Research Article

The Academic Evaluation Practice of Theoretical Courses of Physical and Vocal Music Education Major under the Concept of Quantitative Evaluation

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Under the rapid progress of educational reform, the evaluation method of students’ studies in China is only partially adjusted or even remains at the same level for a long time. There will be a growing gap between it and the existing education system and social needs. Therefore, based on the concept of quantitative evaluation, the gap and unreasonable evaluation methods of academic evaluation of theoretical courses of physical and vocal music education majors caused by unfair educational resources and physical conditions of Chinese students have been studied. Student Growth Percentile (SGP) academic evaluation model based on the current education situation in China is proposed. By analyzing the establishment process of this model and comparing it with the current two academic evaluation models, the advantages and disadvantages of the SGP model are analyzed. Then, a practical application case of the SGP model in a place is used to show the model’s actual evaluation process and feedback results. Through the SGP model on the growth evaluation of group students and the teaching evaluation of teachers, the growth and problems of students in this stage and whether the teachers’ teaching is effective are analyzed to obtain the pertinent results. Finally, the students and teachers are investigated, and their satisfaction with this model is 81% and 75%, respectively, proving this model’s reliability and practicality.

1. Introduction

Based on the current level of theoretical development, academic evaluation is defined as taking “student development” as the core and following the four core requirements of comprehensiveness, development, objectivity, and system. It is an important link in education and teaching to obtain the information about students’ current education through appropriate measurement tools and to use this as the basis to make value judgments on students’ knowledge mastery and learning ability level [1]. Although China’s education evaluation system has a long history, it has long been based on the national “selection of scholars” as the fundamental goal. It mainly went through two periods: the experience assessment and the imperial examination period. The “experience assessment period” is mainly divided into an election system (an electoral or voting system is a set of rules that determine how elections and referendums are conducted and how their results are determined) and a nine-rank system (the nine-rank system, also known as the nine-grade controller system, was used to categorize and classify government officials in Imperial China), mainly local officials conduct inspection and selection of talents with certain subjects and standards. Since these two systems rely on the subjective evaluation of the examiners, they have resulted in the solidification of classes and the drawbacks of class differentiation. In the “Imperial examination period,” which lasted for nearly 1,300 years, the class solidification of the experience assessment period has been changed to a certain extent. Due to the close combination of the selection of scholars and the cultivation of talents, school education has become a vassal of the imperial examination. During this period, the teaching method was rigid, the educational content was narrow, and the social development level was...
stagnant for a long time [2]. After the founding of the People’s Republic of China, education at all levels began to develop with equal emphasis on multiple subjects. Education evaluation is based on the Soviet style five-point system as the core of the performance evaluation method, followed by the implementation of the 100-point system [3]. The evaluation method is based on the static evaluation, which is not conducive to the practice of the concept of “developmental evaluation,” nor can it meet the actual needs of educational evaluation reform. The theoretical courses of the vocal music education major are too large in evaluation results and unreasonable evaluation methods due to two factors: unfair educational resources and physical conditions. This method dampens students’ enthusiasm for learning, restricts their academic development and the improvement of their comprehensive quality, and is not conducive to the construction of teachers’ teams and the improvement of teachers’ professional education [4].

At present, many educational scholars are also committed to promoting the development of educational evaluation. Tawafak et al. improved teaching methods and developed a model of student assessment feedback effectiveness for academic performance. Their integration of student assessment feedback with e-learning through a course plan taught throughout the semester has been shown to help improve the teaching method environment, assessment mechanisms, and student learning outcomes [5]. Lekwa et al. studied the assessment of teacher teaching and behavioral management practices as measured by the Classroom Strategy Assessment System versus the measure of academic progress, and classroom use of evidence-based pedagogy demonstrated greater gains for higher-quality students [6]. Lau et al. proposed a method combining traditional statistical analysis and neural network modeling to predict student performance and achieved a good prediction accuracy of 84.8% [7].

This study starts from the theoretical basis of the Student Growth Percentile (SGP) model construction and introduces the theoretical and mathematical basis of the SGP model in turn. By comparing two common academic evaluation models, the advantages and disadvantages of this model are analyzed. Then, the reliability and evaluation function of the model are shown based on a practical case of the application of a proofreading SGP model. Finally, the applicability of the SGP model in the academic evaluation of the theoretical courses of Chinese vocal music education is analyzed, and construction strategies are proposed. The innovation is to try the American SGP model in Chinese schools and analyze the applicability and improvement of the SGP model from the results.

The structure is presented as follows: (1) introduce the content and main theoretical basis of SGP model; (2) explain the mathematical basis of SGP model design basis; (3) compare and analyze SGP model with other two common academic growth evaluation models; (4) introduce the process and application of SGP model to students and teachers in a certain place; (5) finally, put forward the applicability analysis and construction strategy of SGP model in the academic evaluation of theoretical courses of physical and vocal music education in China.

2. Method

2.1. The Basic Content of the SGP Model. The student growth percentage model or SGP belongs to the growth evaluation model. The core mathematical and statistical methods are percentile regression. The relative change in a student’s position among academic peers is used to assess and predict the student’s academic growth. The so-called “academic peers” are the group of students with the same previous test scores as the student. The main process of the SGP model is to calculate the SGP value, which is used to describe the development of the student’s academic growth level [8]. The academic peers with the same score as Student A in the last exam are used as the reference group, and the percentile of Student A’s score in the reference group in this exam is the SGP value. If the calculated SGP value is 70, it means that the growth rate of student A is 70%, that is, it is better than 70% of their academic peers.

2.2. Theoretical Basis of the SGP Model. In the 1950s and 1960s, due to the upsurge of the civil rights movement, the US government began to pay attention to ensuring citizens’ fair education rights and better basic education. But multiple education reforms have not significantly improved the level of education in the United States. In the Program for International Student Assessment (PISA) test, American students are far lower than students in many developing countries. There are also significant disparities in students’ academic performance of different ethnic groups in different parts of the United States [9]. For this reason, the US government signed the No Child Left Behind Act (NCLB) signed by Bush on January 8, 2002. On December 10, 2015, Barack Hussein Obama signed the Every Student Succeeds Act (ESSA) [10]. NCLB aims to address the educational issues of underprivileged students and black boys. However, the act has resulted in extended teaching hours and neglect of nonuniform subjects to pursue student achievement and accountability to teachers and schools. This not only prevents the creative ability of outstanding students from being developed but also makes the students with unsatisfactory grades lose the possibility of being admitted to a good school. In response to the consequences of NCLB, ESSA regards the achievement and growth of students as the new core of education and no longer focuses on students’ annual performance but takes students’ growth performance as the core factor of evaluation. The transformation of static and mechanized state evaluation indicators into dynamic developmental growth evaluation indicators, paying more attention to the actual growth of students, can be described as a breakthrough in American education. Various initiatives and academic evaluation models for measuring student growth have been developed across the United States, as shown in Figure 1:

In Figure 1, the current common measurement models in the United States are trajectory, incremental, residual, classification, multivariate, projection, and student growth percentage models. The most widely used is the student growth percentage model SGP, which accounts for about...
half of all states in the United States [11]. There are three theoretical foundations of SGP:

2.2.1. The Theory of Individual Differences. Psychological studies have shown that individual differential responses will occur to the same stimulus [12]. The influencing factors of student learning are mainly divided into six aspects, as shown in Figure 2:

From the analysis of the six influencing factors in Figure 2, it can be concluded that since everyone has individual differences, it is difficult to measure students’ learning ability digitally.

In Figure 2, the six influencing factors can be analyzed, and it is difficult to conclude by observing other measures of the student’s learning ability. The traditional academic performance ranking can only show the level of performance but cannot judge learning ability. According to the theory of individual differences, the SGP model mainly calculates the ability gap between students in the percentile of their academic peers by comparing relative grades [13]. The advantage is that students with the same grades have different SGP values because their corresponding academic peer groups are different. The scores of academic peers can be used as another reference object to present the changes in students’ academic development. For example, two students with the same score of 70 have SGP values of 70 and 35, respectively, indicating that the first student has better academic development in the recent stage than the latter.

2.2.2. The Theory of Human Development. Development in the philosophical sense refers to movement and change with the nature of progress and rise [14]. The Marxist worldview is shown in Figure 3:

In Figure 3, Marxism attaches the most importance to the all-round development of people, which means that everyone can achieve harmonious, complete, equal, and free development. Its core is the all-round development of human ability. It is necessary to realize that education must be subject to the natural development and personality development of human beings and obey the development law of people-oriented. Schools cannot regard schools as commodity factories that only pay attention to the qualified rate and excellent rate of products and turn a blind eye to the growth process of students’ initiative. This goes against the core idea of education: human development [15]. The purpose of establishing the SGP model in the academic evaluation growth model is to focus on the dynamic growth of students. The SGP academic growth evaluation model does not determine students’ ability level by the performance data at a single time point but uses regression methods to analyze students’ academic performance at multiple time points, which are more in line with the basic theory of student development.

2.2.3. The Idea of Layered Teaching. In Figure 4, the basis of the idea of stratified teaching is also the theory of individual differences. The theory expands the object from the individual to the group. It establishes different development levels for the students depending on various indicators such as students’ knowledge level, learning ability, academic
performance, and expected goals. The idea of stratified teaching adopts more suitable teaching methods and content for students with different levels and conducts stratified assessment and evaluation [16]. This evaluation method recognizes human differences and implements the most appropriate education rather than the so-called “educational equality” to achieve equity. Politicians need to curb the educational solidification behavior that blocks the survival of the fittest and ensure students’ enthusiasm at all levels.

2.3. Mathematical Basis of SGP Model Design. The educational environment in which all students live is not only the same educational environment but also the learning ability of students is affected by differences in external conditions such as family conditions and the teaching level of schoolteachers. These external factors affect the development of students. If these external factors exist for a long time, they can be regarded as components of students’ ability, so the index used is still the students’ test scores [17]. Because the factors that affect student performance are all included in the test scores, it is only necessary to analyze and evaluate past consecutive grades. The traditional linear regression model describes how the conditional distribution of the dependent variable is affected by the independent variable. Since the grades are not normally distributed and the estimates of the first and last grades are highly unstable, the use of traditional linear regression models is not suitable for this. As the developer of the SGP model, Betebenner innovatively used the method of quantile regression to obtain the SGP value [18]. Since the conditional quantile of dependent variables is affected by independent variables, quantile regression can more accurately describe the variation range of independent variables to dependent variables and the shape of the conditional distribution and accurately capture the data characteristics at both ends of the distribution to obtain more comprehensive data analysis.

Its core is estimating the score corresponding to each percentile and then using the percentile closest to the actual score as its percentile level. Based on the R Programming Language, the b-spline (Basis-spline) function is used to smooth the score distribution of the previous year, as shown in equation (1):

$$Q_{Y_u}(r|Y_{(t-1)i}, \ldots, Y_{ui}) = \sum_{k=1}^{3} \sum_{j=1}^{3} \Phi_{jk}(Y_{ki})\beta_{jk}(r).$$  

In equation (1), $Y_u$ represents the score of the i-th student at the current time $t$; $r$ represents the estimated quantile; $Y_{ui}$ represents the score of the i-th student at the past time $k$; $\Phi_{jk}(Y_{ki})$ is the cubic b-spline basis function with the order $j$ at time $k$ in the past time; $\beta_{jk}$ is the cubic b-spline coefficient. The principle is to smooth the distribution of the previous year’s scores through the b-spline function and estimate 100 quantile regression lines from 0.005 to 0.995 in increments of 0.01. The student’s previous year’s test scores
are then plugged into each percentile equation to arrive at predicted quantiles. Finally, the predicted quantile multiplied by 100 is compared with the current year’s grade, and the midpoint value between the two quantiles multiplied by 100 is the percentile of student growth. If the student’s current grade is the predicted quantile calculated from the previous year’s grade, between 0.425 and 0.435, the student’s growth percentile is 43.

A simple student growth percentile calculation is shown in equation (2):

\[
Pr = \frac{\text{Nbs} + (0.5 \times \text{Ns})}{\text{Tp}} \times 100.
\]

In equation (2), Pr represents the percentile ranking, Nbs represents the number of students below a given score, and Ns represents the number of students with a given score. Tp represents the total number of people. For example, Student C and ten other students scored 60 points in the previous year’s exam. Then these ten students are the academic peers of student C. In the current exam, student C scored 70, and 10 academic peers scored 60/62/65/71/78/75/76/55/68/69. After calculation, the percentile of student growth of C students is \(Pr = \frac{\lfloor (6 + 0.5 \times 4) \rfloor}{11} \times 100 = 72.7\). The growth rate of C students is 72.7%, which is at least higher than that of 72.7% of their academic peers.

According to the research on the continuity and predictability of students’ grades, the SGP model is established by using regression analysis, and the development trend of students’ grades and the grades that may be achieved in the future under this trend is predicted. The predicted and the standard value of proficiency for the long-term target grade is used for numerical analysis. The extent to which students can achieve the target is analyzed [19]. The SGP model is used to derive the regression coefficients for each percentile, which can reasonably calculate the probability that each student will achieve a predetermined percentile grade based on past grades. Tables 1 and 2 are used to estimate the regression coefficients of the SGP model.

In Tables 1 and 2, grades in the first and second academic years are used to predict grades in the third academic year. The regression coefficients obtained in the second school year are relatively more suitable, indicating that the second school year’s scores can accurately predict the third school year’s score increase percentage. According to the current academic growth trend, the prediction of each student’s required scores when they reach different levels of SGP value (set the standard score as 620) is shown in Table 3:

Table 3 can divide students into three groups. Students 1 and 2 are compared for the first group. They all scored 581 points, failed to meet the standard, and were poor students. However, the SGP value of student 1 is 10, which is much smaller than the SGP value of student 2, which is 70. The growth rate of student 2 is much higher than that of student 1, which is about 60% higher. If a horizontal comparison is made to achieve the standard score of 620, Student 1 only needs to achieve an SGP value of 70, but Student 2 needs to achieve a score of 90 or above. Therefore, if both are required to meet the standard, Student 2 must work harder. Students 3 and 4 are compared for the second group. Students 3 and 4 scored close to 718 but did not meet the standard and were middle-grade students. The SGP value of Student 3 is 70 compared to the SGP value of Student 4, which is about 30, indicating that the growth rate of Student 3 is higher. If a horizontal comparison is made, the SGP value of Student 3 reaching the standard is 80, which is much higher than that of Student 4, which is 30, indicating that Student 4 may have an advantage in learning ability compared with 3. Finally, Students 5 and 6 are divided into the third group for comparison, and the scores have reached the standard and are students with excellent grades. Student 5’s SGP value is higher than Student 6’s 30, indicating that Student 5 has a higher level of growth, but Student 6 is relatively more capable of achieving better scores.

Students with the same grades have different levels of effort, and teachers’ corresponding teaching strategies cannot be the same. Student 2 still fails to meet the standard despite his outstanding performance compared to his academic peers, which may mean that the student lacks learning ability, and the teacher needs to intervene and guide his learning method. Student 4 can be helped to achieve standard grades with just a little push. Students in the Student 3 category need to pay attention and help them find the cause of their learning difficulties. The top Student 6 has reached the standard, but the level of effort is far from enough. The teacher should take incentives and propose more challenging teaching content to give full play to his strength to achieve better results.

2.4. Comparative Analysis of the SGP Model and Two Academic Growth Evaluation Models. The SGP model is compared and analyzed with the two academic growth evaluation models of the incremental score and the trajectory model. The core of the incremental model is the growth description. At the heart of the trajectory, the model is the growth forecast. The incremental model mainly describes the change of students’ grades between two-time points and reflects the change of grades through the magnitude of the value. The equation is value-added score = score at the current time point — score at the previous point. Incremental models can also be used to describe grade growth for groups of students. The scores for a group of students’ gains in grades are averaged. If the average score is positive, the students’ performance has generally improved; otherwise, the performance has generally declined. The trajectory model is based on linear assumptions, if the student’s performance will continue its previous growth trajectory and can predict the student’s performance in a certain year. It requires data on student test scores at least two-time points, as well as a common vertical scale. The scale should contain the actual and the predicted future test scores for each time. The principles of the two models are shown in Figure 5:

In Figure 5, the student has a score of 70 in a subject in the second grade and 75 in the third grade. The trajectory model assumes that the student’s future grade changes will follow the law of increasing 5 points every year. If a straight line connects the grades of the second grade and the third grade, the annual test scores in the future will continue the
positive slope of this straight line and maintain the development trend of increasing 5 points every year.

Trajectory models are also used to predict grade growth in student cohorts and to calculate cohort excellence and pass rates. Compared with these two basic models, the SGP model has obvious advantages. (1) The model introduces the concept of “academic peers,” which more accurately explains the meaning of growth. (2) The model does not require large-scale vertical scales but can also clarify the reasons for changes in grades and predict changes in grades, providing richer data and information for student growth. The concept of percentage is used to show the growth and progress of the performance is easier to understand.

### 3. Results and Discussion

#### 3.1. The Evaluation Process and Application of the Practical Case of the SGP Model to Students and Teachers in a Certain place.

The results of two subjects, physical education and vocal music, are analyzed over four years in a location. The student’s median SPG quantile (MSGP) is used to describe the trend of achievement in two subjects, as shown in Figure 6:

In Figure 6, from 2015 to 2019, the overall development of students’ performance in two subjects in the region has stabilized and improved. Although lower than the regional standard score of 60 before 2019, it has improved in subsequent years. The SGP model can also use information classification to divide students into different groups to provide educators with needed student growth information.

From 2018 to 2019, the distribution of MSGP values of teachers in this region is shown in Figure 7:

In Figure 7, although the proportion of teachers with low-level scores is small, the MSGP values of most teachers remain high. Districts can use the Achieve NJ evaluation system, including the SGP model, to distinguish teachers with high-teaching quality. High-quality teachers will continue to serve, while ineffective teachers will be retained or dismissed by improving their teaching level to obtain more effective grades in the following year. This screening method can effectively improve the overall quality of the teaching staff.

The SGP model successfully combines students’ academic performance with teachers’ teaching evaluation, and the results are digitized through the model. This ensures the authenticity and reliability of the evaluation results to a certain extent and dispels the long-term professional concerns of teachers. Students and teachers are 81% and 75% satisfied with the evaluation of this model, respectively.


In recent years, China has made great efforts in education reform. Whether it is the implementation of the “double reduction policy” (in order to effectively reduce the burden of heavy homework and off-campus training for students in compulsory education, the Ministry of Education of China issued the policy in 2021) or the development of vocational education, all of which are hoped for better development, but the unsuitable evaluation system is still hindering the pace of healthy education development. The state should also increase investment in the evaluation system so that more children are motivated to learn and more parents have more confidence in education.

Educational reform should be promoted from top to bottom, using MSGP and other means to strengthen the construction of the teaching staff. The evaluation standard of teachers should be based on ability rather than qualifications to improve the overall level of the teaching staff. Each region

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**Table 1:** Estimated regression coefficients calculated from the first year.

<table>
<thead>
<tr>
<th>Quantile regression coefficient</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>165.32</td>
<td>172.38</td>
<td>177.47</td>
<td>182.02</td>
<td>181.43</td>
<td>188.63</td>
<td>202.12</td>
<td>205.41</td>
<td>181.04</td>
</tr>
<tr>
<td>Standard error</td>
<td>13.85</td>
<td>10.69</td>
<td>10.56</td>
<td>9.86</td>
<td>10.79</td>
<td>11.08</td>
<td>12.43</td>
<td>13.5</td>
<td>18.74</td>
</tr>
<tr>
<td>First year scoring coefficient</td>
<td>0.18</td>
<td>0.17</td>
<td>0.17</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.19</td>
<td>0.21</td>
</tr>
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</table>

**Table 2:** Estimated regression coefficients calculated from the second year.

<table>
<thead>
<tr>
<th>Quantile regression coefficient</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
</tr>
</thead>
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<td>12.43</td>
<td>13.5</td>
<td>18.74</td>
</tr>
<tr>
<td>Second year scoring coefficient</td>
<td>0.18</td>
<td>0.17</td>
<td>0.17</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.19</td>
<td>0.21</td>
</tr>
</tbody>
</table>

**Table 3:** Example of estimated scores for six students based on predetermined SGP values.

<table>
<thead>
<tr>
<th>Grade</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>581</td>
<td>584</td>
<td>593</td>
<td>599</td>
<td>504</td>
<td>609</td>
<td>614</td>
<td>620</td>
<td>628</td>
<td>637</td>
</tr>
<tr>
<td>581</td>
<td>582</td>
<td>556</td>
<td>562</td>
<td>567</td>
<td>572</td>
<td>577</td>
<td>584</td>
<td>591</td>
<td>600</td>
</tr>
<tr>
<td>618</td>
<td>606</td>
<td>590</td>
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<td>615</td>
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<tr>
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<td>615</td>
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<td>633</td>
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<td>633</td>
<td>609</td>
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<td>628</td>
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<td>652</td>
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<td>718</td>
</tr>
<tr>
<td>633</td>
<td>627</td>
<td>642</td>
<td>652</td>
<td>661</td>
<td>661</td>
<td>673</td>
<td>688</td>
<td>718</td>
<td>718</td>
</tr>
</tbody>
</table>

**Table 3:** Example of estimated scores for six students based on predetermined SGP values.

<table>
<thead>
<tr>
<th>Students number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>581</td>
<td>581</td>
<td>618</td>
<td>618</td>
<td>633</td>
<td>633</td>
</tr>
<tr>
<td>10%</td>
<td>584</td>
<td>548</td>
<td>582</td>
<td>606</td>
<td>592</td>
<td>612</td>
</tr>
<tr>
<td>20%</td>
<td>593</td>
<td>556</td>
<td>590</td>
<td>615</td>
<td>600</td>
<td>624</td>
</tr>
<tr>
<td>30%</td>
<td>599</td>
<td>562</td>
<td>596</td>
<td>621</td>
<td>606</td>
<td>634</td>
</tr>
<tr>
<td>40%</td>
<td>504</td>
<td>567</td>
<td>601</td>
<td>626</td>
<td>611</td>
<td>643</td>
</tr>
<tr>
<td>50%</td>
<td>609</td>
<td>572</td>
<td>606</td>
<td>631</td>
<td>616</td>
<td>652</td>
</tr>
<tr>
<td>60%</td>
<td>614</td>
<td>577</td>
<td>612</td>
<td>636</td>
<td>622</td>
<td>661</td>
</tr>
<tr>
<td>70%</td>
<td>620</td>
<td>584</td>
<td>618</td>
<td>642</td>
<td>628</td>
<td>673</td>
</tr>
<tr>
<td>80%</td>
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<td>635</td>
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<td>645</td>
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</tr>
</tbody>
</table>
should set up a team of experts to investigate and study the shortcomings of school education in various regions for a long time and implement effective measures for many students with poor long-term performance growth rates through evaluation methods such as the SGP model to eradicate their shortcomings and ensure the purity of school education. The Ministry of Education should carry out more types of education pilots, reorganize the education and teaching team, and be the vanguard of education reform.

4. Conclusion

The SGP model can evaluate students’ academic performance to obtain their individual learning dynamics and reflect the academic characteristics of students in the region. Second, the model is also effective in educator job evaluations. MSGP values are used to monitor educators. Although the SGP model is computationally complex, the concept is easy to understand and can be used as a reference. Finally, the combination of the SGP model and the Chinese evaluation system cannot fully reflect the entire performance of educators. As an integral part of the multidimensional evaluation system, it can still be a very valuable indicator for measuring teacher effectiveness. Due to time and personal ability, there are still many problems left unresolved. Children are the hope of the future, and their education should be valued by everyone. The future research will devote more energy to the academic evaluation which will contribute to China’s education.
Data Availability

The dataset used in this paper are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

References


