education > education + supervision), which contradicts the results of

scheme 1 (supervision > family). Therefore, the joint strategy of family, school and society probably more benefits the cultivation of pupils' learning behavior under the effect of education.

4.3 Simulation Analysis of Three-Factor Combination strategy (Scheme 3)

To verify the above conjecture, the three-factor combination strategy in scheme 3 was simulated, and the simulation results are shown in figure 8.

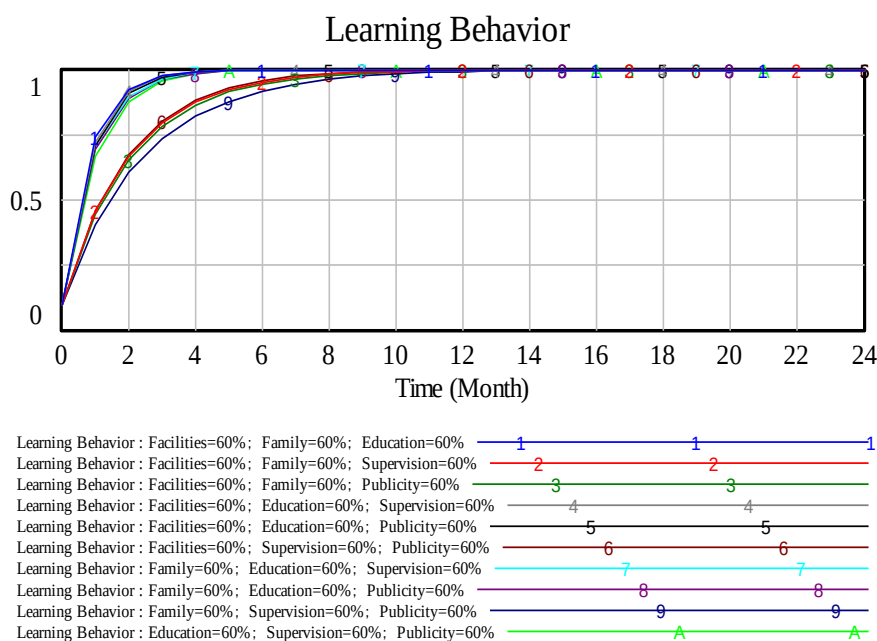


Figure 8. Comparison of learning behavior (three-factor combination strategy)

The influence effects are as follows:

Strategy 1 > strategy 4 > strategy 5 > strategy 7 > strategy 8 > strategy A > strategy 6 > strategy 2 > strategy 3 > strategy 9

Strategy 1 of scheme 3 has the most significant effect on pupils' learning behavior. In addition, by comparing the strategies in scheme 3, it can be found that strategy 1 > strategy 4 = strategy 8 > strategy A (facilities + family + education > facilities + education + supervision = family + education + publicity > education + supervision +

publicity), which verifies the conjecture of scheme 2 (family + education > education + supervision). It can be seen that under the effect of education, the family has a greater impact on pupils' learning behavior than perfect supervision means.

4.4 Simulation Analysis of Multi-Factor Combination strategy (Scheme 4)

The simulation results of the four-factor combination strategy are shown in figure 9, and the influence effects are as follows:

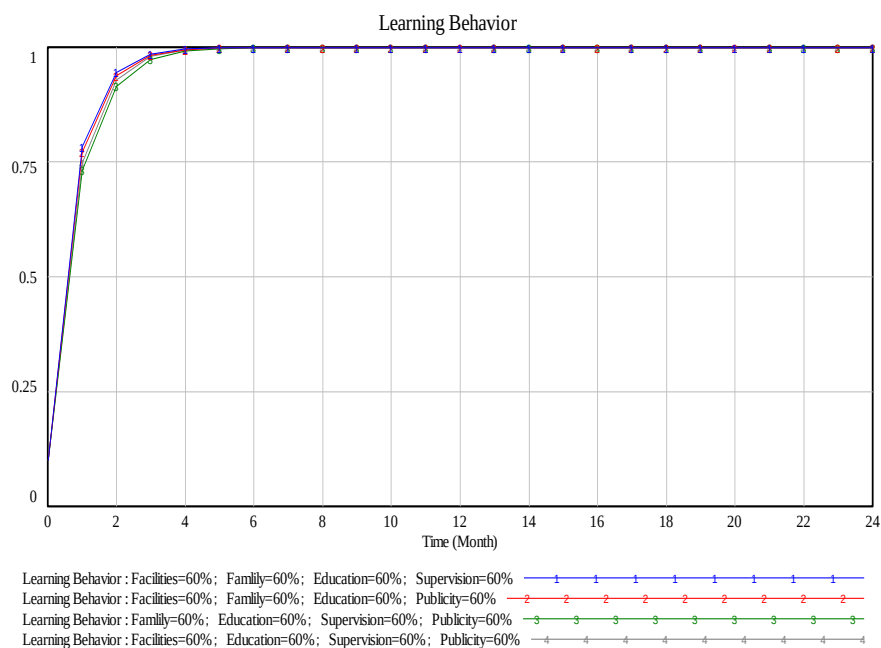


Figure 9. Comparison of learning behavior (multi-factor combination strategy)

The simulation results showed that when other factors were the same, it is found that strengthening supervision was more effective than improving publicity in cultivating pupils' learning behavior, that is, strategy 1 > strategy 2 (facilities

+ family + education + supervision > facilities + family + education + publicity), which was in line with the conclusion of strategy 4 > strategy 5 (supervision > publicity) in scheme 1.

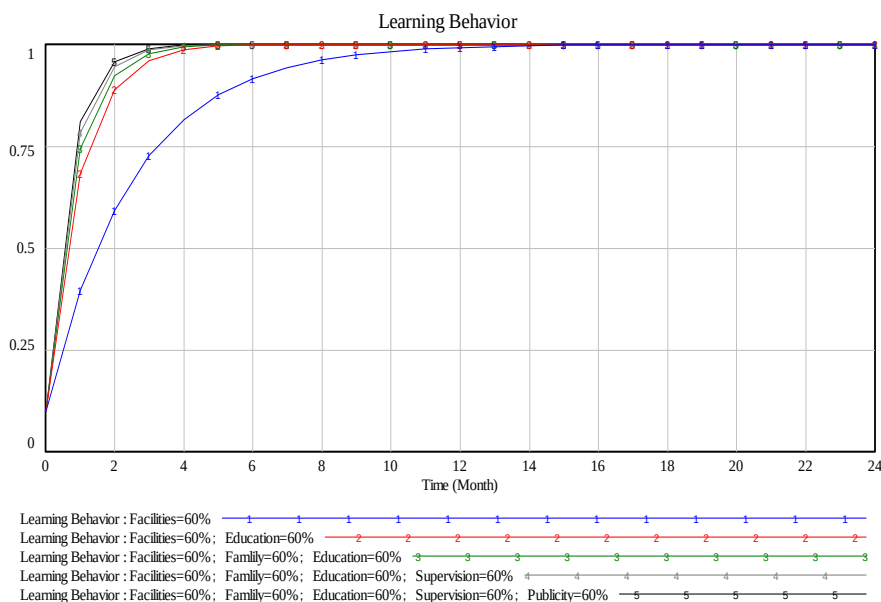


Figure 10. Comparison of learning behavior (mixed strategy)

Finally, the strategies with greater impact in the four schemes were compared and analyzed. Strategy 3 (line 1) in scheme 1, strategy 2 (line 2) in scheme 2 and strategy 1 (line 3) in scheme 3 were selected to compare with strategy 1 (line 4) and strategy 5 (line 5) in scheme 4. The effect of

each strategy on learning behavior is shown in figure 10. The analysis and simulation results showed that the more comprehensive factors affecting pupils' learning behavior meant more improvement in cultivating pupils' learning behavior. A single strategy has a limited impact

on pupils' learning behavior. Therefore, to improve the implementation efficiency of educational policies and improve pupils' learning behavior, it is essential for schools to formulate compound policies and measures.

5. Conclusions

The learning behavior of pupils is affected by many factors. Appropriate education intensity and enabling an educational environment are the premise of cultivating pupils' learning behavior. Therefore, schools and society should improve the construction of educational facilities and create a good learning environment for pupils. In addition, schools need to actively carry out learning behavior publicity and education activities and strengthen the supervision of pupils' learning behavior to improve their attention to learning, which will be more conducive to the cultivation and maintenance of their learning behavior.

According to the simulation results:

1. Increasing education intensity can arouse pupils' attention to learning in a short time.
2. Under the effect of education, the family has a greater impact on pupils' learning behavior than perfect supervision means.
3. When other factors are the same, it is found that strengthening supervision is more effective than improving publicity in cultivating pupils' learning behavior.
4. The more comprehensive factors affecting pupils' learning behavior meant more improvement in cultivating pupils' learning behavior.

The joint strategy of family, school and society has a multiplier effect on cultivating pupils' learning behavior with half the effort. As another important growth environment for pupils except for campus, the family has a long-term and vital impact on cultivating pupils' learning behavior. Schools should establish a good cooperation relationship with family and society to jointly cultivate pupils' learning behavior. At the same time, pupils' parents should also consciously carry out learning activities, teach by precepts and examples, actively popularize knowledge to pupils, inspire their learning awareness at school or home, standardize their learning behavior at home and teach them to obey good learning behavior to form a good habit of lifelong learning.

In this paper, to highlight the importance of family factors in cultivating pupils' learning behavior, we considered social factors and school factors. In real life, school and society have important roles in developing pupils' learning behavior. In future research, social and school factors will be studied separately to further refine the impact of social-and school-related factors on pupils' learning behavior.

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Competing Interests

The authors declare no competing interests.

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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