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Will the Wave of Early Retirement of Teachers in Malaysia Continue? A Grey Prediction Based on GM(1,1) Gray Prediction Model

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Abstract

The number of teachers in Malaysia has decreased since 2017 as a result of a tendency toward early retirement among teachers. Numerous organizations have suggested that laws be passed in reaction to this trend to lessen the effects, but Malaysia has yet to come up with any viable solutions. Is it possible that these circumstances will allow for a progressive decrease in the number of early retirees in the near future? Based on this inquiry, a GM(1,1) gray prediction model was created and a gray prediction was formed, which indicates that in 2022–2024, Malaysia's teacher population and teacher–student radio will continue to decline. The Malaysian government needs to take this seriously and aggressively implement a number of steps to prevent the negative effects of early teacher retirement on educational standards.

Keywords: early retirement, Malaysia teacher, gray prediction model

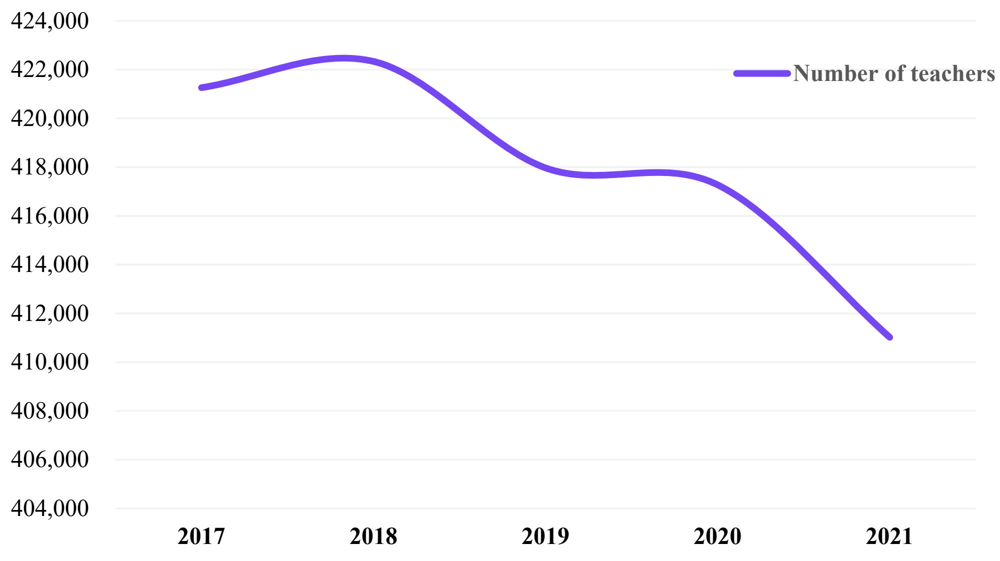
1. Introduction

Media sources state that since 2017, there has been a very noticeable early retirement of teachers in Malaysia. More than 10,000 teachers are expected to have chosen early retirement annually throughout the last few years, according to the National Union of The Teaching Profession (NUTP). The figures from the Malaysian Department of Education confirm that this has caused a fall in the number of teachers. The chart below shows the number of teachers in Malaysia from 2017 to 2021. It is clear from the chart that both primary and secondary school teacher enrollment has decreased, and that there is a general downward trend.

Table 1. Number of teachers in Malaysia 2017-2021

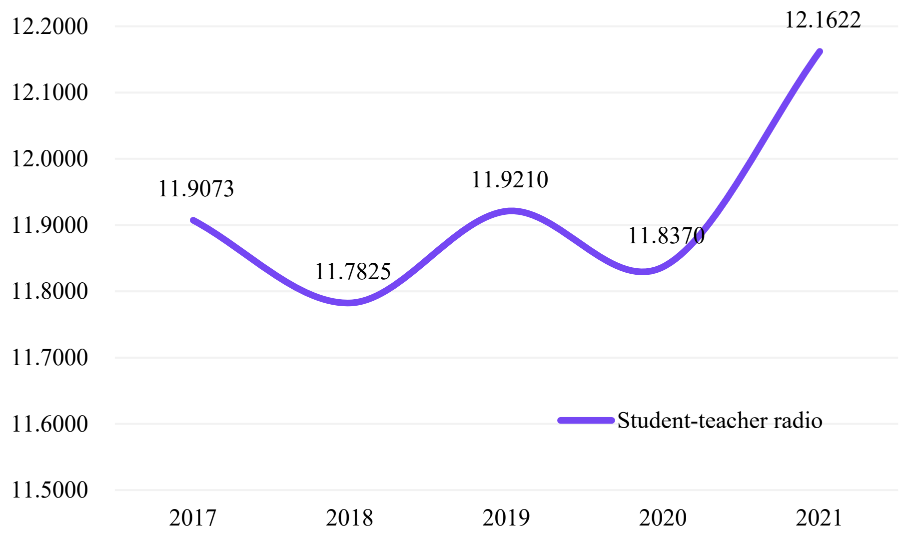
Year	2017	2018	2019	2020	2021	Total
Pre-school	8,995	9,179	9,304	9,227	9,277	45,982
Primary School	230,631	229,682	226,236	227,873	225,762	1,140,184
Secondary School	181,633	183,473	182,426	180,171	175,979	903,682
Total	421,259	422,334	417,966	417,271	411,018	2,089,848

Figure 1. Trends in the number of teachers in Malaysia, 2017-2021



The early retirement trend has had some detrimental effects on Malaysian schooling. The rising student-teacher ratio is one of the quantitative indicators. It is generally accepted that a lower indicator will have a positive impact on education, such as higher grades, higher graduation rates, and lower dropout rates. This indicator is obtained by dividing the number of students by the number of teachers. The Malaysian Ministry of Education reports that from 11.9073 in 2017 to 12.1622 in 2021, Malaysia's student-teacher ratio has grown. Although the increase in this statistic is not significant in absolute terms, it does indicate that teachers are under more pressure to educate. The quality of instruction and learning will gradually deteriorate if the situation persists.

Figure 2. Trends in student-teacher ratio in Malaysia, 2017-2021



The wave of early retirement among Malaysian teachers has led to various impacts on the country's education system. Firstly, the early retirement trend has caused a significant shortage of experienced teachers in Malaysia. This shortage may result in larger class sizes, overworked remaining teachers, and decreased individual attention for students. Consequently, the quality of education might be compromised, affecting student performance and achievement. Also, the early retirement of experienced teachers may lead to a loss of specialized knowledge in various subjects and teaching methods. This may result in a less diverse and comprehensive curriculum, limiting the exposure of students to different perspectives, ideas, and teaching styles. Consequently, students' ability to think critically and adapt to different learning environments could be affected. At the mean time, as more teachers take early retirement, the Malaysian government may need to invest more in recruiting and training new teachers to fill the gaps. This additional financial burden could potentially strain the education budget and affect the allocation of resources for other important aspects of education, such as infrastructure and learning materials. The early retirement trend among Malaysian teachers has various implications for the country's education system. Addressing these challenges will require increased investment in teacher training and professional development, as well as policy adjustments to ensure a stable and high-quality education environment for Malaysia's future generations.

To more effectively address this issue, the Ministry of Education will compile data on the reasons for early retirement and the duration of teachers' service. The loss of teachers, according to the Malaysian government, has a significant impact on the caliber of instruction and learning. This phenomenon currently worries the government of Malaysia. However, no workable remedies have yet been presented by the Malaysian Ministry of Education.

2. Literature review

There is a long list of possible risk and protective factors for teacher retention that can be categorized as teacher, school, and national characteristics, according to earlier study. The majority of studies have concentrated especially on the relationship between unique teacher qualities and elements that affect whether teachers leave the profession or are retained, like stress perceptions and performance efficacy (Skaalvik, 2016). Surprisingly few research, meanwhile, have evaluated teacher qualities in a wider school- or country-level context. The leadership style (Player et al., 2017), school identity (Chan et al., 2008), school culture (Cohen et al., 2009), induction and mentoring programs (Ingersoll & Strong, 2011), and organizational structure have all been highlighted as influencers on schools to date (Ellis et al. 2017; Ingersoll, 2001). The decision to leave the teaching profession has reportedly been influenced by national issues like wage and working circumstances (den Brok et al., 2017; Imazeki, 2005). However, very few research have examined determinants at the person and school levels (e.g. Liu, 2007; Miller & Youngs, 2021).

Attracting talented and motivated applicants to become teachers is one of the main goals in keeping qualified instructors in the classroom. Not everyone possesses the wide range of personality qualities and intellectual, social, and emotional aptitudes necessary for a career as a teacher. However, teaching is viewed differently among cultures and educational systems (Frost, 2012).

We take into account a variety of indicators that have been brought up in earlier research. First, the inclination to leave teaching early may be influenced by initial opinions of the job. Some people have a lifelong desire of becoming teachers, while others consider it to be their second-best job option. A long-term teaching career seems to be more likely for those who consider teaching to be their major professional choice (Watt & Richardson, 2008). Higher rates of burnout and lower levels of professional optimism are linked to thinking of teaching as a second-choice career, which may lead to a decision to leave the field (McLean et al., 2019).

Second, dditionally to initial attitudes regarding teaching, prior employment experience may have influenced the choice to leave the teaching profession. Long-term teaching careers may be more likely for teachers who have realized their dreams following a rocky career path. Teaching resilience, which is necessary for overcoming a difficult transition into teaching, is thought to be largely influenced by prior experience in a career other than teaching (Wilkins & Comber, 2015). Ten years after graduation, teachers in their second career report higher job satisfaction and less stress than those in their first employment (Troesch & Bauer, 2017).

Third, the majority of prior studies have emphasized the significance of intrinsic, altruistic, and extrinsic reasons for beginning a teaching career (e.g., Bergmark et al., 2018). The connection between the intention to leave the profession early is significantly less well understood. Typically, behaviors that are intrinsically driven are ones that are carried out largely for personal enjoyment and satisfaction. Altruistic motivations, which are closely linked, refer to activities taken with no thought for oneself but for the benefit of others.

Extrinsic motivation focuses on motivations for individual behavior that are goal-driven and is typically connected to the qualities of the job itself. According to Manuel and Hughes (2006), the teaching profession is characterized by high levels of intrinsic and altruistic motivation, which is linked to a greater commitment to teaching later in the career (Watt & Richardson, 2008). Teachers still differ from one another in important ways, and it's unclear how teaching motivation changes over time. For instance, we may surmise that it might be more challenging to bounce back if there is a loss of intrinsic and altruistic desire, leading disgruntled teachers to give up on their careers.

Fourth, in line with the idea of extrinsic motivation, remuneration for instructors play a significant role in deciding whether to stay in a position or leave it (e.g. Ingersoll, 2001). It has been discovered that high teacher pay are successful in luring and keeping instructors (Hendricks, 2015). In earlier studies, teacher compensation satisfaction has been thoroughly examined; however, the larger policy context of income comparisons has received less attention.

Finally, one of the most significant teacher recruitment procedures is governed at the federal level. Some education systems also use policy methods to screen, choose, or appoint teacher applicants in place of diploma requirements to manage the supply of new teachers. A variety of evaluation techniques, including as competitive exams and interviews, can be used to assess applicants' teaching motivation, subject knowledge, or fundamental abilities (such literacy). Two significant effects on ECT retention may result from stricter entry requirements for teacher training. First of all, chosen teachers will have greater credentials for the teaching field and consequently a higher likelihood of being good educators. Second, the testing or selection process may have a "labelling impact," making candidates for the teaching profession feel special and motivated to live up to this initial favorable evaluation. Prior studies have found connections between national teacher selection procedures and teacher quality (Ingvarson & Rowley, 2017), but to our knowledge, the relationship between entry requirements and teacher retention has never been studied in the context of broader teacher and school characteristics.

3. Methodology

The Grey Prediction Model, particularly GM(1,1) grey prediction model, is a popular forecasting method due to its ability to make predictions with limited and incomplete data. It is especially useful when there is a lack of historical information or when the system being analyzed is characterized by uncertainty and randomness. The retirement wave in Malaysia is a recent problem, so data is limited, the Grey Prediction Model can be useful because it can work with small data sets. The retirement rate of teachers can be influenced by various complex factors such as economic conditions, government policies, and demographic changes. The Grey Prediction Model is designed to handle uncertainty and can provide valuable insights when the relationships between these factors are not well understood. Based on the above reasons, we believe that it is appropriate to use the gray forecasting model.

(1) To use this model, we need to take the following measures:
Collect historical data: Gather the number of teacher retirements in Malaysia over past 5 years;
(2) Create a cumulative sum sequence (X_0): Calculate the cumulative sum of teacher retirements for each year of the collected data. It is important to carry out the data level ratio test on the known data columns in order to guarantee the viability of the GM(1,1) model.
The original data are known $x^{(0)}$:

$$x(0) = (x^{(0)}(1), x^{(0)}(2), \ldots, x^{(0)}(n)$$

Calculate the rank equivalence of a series:

$$\lambda(k) = \frac{x^{(0)}(k-1)}{x^{(0)}(k)}, k = 2,3,\ldots,n$$

If all the rank ratios $\lambda(k)$ fall within $(e^{-\frac{2}{n+1}}, e^{\frac{2}{n+2}})$, then the series $x^{(0)}$ can be used as a grey prediction for the data of the model GM(1,1), and if it does not pass, a change is made to the series $x^{(0)}$ so that it falls within the range. That is, take the appropriate constant C and do a translation swap:

$$y^{(0)}(k) = x^{(0)}(k) + c, k = 1, 2, \ldots, n$$

A further grade ratio test is carried out until it passes or the model is replaced.
(3) Generate a first-order accumulated generating operation (AGO) sequence (X_1). Calculate the average of each neighboring pair of data points in the cumulative sum sequence (X_0). This sequence (X_1) represents the first-order accumulated generating operation.
A single accumulation of the original data column $x^{(0)}$ (AGO) generates the series $x^{(1)}$:

$$x^{(1)}(1) = (x^{(1)}(1), x^{(1)}(2), \ldots, x^{(1)}(n)$$

Where:

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i), k = 1,2,\ldots,n$$

The corresponding differential equation is: (a is the development factor and b is the amount of grey action).

$$\frac{dx^{(1)}}{dt} + ax^{(1)}t = b$$

(4) Estimate the model parameters: Use least squares estimation to find the GM(1,1) model parameters . Coefficient solving (constructing data matrices and data vectors) and differential equation solving.
Data Matrix B:

$$B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix}$$

Data vector *Y*:

$$Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix}$$

Where $z^{(1)}$ is the weighted average.

$$z^{(1)}(k) = 0.5x^{(1)}(k) + 0.5x^{(1)}(k-1), k = 2,3,\ldots,n$$

(5) Calculate the discrete-time response equation: Use the estimated model parameters (a and b) to determine the discrete-time response equation, which will be used to predict the number of teacher retirements for future years.

Calculation factor $\hat{\mu}$ (Least squares).

$$\hat{\mu} = (a,b)^T = (B^T B)^{-1} B^T Y$$

Solving the previous differential equation yields:

$$\hat{x}^{(1)}(k+1) = (x^{(0)}(1) - \frac{b}{a})e^{-ak} + \frac{b}{a}, k = 1,2,\ldots,n-1$$

$$\hat{x}^{(0)} = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}k, k = 1,2,\ldots,n-1$$

$$\hat{x}^{(1)}(1) = \hat{x}^{(0)}(1) = x^{(0)}(1)$$

From the three equations above, it follows that:

$$\hat{x}^{(0)}(k+1) = (x^{(0)}(1) - \frac{b}{a})(1-e^{a})e^{-ak}, k = 1,2,\ldots,n-1$$

(6) Perform inverse accumulated generating operation (IAGO): Apply the inverse accumulated generating operation to the predicted values obtained from the discrete-time response equation. This will give you the forecasted retirements for each year. Predict the number of teacher retirements: Use the discrete-time response equation and the IAGO to predict the number of teacher retirements in Malaysia for the next three years.

(7) Residual test and stepwise deviation test

Residual test $\varepsilon^{(k)}$:

$$\varepsilon(k) = \frac{x^{(0)}(k) - \hat{x}^{(0)}(k)}{x^{(0)}(k)}, k = 1,2,\ldots,n$$

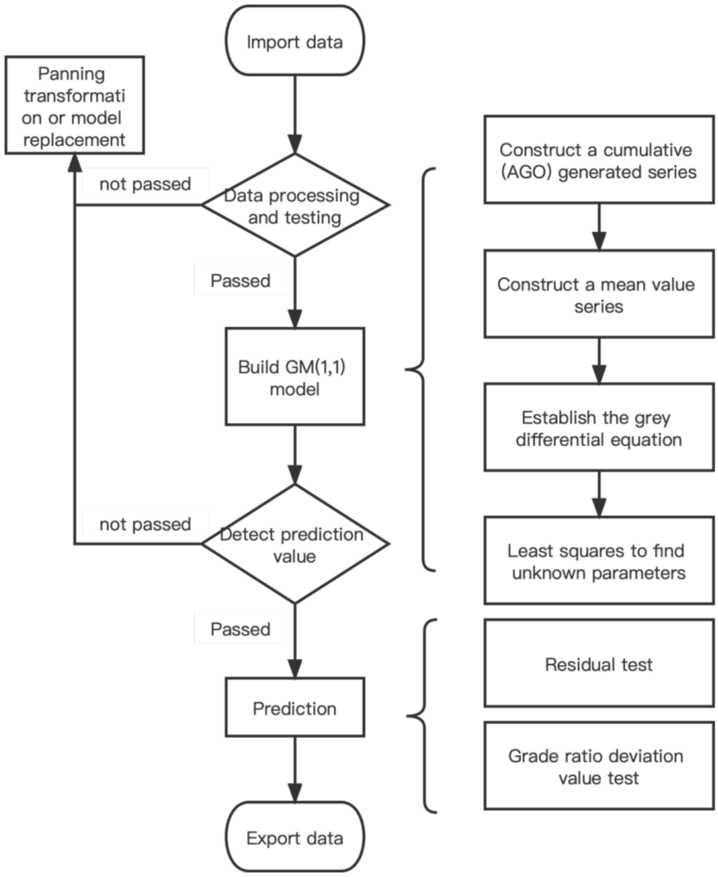
The prediction accuracy of the model can be judged by substituting the following list for the prediction results:

	Accuracy Grade			
	1	2	3	4
Relative Error (a)	<0.01	<0.05	<0.10	≧0.20
Relative Accuracy (ε)	>0.90	>0.80	>0.70	≦0.60
Small error Probability (P)	>0.95	>0.80	>0.70	≦0.70
Variance Ratio (C)	<0.35	<0.50	<0.65	≧0.65

* 1-Excellent 2-Qualified 3-Basically qualified 4-Failure

The process is illustrated below:

Figure 3. Flow chart of grey prediction model



4. Grey prediction model construction and testing

Grey prediction's primary advantage is that it can be used with little amounts of data (up to 20), but not with huge numbers. A grey prediction model can be used to accurately anticipate the number of teachers in Malaysia in the future despite the complicated causes of early retirement among Malaysian teachers and the scant data currently available.

Substituting the data using R yields the following results:

4.1. Prediction of number of teachers

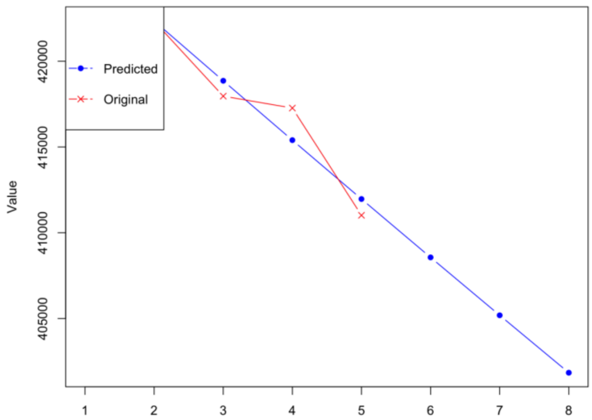
GM(1,1) model parameter estimates are as follows:.

Development Factors (a)	-0.008297155	Grey Volume of Action (u)	427600.7

Predicting result:

Time	Actual Value	Predicted Value	Absolute Residual	Relative Residual
2017	421,259	421259	0.0000	0.0000
2018	422,334	422350.9	-16.8720	0.0004
2019	417,966	418861.1	-895.0593	0.0021
2020	417,271	415400.1	1870.9180	0.0045
2021	411,018	411967.7	-949.7028	0.0023
2022		408563.7		
2023		405187.8		
2024		401839.8		

Figure 4. Prediction results of the number of teachers



According to the projection model mentioned above, it is anticipated that the number of teachers in Malaysia would continue to decrease, with estimates for 2022–2024 putting that number at 408,563, 405,187, and 401,839, respectively. This may be strongly related to COVID-19, as many instructors have reported that in the MCO state, online classes have added a lot of repetitive administrative duties to them, and some older teachers need to spend more time commissioning equipment since they are less familiar with new technology.

According to a research study by AZ Khairani et al. (2019), the top five reasons Malaysian teachers choose this career are A) they enjoy working with children, B) it offers opportunities for longer-term studies, C) it guarantees a job, D) they get called, and E) they get recommendations from friends and family. And less than 50% of people highly favored any of these criteria.

In the 5G era, Malaysian teachers have blurred the lines between work and play, making it impossible for them to strike a balance between the two. Once that balance is lost, it is impossible to restore, and the benefits of the teaching profession cease to be apparent.

Testing result

Test Indicator	Test Result
Sum of Squared Residuals	5203684
Average Relative Error	0.2244%
Relative Accuracy	99.7756%
Variance Ratio (C)	19.5968%
Small Error Probability (P)	0.9999

When the results of the aforementioned tests were inserted into Table 1 to evaluate the results of the model prediction, the GM(1,1) model prediction grade was determined to be outstanding. This suggests that the prognosis is very accurate, that the reduction in the number of teachers at Malaysia's higher institutions is anticipated to continue, and that the Malaysian government is not currently putting up any improved policies to lessen the effects of this trend.

4.2. Prediction of teacher-student ratio

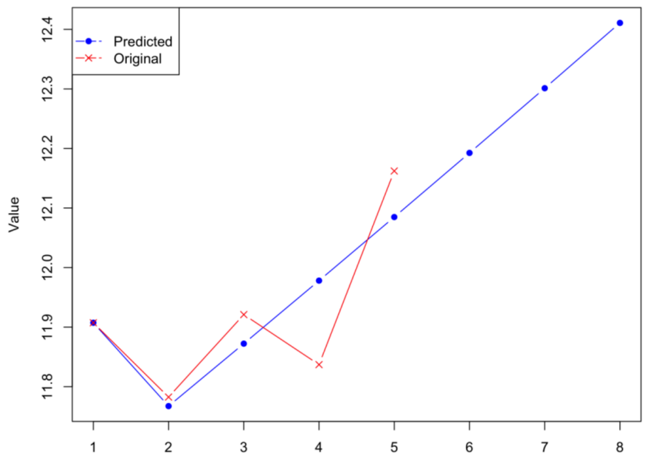
GM(1,1) model parameter estimates.

Development Factors (a)	0.008874991	Grey Volume of Action (u)	11.60949

Predicting result:

Time	Actual Value	Predicted Value	Absolute Residual	Relative Residual
2017	11.9073	11.9073	0.0000	0.0000
2018	11.7825	11.7673	0.0152	0.0013
2019	11.9210	11.8722	0.0488	0.0041
2020	11.8370	11.9780	-0.1410	0.0119
2021	12.1622	12.0848	0.0774	0.0064
2022		12.1926		
2023		12.3012		
2024		12.4109		

Figure 5. Prediction results of Teacher-Student Ratio



According to the GM(1,1) model, Malaysia's overall teacher-student ratio is on the rise and is anticipated to reach 12.1926%, 12.3012%, and 12.4109% in 2022–2024, respectively. This indirectly illustrates the country's current teacher shortage. The quality of teaching and learning is negatively impacted by early retirement of Malaysian teachers since it increases the teacher-student ratio.

Testing result

Test Indicator	Test Result
Sum of Squared Residuals	0.0285
Average Relative Error	0.5915%
Relative Accuracy	99.4085%
Variance Ratio (C)	43.0462%
Small Error Probability (P)	0.9999

The level of prediction accuracy for the GM(1,1) model that belongs to C-value is [0.35,0.5], P>0.80: Qualified. Because the teacher-student ratio is a relative indicator, which means that both the number of teachers and the number of pupils are changing at the same time, there is less data available between 2017 and 2021, and there is a wide range in the indicator's prediction accuracy.

5. Conclusion

The Grey Forecasting Model is a widely used statistical tool for making predictions about future trends based on historical data. In this case, the model has analyzed the patterns of teacher resignations in Malaysia and has projected that the trend is likely to persist in the near future.This conclusion has significant implications for the education sector in Malaysia. The high rate of teacher turnover can lead to a number of challenges, such as disruptions to classroom continuity, decreased student performance, and increased costs associated with recruiting and training new teachers.

It is therefore important for policymakers and education leaders in Malaysia to take proactive steps to address the underlying factors driving the teacher resignations. This may involve implementing policies to improve teacher job satisfaction and retention, providing better support for teachers in terms of training and resources, and addressing issues such as low pay and heavy workloads.

Overall, the Grey Forecasting Model provides valuable insights into the future trajectory of the teacher workforce in Malaysia and can serve as a useful tool for guiding strategic planning and decision-making in the education sector.

To address the issue of teacher resignations in Malaysia, the government can take the following measures:

1. Improve teacher salaries and benefits: Providing competitive salaries and benefits can attract more talented individuals to the teaching profession and reduce financial stress for teachers, thus increasing their job satisfaction.

2. Strengthen teacher training and support: Offering better training and support can enhance teachers' professional skills and teaching abilities, helping them to better address the increasingly complex challenges in education and increasing their sense of professional identity.
3. Optimize education management and supervision mechanisms: Strengthening the management and supervision of educational institutions can improve their operational efficiency and teaching quality, thereby enhancing teachers' job satisfaction and teaching outcomes.
4. Optimize teaching environments and facilities: Providing better teaching environments and facilities can offer teachers better teaching resources and working conditions, while also improving student learning outcomes and reducing teachers' work pressures.

References

Ahmad Zamri Khairani and Mohd Ali Samsudin, (2019), Career Profile among Malaysian In-Service Teachers, CICE Series, (6)6, 121-129.

Bergmark, U., Lundstrom, S., Manderstedt, L., & Palo, A. (2018). Why become a teacher? Student teachers' perceptions of the teaching profession and motives for career choice. European Journal of Teacher Education, 41(3), 266e281. https://doi.org/10.1080/02619768.2018.1448784

Chan, W.-Y., Lau, S., Nie, Y., Lim, S., & Hogan, D. (2008). Organizational and personal predictors of teacher commitment: The mediating role of teacher efficacy and identification with school. American Educational Research Journal, 45(3),597e630. https://doi.org/10.3102/0002831208318259

Cho, Y. J., & Lewis, G. B. (2012). Turnover intention and turnover behavior: Implications for retaining federal employees. Review of Public Personnel Administration, 32(1), 4e23. https://doi.org/10.1177/0734371X11408701

den Brok, P., Wubbels, T., & van Tartwijk, J. (2017). Exploring beginning teachers' attrition in The Netherlands. Teachers and Teaching, 23(8), 881e895. https://doi.org/10.1080/13540602.2017.1360859

Ding, Song; Hipel, Keith W.; Dang, Yao-guo (2018). Forecasting China's electricity consumption using a new grey prediction model. Energy, 149(), 314–328. doi: 10.1016/j.energy.2018.01.169

Ellis, C., Skidmore, S. T., & Combs, J. P. (2017). The hiring process matters: The role of persone-job and persone-organization fit in teacher satisfaction. Educational Administration Quarterly, 53(3), 448e474. https://doi.org/10.1177/0013161X16687007

Frost, D. (2012). From professional development to system change: Teacher leadership and innovation. Professional Development in Education, 38(2), 205e227. https://doi.org/10.1080/19415257.2012.657861

Hendricks, M. D. (2015). Towards an optimal teacher salary schedule: Designing base salary to attract and retain effective teachers. Economics of Education Review, 47(Supplement C), 143e167. https://doi.org/10.1016/j.econedurev.2015.05.008

Imazeki, J. (2005). Teacher salaries and teacher attrition. Economics of Education Review, 24(4), 431e449. https://doi.org/10.1016/j.econedurev.2004.07.014

Ingersoll, R. M. (2001). Teacher turnover and teacher shortages: An organizational analysis. American Educational Research Journal, 38(3), 499e534. https://doi.org/10.3102/00028312038003499

Ingersoll, R. M., & Strong, M. (2011). The impact of induction and mentoring programs for beginning teachers. A Critical Review of the Research, 81(2), 201e233. https://doi.org/10.3102/0034654311403323

Ingvarson, L., & Rowley, G. (2017). Quality assurance in teacher education and outcomes: A study of 17 countries. Educational Researcher, 46(4), 177e193. https://doi.org/10.3102/0013189X17711900

Manuel, J., & Hughes, J. (2006). 'It has always been my dream': Exploring pre-service teachers' motivations for choosing to teach. Teacher Development, 10(1), 5e24. https://doi.org/10.1080/13664530600587311

McLean, L., Taylor, M., & Jimenez, M. (2019). Career choice motivations in teacher training as predictors of burnout and career optimism in the first year of teaching. Teaching and Teacher Education, 85, 204e214. https://doi.org/10.1016/j.tate.2019.06.020

Miller, J. M., Youngs, P., Perrone, F., & Grogan, E. (2020). Using measures of fit to predict beginning teacher retention. The Elementary School Journal, 120(3),399e421. https://doi.org/10.1086/707094

Ministry of Education Malaysia,10 Dec 2021, Malaysia Education Statistic 2021, Ministry of Education Malaysia. https://www.moe.gov.my/statistik-menu/statistik-bilangan-sekolah-murid-guru

Player, D., Youngs, P., Perrone, F., & Grogan, E. (2017). How principal leadership and person-job fit are associated with teacher mobility and attrition. Teaching and Teacher Education, 67, 330e339. https://doi.org/10.1016/j.tate.2017.06.017

Skaalvik, E. M., & Skaalvik, S. (2016). Teacher stress and teacher self-efficacy as predictors of engagement, emotional exhaustion, and motivation to leave the teaching profession. Creative Education, (13), 1785e1799. https://doi.org/10.4236/ce.2016.713182, 07

Troesch, L. M., & Bauer, C. E. (2017). Second career teachers: Job satisfaction, job stress, and the role of self-efficacy. Teaching and Teacher Education, 67, 389e398. https://doi.org/10.1016/j.tate.2017.07.006

The Hun School of Princeton, Dec 2022, Everything You Need To Know About Student-Teacher Ratios, https://www.hunschool.org/resources/student-teacher-ratios

Van den Borre, L., Spruyt, B., & Van Droogenbroeck, F. (2021). Early career teacher retention intention: Individual, school and country characteristics. Teaching and Teacher Education, 105, 103427. doi: 10.1016/j.tate.2021.103427

Watt, H. M. G., & Richardson, P. W. (2008). Motivations, perceptions, and aspirations concerning teaching as a career for different types of beginning teachers. Learning and Instruction, 18(5), 408e428. https://doi.org/10.1016/j.learninstruc.2008.06.002

Wilkins, C., & Comber, C. (2015). 'Elite' career-changers in the teaching profession. British Educational Research Journal, 41(6), 1010e1030. https://doi.org/10.1002/berj.3183

Zeng, Bo; Duan, Huiming; Zhou, Yufeng (2019). A new multivariable grey prediction model with structure compatibility. Applied Mathematical Modelling, S0307904X19303415. doi: 10.1016/j.apm.2019.05.044