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Informatisation of educational reform based on fractional differential equations

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Abstract

Information technology application ability is a necessary professional ability for teachers in the information society. The means to take effective measures to promote the acquisition and transfer of teacher information technology application ability involves undertaking measures to facilitate teachers to transform teaching methods, deepen basic education curriculum reform and promote teachers' lifelong learning. It plays a vital role in effectively promoting the independent development of majors and further cracking the bottleneck problem of educational information development. This study uses the fractional differential equation method to select 220 elementary and middle school teachers in the Northeast Teacher Education Innovation Experimental Zone as the research objects. The research objects are measured by a scale and fractional differential equations are used to build a system that includes school factors, human factors, policy and institutional factors, training factors, self-efficacy factors and motivation factors of teacher information technology application ability transfer fractional differential equation influencing factor model; we hope to solve the problem of 'learning and use disconnect' in the process of teacher information technology application ability training, and to promote the effective transfer of teacher information technology application ability that can be used as an important reference.

Keywords: fractional differential equation, information technology application ability, teacher education technology, ability transfer
AMS 2010 codes: 97B10

1 Introduction

The 'National Medium and Long-term Educational Reform and Development Plan Outline (2010–2020)' clearly states: 'Information technology has a revolutionary impact on education development and must be highly valued' (Ministry of Education, 2010). The construction of a contingent of teachers is the basic guarantee for the sustainable development of education informatisation, and the ability to apply information technology is a necessary professional ability for teachers in an information society. In October 2013, the Ministry of

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Education decided to implement the ‘National Primary and Secondary School Teachers’ Information Technology Application Ability Improvement Project’, which aims to systematically improve teacher information through the implementation of the three major links of ‘training-evaluation-application’ under the guidance of standard technical application capabilities. The above research points out the direction of related research on teacher information technology application ability training, that is, through the collection, processing and analysis of teacher information technology application ability transfer related data, exploration of factors that affect teacher information technology application ability transfer and formulation of the ability to promote ability transfer specific strategies. However, the existing research in this field still has shortcomings in the number of data samples and data analysis methods, and it is urgently necessary for future research to improve. This research will try to overcome the shortcomings of previous studies in sample size and data analysis methods, explore the factors affecting the transfer of teacher information technology application ability and build a model of related factors of fractional differential equations [1].

2 Materials and methods

2.1 Conditional assumptions

Through combing the relevant research at home and abroad, we conclude that the current factors affecting the transfer of teachers’ information technology application ability mainly include policy systems, schools, human activities, training, motivation and self-efficacy factors. Figure 1 shows a schematic diagram of the conditional assumption model. Therefore, this study makes the following assumptions:

Fig. 1 Schematic diagram of conditional assumption model

H1: The software and hardware conditions of the teacher’s school and the guarantee of time resources will affect the self-efficacy of teachers’ information technology application ability transfer.

H2: The software and hardware conditions, time arrangement and the strength of teachers in the training of teachers’ information technology application ability will affect the self-efficacy of teachers’ information technology application ability transfer.

H3: National or local related policies and systems will have an impact on the motivation of teachers’ information technology application ability transfer.

H4: School leaders, colleagues, students and domain experts have an impact on teachers’ motivation for the transfer of information technology application ability.

H5: National or local related policies and systems will have an impact on the school’s human and material investment in teachers’ learning and use of information technology.

H6: National or local related policies and systems will have an impact on the quality of teachers’ participation in information technology application ability training.

H7: National or local policies and systems will affect the concepts, attitudes and practices of school leaders, colleagues, students and field experts on learning and applying information technology.

The model based on the above research assumptions is shown in Figure 1. The model contains six latent variables of school, training, policy system, human, self-efficacy and motivation. This study adopts the structural equation model method, through four steps of hypothetical model construction, model fitting, model evaluation and model modification, and finally builds a model of the influencing factors of the fractional differential equation of teacher information technology application ability transfer.

2.2 Influencing factor model of fractional differential equation

So far, there has been no unified definition expression for fractional calculus. Mathematicians analyse the problem from different angles and get different definitions. At this stage, there are three main definitions of fractional calculus: Grunwald-Let Niko definition (G-L), Riemann-Liouville definition (RL) and Capote definition. The definition of G-L is derived from the difference definition of integer-order differential. The definitions of RL and Capote are derived from the Cauchy formula of integral order. Using Gamma function $\Gamma(x)$, the calculus order can be extended from integer to fraction, $[\cdot]$ represents the integer part, the change interval of $f(x)$ is $[a, b]$ and the fractional calculus of order ν defined by G-L is

$${}_a D_b^\nu f(x) = \lim_{h \rightarrow 0} h^{-\nu} \sum_{j=0}^{[(b-a)/h]} (-1)^j \frac{\Gamma(\nu+1)}{j! \Gamma(\nu-j+1)} f(x-jh) \quad (1)$$

According to the derivation in the literature, when $\nu > 0$, ${}_a D_b^\nu$ represents a fractional differential operator of order ν ; when $\nu < 0$, ${}_a D_b^\nu$ represents a fractional integral operator. The ν -order fractional integral defined by RL is

$${}_a D_b^\nu f(x) = \frac{1}{\Gamma(-\nu)} \int_a^b (b-\xi)^{-\nu-1} f(\xi) d\xi \quad (2)$$

The introduction of fractional integration theory into image denoising is a new development direction. If the duration of the unary signal $f(t)$ is $t \in [a, t]$, and the signal duration is divided into equal intervals by the interval $h = 1$, then $n = [(t-a)/h] = [t-a]$. When $\nu < 0$, we define the approximate expression of the fractional integral of the next element signal $f(t)$ in G-L:

$$I_{G-L}^{-\nu} f(t) \approx f(t) + (-\nu) f(t-1) + \frac{(-\nu)(-\nu+1)}{2} f(t-2) + \dots + \frac{\Gamma(-\nu+1)}{n! \Gamma(-\nu-n+1)} f(t-n) \quad (3)$$

R-L defines the approximate expression of the ν -order integral of the next element signal $f(t)$:

$$\begin{aligned} I_{R-L}^\nu f(t) &= \frac{1}{\Gamma(-\nu)(-2\nu)} f(t) + \frac{1}{\Gamma(-\nu)(-2\nu)} \sum_{k=1}^{n-1} [(k+1)^{-\nu} - (k-1)^{-\nu}] f(t-k) \\ &+ \frac{1}{\Gamma(-\nu)(-2\nu)} [n^{-\nu} - (n-1)^{-\nu}] f(t-n) + \dots \end{aligned} \quad (4)$$

We perform partial fractional integration along eight directions (0° , 45° , 90° , 135° , 180° , 225° , 270° and 315°) of the pixels of the two-dimensional digital image, respectively, to construct eight 3×3 masks, and superimpose them to get a 5×5 mask as shown in Figure 1.

It is known that for any square integrable energy signal $s(t) \in L^2(R)$, when $\nu > 0$, D^ν represents the ν -order differential multiplicative operator; $D^{-\nu} = I^\nu$ represents the ν -order integral multiplicative operator. The Fourier transform of the fractional differential is

$$D^\nu s(t) \Leftrightarrow (D^\nu s)(\omega) = (i\omega)^\nu \hat{s}(\omega) = |\omega|^\nu \exp[i\theta(\omega)] \hat{s}(\omega) = |\omega|^\nu \exp\left[\frac{\nu\pi i}{2} \text{sgn}(\omega)\right] \hat{s}(\omega) \quad (5)$$

According to the theory of fractional operators, fractional differentiation and fractional integral are the inverse operations of each other, $D^- = I$ represents the fractional integral operator and set $\nu' = -\nu$; then the Fourier

transform of the fractional integral can be obtained from Eq. (5):

$$I^{\nu'} s(t) \xleftrightarrow{FT} (\hat{I}^{\nu'} s)(\omega) = (i\omega)^{\nu'} \hat{s}(\omega) = |\omega|^{\nu'} \exp[i\varphi(\omega)] \hat{s}(\omega) = |\omega|^{\nu'} \exp\left[\frac{\nu'\pi i}{2} \operatorname{sgn}(\omega)\right] \hat{s}(\omega) \quad (6)$$

From Eqs (5) and (6), we draw the frequency response diagram of each order fractional derivative and integral.

3 Research results

A total of 206 valid questionnaires were collected in the research, including 25 male teachers and 181 female teachers, 16 teachers with postgraduate education, 183 undergraduates and 7 junior college graduates (Table 1). Analysing the test data of the scale using SPSS statistical analysis software, it can be concluded that the Cronbach's alpha of the scale is 0.912, which indicates that the test scale has good reliability and can be used for the next step of structural equation modelling construction.

Table 1 Descriptive statistics of survey subjects

Numbering	Item
1	Applying information technology to daily teaching will make my teaching behaviour more effective
2	Applying information technology to daily teaching will give me better career development opportunities
3	I am confident that in the course of teaching preparation, I can select appropriate information technology assistance (such as using PPT, Flash and web technologies to produce demonstration courseware) based on the course standard for the teaching design of the course
4	I am confident that in the classroom teaching process, I choose appropriate information technology (such as using simulation software to demonstrate the chemical reaction process) to promote student learning and improve classroom teaching effects
5	The state lists teachers' information technology ability as an important indicator of teacher ability assessment, which will encourage me to apply information technology in daily teaching
6	If my province or city proposes a clear policy or action plan related to teacher information technology capabilities, it will encourage me to apply information technology in daily teaching
7	If the teacher's information technology application ability training can provide a good course structure and a software and hardware learning environment, it will help me apply information technology to daily teaching
8	If the teacher's information technology application ability training is reasonable in terms of class schedule and teacher staff, it will help me to apply information technology to daily teaching
9	If the teacher's information technology application ability training can provide high-quality training follow-up support (such as setting up discussion groups, answering support etc.), it will help me apply information technology to daily teaching
10	If the school can provide sufficient hardware guarantee for teachers to apply information technology (such as computers, high-speed broadband, multimedia classrooms, printers, scanners etc.), it will prompt me to apply information technology in daily teaching
11	If the school can provide sufficient software guarantee for teachers to apply information technology (such as office software, courseware production software, production material resources etc.), it will prompt me to apply information technology in daily teaching
12	If the school can give teachers a certain degree of teaching autonomy, it will help me apply information technology to daily teaching
13	If school leaders attach importance to teachers' information technology application ability, it will prompt me to apply information technology in daily teaching
14	If my colleagues are keen to apply information technology to daily teaching, it will prompt me to apply information technology in daily teaching
15	If the students like it that the teacher applies information technology to daily teaching, it will help me to apply information technology to daily teaching
16	If domain experts are positive about applying information technology to daily teaching, it will prompt me to apply information technology in daily teaching

Next, this research uses AMOS software to test the hypothesis model, including three steps: recognition calculation, fit detection and model correction:

3.1 Calculation of model recognition

Only on the premise that the model can be identified can we successfully estimate the various parameters in the model and complete the model's fit detection. This study adopts the t-law and uses the degrees of freedom to judge the degree of model recognition. Through calculation, the degree of freedom of the hypothetical model is ascertained to be 96, that is, the recognition degree of the model is over-recognition, which means that the next step of model fit detection can be performed [2].

3.1.1 Model fit test

This is mainly done by comparing the covariance matrix of the hypothetical model with the covariance matrix of the sample data. The closer the covariance matrix of the two is, the better the fit of the hypothetical model. It is difficult to judge whether the two covariance matrices are close to each other by simply observing the two covariance matrices. Therefore, the fit of the structural equation model is generally tested by the chi-square degree of freedom ratio (χ^2/f), the residual mean square root (RMR), the fitness index (GFI), asymptotic residual mean square root (RMSEA), standard fit index (NFI), comparative fit index (CFI) and other index coefficient judgements, where the chi-square degree of freedom ratio is the ratio of the chi-square value (χ^2) and the degree of freedom (f).

The smaller the chi-square degree of freedom ratio, the better the model fit. Generally speaking, the ratio of chi-square degrees of freedom <3 is acceptable; RMR is the mean square and square root of the residuals, which is the average value of the fitting residuals. Generally speaking, the smaller the RMR value, the better the model fit. The reference value of RMR is 0.05, and the value of RMR is >0.05 , indicating that the hypothetical model needs to be revised; GFI is the fitness index, which measures the extent to which the covariance matrix of the sample data is predicted by the covariance matrix of the hypothetical model.

The reference value of GFI is 0.9 and the value of GFI is <0.9 , indicating that the hypothetical model needs to be revised; RMSEA is the asymptotic residual mean square and square root. It is generally believed that the model with an RMSEA value >0.05 has a good fit; NFI is the standard fit index. It is generally believed that the model with an NFI value >0.9 has a good fit; CFI is a comparative fit index. It is generally believed that a model with a CFI value >0.9 has a good fit. The results of the analysis using AMOS software (Table 2) show that, except for the two index coefficients of the NFI and the CFI, the other index coefficients are not up to the standard, indicating that the fit of the hypothetical model is not good. We thus revise the hypothetical model.

Table 2 Test index coefficients of model fit

Participant characteristics	Eigenvalues	Number of people	Percentage (%)
Gender	Male	25	12.1
	Female	181	87.9
Education	Specialist	7	3.4
	Undergraduate	183	88.8
	Postgraduate	16	7.8
Teaching age	3 years and below	5	2.5
	3–10 years	32	15.5
	10 (including 10 years) – 15 years	40	19.4
	15 years and above	129	62.6
School nature	Municipal key primary and secondary schools	51	24.8
	Municipal primary and secondary schools	113	54.9
	Primary and secondary schools below the county level	42	20.3

3.1.2 Model revision

After the model fit is tested, several correction suggestions are included in the analysis result report. The correction indicators include three sub-options of covariance, variance and regression coefficient. Generally speaking, model revision only adopts revision suggestions with revision index >5 . After the analysis of the data, the suggestion to modify the model with a revised index >5 includes adding the communal relationship between e2 and e3 error variables, that is, adding the path from motivation to self-efficacy. The revised model path is shown in Figure 2 [3]. The test results of model fit after correction are shown in Table 3. It can be seen that, except for the residual mean square and square root index coefficient values being slightly higher than the standard value, the other index coefficients have reached the standard, indicating that the hypothetical model has a good fit. Compared with the hypothetical model, the revised model not only retains the original seven hypothetical influence paths but also adds an influence path from motivation to self-efficacy, that is, the motivation of teacher information technology application ability transfer will affect teachers' information technology application ability, and the self-efficacy of migration has an impact. Based on the above analysis results, this research constructs a model of the influencing factors of teachers' information technology application ability transfer fractional differential equations that includes school, human factors, policy systems, training, self-efficacy and motivation. Among them, self-efficacy and motivation are internal factors, whereas policy systems and training are external factors (Figure 3).

Fig. 2 The revised model path

Table 3 Modified model fitness test index coefficients

Indicator name	Chi-square degree of freedom ratio	Residual mean square and square root	GFI	Asymptotic residual mean square and square root	NFI	CFI
Reference	<3.00	<0.05	>0.90	<0.05	>0.90	>0.90
Actual value	3.311	0.092	0.857	0.078	0.974	0.973

CFI, comparative fit index; GFI, fitness index; NFI, standard fit index

Fig. 3 The model of the influencing factors of the fractional differential equation for the transfer of teacher information technology application ability

3.2 Influencing factors of intrinsic fractional differential equation

3.2.1 Motivation

Motivational factors refer to internal psychological factors related to teachers' application of information technology to daily teaching. They stimulate, maintain and guide the transfer of teachers' information technology application ability. Motivation is divided into intrinsic motivation and extrinsic motivation. It expresses the teacher's self-determination in the process of applying information technology, but the degree is different. Extrinsic motivation is accompanied by external pressure and experience requested by the outside world, and intrinsic motivation is accompanied by full personal will and choice. Generally speaking, teachers apply information technology to daily teaching as a necessary and sufficient condition to be qualified for the teaching profession; or teachers believe that certain teaching achievements can be brought about by applying information technology to daily teaching, for example, through the application of information technology in curriculum teaching activities, which can make classroom teaching achieve twice the result with half the effort; these are likely to form the internal motivation of teachers to apply information technology to daily teaching. Extrinsic motivation is the result of teachers being pressured by the outside world. In the model of the influencing factors of the fractional differential equation for the transfer of teachers' information technology application ability, it is mainly manifested in the application of information technology to daily teaching, which is forced to be formed by the influence of policies, institutions and human activities.

3.2.2 Self-efficacy

Self-efficacy factors refer to teachers' self-judgement and beliefs about applying information technology to daily teaching ability. Self-efficacy can be divided into result expectation and efficacy expectation. Efficacy expectation refers to the teacher's belief that he has the ability to successfully perform this specific behaviour; result expectation refers to the teacher's subjective judgement that a certain behaviour on one's part may lead to a certain result. Good results will activate the behaviour. The self-efficacy in this study specifically refers to the expectation of effectiveness, that is, teachers' belief in applying the information technology they have learned to

daily teaching. For example, teachers need to have the confidence to effectively apply the information technology they have mastered to daily teaching activities. Self-efficacy will also be affected by schools, training and motivation. If schools can provide teachers with sufficient software and hardware support, expert support and resource guarantees for teachers' learning and application of information technology, it will be possible to improve teachers' self-efficacy in applying information technology. The information technology training teachers participate in can be configured effectively in terms of teaching faculty, curriculum settings, practical support and knowledge transfer support, and it will be possible to improve teachers' self-efficacy in applying information technology. In addition, experimental research data shows that the motivation of teachers' information technology application ability transfer will also have a certain impact on self-efficacy [4].

3.3 Influencing factors of external fractional differential equations

3.3.1 School

This refers to the impact of non-human factors within the school on the application of information technology to teachers in daily teaching, including the school's school-running philosophy and operating mechanism, and whether the school has the ability to encourage teachers to learn advanced technology and apply it to specific subject teaching. Ideas and mechanisms will likely have an impact on teachers' application of information technology to daily teaching; sufficient and high-quality hardware and software configurations will likely affect teachers' application of information technology. In addition, the issue of whether the school can grant teachers a certain degree of teaching autonomy will also have a certain impact on teachers' application of information technology. In addition to directly affecting the transfer of teachers' information technology application ability, schools also indirectly affect teachers' self-efficacy in applying information technology.

3.3.2 Training

Training factors refer to the information technology training that teachers participate in, including training time arrangement, teacher allocation, curriculum setting, learning support and knowledge transfer support. High-quality information technology training may have a direct impact on teachers' application of information technology to daily teaching. For example, if the training schedule, teacher allocation and curriculum settings can be arranged in a targeted manner with full consideration of the knowledge status and learning characteristics of the trained teachers, it will be possible to promote the teachers to obtain a solid information technology application ability and then apply information technology to daily teaching. If relevant training focuses not only on pre-training and training but also on knowledge transfer support after training, it may be beneficial to teachers to maintain and transfer the knowledge learned in training, and promote teachers to apply information technology in daily teaching activities. In addition, in addition to the direct impact on the transfer of teachers' information technology application ability, training may also have an indirect impact by affecting self-efficacy.

3.3.3 Policy system

This refers to national and local policies, systems and action plans related to teachers' information technology application capabilities. The policy system is a relatively special factor in the fractional differential equation influencing factor model of the transfer of teachers' information technology application ability. It does not directly affect the transfer of teachers' information technology application ability, but does so indirectly through schools, training, and human and motivational factors that have an impact on teachers' learning and application of information technology. It is the factor that has the most relational paths in the entire model. Generally speaking, national or local policies and systems related to teachers' learning and application of information technology will directly affect schools' support for the application of information technology in daily teaching, and also affect the attitudes and views of school leaders and colleagues towards information technology. Further, the motivation of teachers to learn and apply information technology in their teaching methods is affected; there is also an indirect impact on the transfer of teachers' information technology application ability [5].

3.3.4 Human factors

Human factors refer to factors from school leaders, colleagues, field experts and students that may have an impact on teachers' learning and application of information technology. Human factors also do not directly affect the transfer of teachers' information technology application ability, but indirectly play a role through motivation. Generally speaking, human factors are constituted by the views, attitudes and practices of school leaders on information technology, such as school leaders encouraging teachers to apply information technology in daily teaching activities; school leaders valuing teachers with higher levels of proficiency in information technology; colleagues' views and attitudes towards information technology and practices, such as whether colleagues are keen on learning and applying information technology; teachers with higher levels of information technology being rewarded with a more prestigious position among colleagues; domain experts mainly referring to the views and attitudes of teaching method experts on information technology; and prevalence of the attitude of using advanced technology to assist teaching in daily teaching activities. All of the above may directly affect teachers' motivation to apply information technology in daily teaching, and indirectly affect the transfer of teachers' information technology application ability.

4 Discussion

The construction of the model is not the ultimate goal of this research. This research hopes to clarify the factors that may affect the transfer of teachers' information technology application ability and their mutual influences, so as to formulate teachers' information technology application ability standards and select training models. We provide references for the construction of training resources and discuss a related evaluation system. Specific suggestions are as follows:

4.1 Strengthen the role of national and local education management agencies in the transfer of teachers' information technology application capabilities

The role of national and local education management agencies in the transfer of teachers' information technology application ability is mainly manifested in the formulation of corresponding policies, systems and incentive mechanisms to guide and encourage teachers to learn and master information technology, and effectively apply it to daily teaching. In the future process of teacher information technology application ability training, national and local education institutions should strengthen the formulation of relevant policies, systems and incentive mechanisms, simultaneously do a good job in publicity and promotion, and improve effective operating mechanisms so that teachers' information technology application ability training is relevant. The work is carried out continuously, stably and normally. In addition, the relevant national functional departments should carry out innovations and improvements in the teacher qualification certificate system, take information technology application ability as one of the necessary standards for teacher professional access, and encourage and promote pre-service teachers to apply the information technology application ability acquired in the normal education stage to daily teaching [6].

4.2 Strengthen the role of teacher education institutions in the transfer of teacher information technology application ability

The role of teacher education institutions in the transfer of teacher information technology application ability is mainly manifested in the following measures: organising teachers to participate in the corresponding information technology application ability courses, helping teachers to master basic information technology skills and applying the acquired information technology to them. Ensuring that teachers acquire the ability to effectively transfer information technology skills to the real classroom teaching environment necessitates exposing them to a framework of ongoing guidance and assistance. In the future, teachers' information technology application ability training should refer to advanced foreign teacher education institution construction standards

and accreditation systems, formulate a teacher education institution construction standard system and accreditation system that meets China's actual conditions and strengthen teacher education institutions' institutional mechanisms, software and hardware infrastructure construction. The information technology application ability training curriculum system of teacher education institutions also needs to be continuously improved to increase the proportion of practical courses. In addition, teacher education institutions should not be limited to 'one-time training', but should be based on the construction of a lifelong learning system for teachers' information technology application ability training, which ideally needs to be designed in such a way as to promote the effective transfer of teachers' information technology application ability [7, 8].

4.3 Strengthen the role of schools in the transfer of teachers' information technology application ability

The role of schools in the transfer of teachers' information technology application ability is mainly manifested in environmental construction, including soft and hard environments [9, 10]. The soft environment mainly refers to the school's school-running philosophy, measures to promote the professional development of teachers and the application of information technology atmosphere created by school leaders and colleagues; the hard environment mainly refers to the school's software and hardware infrastructure construction, learning resource construction etc. In the future process of cultivating teachers' information technology application ability, schools should not only increase their efforts in the construction of the hard environment but also pay attention to the construction of the soft environment, encourage teachers to learn information technology, give teachers a certain degree of teaching autonomy and motivate teachers to effectively capitalise on their information technology skills in the day-to-day teaching environment; and doing so will go a long way in ensuring that teachers effectively apply the learned information technology skills in teaching activities, improve teaching efficiency, form a good learning atmosphere of 'leadership support, teachers' enthusiasm' in the school and promote the effective transfer of teachers' information technology application ability.

5 Conclusion

To summarise, based on the structural equation model, this study constructed a model of the influencing factors of teacher information technology application ability transfer fractional differential equations containing six influencing factors of fractional differential equations. The mutual influence relationship is clearly defined.

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References

- [1] Yilmaz R M. Educational magic toys developed with augmented reality technology for early childhood education[J]. *Computers in Human Behavior*, 2016, 54(JAN.):240-248.
- [2] Sackin P. Randomised controlled trial of educational package on menorrhagia[J]. *Journal of Fluid Mechanics*, 2015, 517(6):167-198.
- [3] Brusilovsky P, Pesin L. Adaptive Navigation Support in Educational Hypermedia: An Evaluation of the ISIS-Tutor[J]. *Chemcatchem*, 2015, 34(4):487-497.
- [4] Nodoushan M. Review of Networked Learning: An Educational Paradigm for the Age of Digital Networks[J]. *British Journal of Educational Technology*, 2015, 46(6):E31-E32.
- [5] Timms, Michael J. Letting Artificial Intelligence in Education Out of the Box: Educational Cobots and Smart Classrooms[J]. *International Journal of Artificial Intelligence in Education*, 2016, 26(2):701-712.
- [6] Xing W, Guo R, Eva P, et al. Participation-based student final performance prediction model through interpretable Genetic Programming: Integrating learning analytics, educational data mining and theory[J]. *Computers in Human Behavior*, 2015, 47(jun.):168-181.

- [7] Mocior E, Kruse M. Educational values and services of ecosystems and landscapes – An overview[J]. *Ecological Indicators*, 2016, 60(jan.):137-151.
- [8] Laru J, Naykki P, Jarvela S. Four Stages of Research on the Educational Use of Ubiquitous Computing[J]. *IEEE Transactions on Learning Technologies*, 2015, 8(1):69-82.
- [9] Veliolu Z. Soluble Product of Parafree Lie Algebras and Its Residual Properties[J]. *Applied Mathematics and Nonlinear Sciences*, 2019, 5(1):509-514.
- [10] Nce N, Shamilov A. An Application of New Method to Obtain Probability Density Function of Solution of Stochastic Differential Equations[J]. *Applied Mathematics and Nonlinear Sciences*, 2020, 5(1):337-348.

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