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AN EXPLORATION ON THE ASSOCIATION RULES OF SECONDARY EDUCATION TEACHER QUALIFICATION EXAMINATION IN TAIWAN

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Abstract

Since 1994, Taiwan has amended the Teacher Education Act to establish a "diversified, reserve, and self-funded" system, initiating a diversified teacher training framework. The most recent full revision of the Teacher Education Act occurred in 2019, which adjusted the sequence of the teacher qualification examination and the educational internship. Under the new system, candidates must first pass the teacher qualification examination and obtain a teacher qualification certificate before proceeding to the internship stage. The internship lasts for six months, and only after successfully passing the internship evaluation can candidates officially obtain a teaching certificate and qualify to teach. This highlights that the teaching certificate serves as a critical threshold to determine whether a teacher meets the required professional competency standards. This study focuses on secondary education teacher candidates who participated in the teacher qualification examination between 2016 and March or April 2022, as well as those with various background variables who completed their educational internships from 2015 to January 2022. Using data mining techniques for 23,368 persons, the research aimed to establish the best model for analyzing, predicting, and exploring the association rules and passing rates for teacher candidates based on different background variables and sources of teacher training. The findings revealed that the key association rules and significant indicators for secondary education teacher candidates were: gender (female), age (20-24 years old), recent graduates, qualification exam passed, exam-before-internship sequence, and public-school attributes. These factors were identified as crucial association rules and predictors of success in the teacher qualification examination.

Keywords: *Association rules, secondary education, teacher qualifications.*

1. Introduction

Since 1994, Taiwan amended the Teacher Education Act to be a "diversified, reserve, and self-funded" system, and a diversified teacher training system has been introduced. The role of determining whether a teacher has met the standards of work competence has opened a new era of teacher qualification examinations. After the amendment of the Teacher Education Act in 2002, the internship period was shortened to half a year, and only after passing the internship can you register for the Teacher Qualification Examination (Ministry of Education, 2022). In 2019, the Teacher Training Law was amended to provide that student must first pass the teacher qualification examination and obtain a teacher qualification certificate before entering the internship stage, which lasts for half a year, and can only obtain a teacher certificate after passing the internship performance assessment (Ministry of Education, 2022).

In Taiwan's teacher training, the number of teachers has increased dramatically from the era of unified planning to the era of diversified reserves, while the number of students has been decreasing due to the declining birth-rate, so it has become important to test and select the quality of teachers through the teacher qualification examination (Lin, 2009). In the face of the challenges of education reform and emerging educational technologies, it is an innovative research trend to use big data to analyze and mine teachers' career development data and transform them into valuable information (Kuo and Lin, 2017; Wu et al., 2021). Extracting valuable knowledge from complex data can help improve education policies and processes, especially in the discovery and analysis of big data for teacher qualification examinations, which is an innovative research direction.

This study attempts to understand the impact of background variables of teacher training students on the pass rate of teacher qualification examinations through the database of statistical annual reports on teacher training in the Republic of China, and uses association rules to analyze education big data, so as to provide model prediction and construction (Daniel, 2019).

2. Literature review

Since Taiwan's teacher training has become diversified, it is necessary to select excellent teachers through accreditation, so as to control the quality of teachers, protect students' right to education, and enhance the professional image of teachers. Teacher qualification examination is the embodiment of teacher professionalism, which can not only promote teachers to continuously improve their education and teaching ability through qualification examinations, but also reflect the problems of teacher training, promote their continuous reform and progress, and promote the degree of teacher professionalism as a whole (Lu et al., 2016). Since 2005, the Ministry of Education (MOE) has launched a teacher qualification examination in order to control the quality of teachers by addressing the formality of the initial review (Zhang, 2009).

In 2019, the Teacher Education Act was amended from the original "first practice and then inspection" to "first inspection and then practice", and the original name of "Teacher Qualification Examination was amended to "Teacher Qualification Examination" in accordance with the law. The process requires those who have completed the pre-service education certificate or certificate according to their respective subjects, and passed the teacher qualification examination, before they can apply to the university where the teacher is trained to take a half-year full-time education internship including teaching internship, tutor (grade) internship, administrative internship, and research activities (Teacher Training Law, 2019).

For example, the introduction of a new teaching certification system in the United Kingdom, where teachers must renew their teaching qualifications every five years in order to continue to have teaching qualifications; In terms of teaching practice, all teacher training students must go through two school internships, and observe teaching and trial teaching in the class. In Germany, after passing the first state examination, you can only carry out internships, and in the internship system, you need to participate in 8-10 weeks of internship in teacher education courses, and then 1 and a half to 2 years of internship after passing the exam, after half a year of internship, one year of independent teaching, and then prepare for the second state examination. In the United States, the "Bring Every Student Act" stipulates that every teacher must have a bachelor's degree, licenses and certificates set by each state, and each state will arrange a teaching internship in the last semester of the teacher training program, stipulating that teacher training students must have at least 15 weeks of on-site teaching trial teaching, teaching and other on-site experience; In terms of advanced internships, administrative internships and counselling internships are often added (Wang et al., 2011). For example, the introduction of a new teaching certification system in the United Kingdom, where teachers must renew their teaching qualifications every five years in order to continue to have teaching qualifications; In terms of teaching practice, all teacher training students must go through two school internships, and observe teaching and trial teaching in the class. In Germany, after passing the first state examination, you can only carry out internships, and in the internship system, you need to participate in 8-10 weeks of internship in teacher education courses, and then 1 and a half to 2 years of internship after passing the exam, after half a year of internship, one year of independent teaching, and then prepare for the second state examination. In the United States, the "No Child Left Behind Act" stipulates that every teacher must have a bachelor's degree, licenses and certificates set by each state, and each state will arrange a teaching internship in the last semester of the teacher training program, stipulating that teacher training students must have at least 15 weeks of on-site teaching trial teaching, teaching and other on-site experience; In terms of advanced internships, administrative internships and counselling internships are often added (Wang et al., 2011).

Teacher development faces many challenges such as policy changes, funding issues, and teacher recruitment and retention, and in terms of teacher certification exams, Bowling and Ball (2018) investigated alternatives in education across education, vocational and technical education, and agricultural education certification, which argues that these challenges, whether at the national, state, regional, or school level, can lead to ongoing teacher shortages, with many U.S. school districts facing challenges in recruiting qualified teachers, retaining open positions, or eliminating positions altogether.

3. Study Design

3.1. Algorithms for association rule

The main purpose of this study is to explore the association rules of teacher qualification verification at the secondary education stage, explore the characteristics and association rules between secondary teacher qualification verification data and secondary teacher qualification verification attributes, and supplement the association analysis with the help of Apriori algorithm. Based on the Apriori algorithm proposed by Agrawal and Srikant (1993), the support, reliability and correlation are calculated, and then the Important Association Rule Mining (IARM) algorithm is developed to calculate the importance of the rules. The IARM algorithm uses the Importance Indicator (*Imp.).*) measures the importance of association rules to strengthen the support and confidence based on the Apriori algorithm architecture (Weng, 2012).

3.2. Research databases

A total of 23,368 students enrolled in the secondary education stage from 2016 to March and April 2022 and completed internships in the middle education stage from 2015 to January 2022. The variables analyzed are in order of fresh graduates, the source of teacher training students, the school attributes of the teacher training university, the public and private attributes of the teacher training school, age, gender, educational background, the number of times they participated in the teaching inspection in 2016-2022 years, the passing of the teaching examination, and the teacher qualification examination system.

4. Results

4.1. Data type 1: The total number of teacher training students participating in the teaching and inspection database was 23,368

After the second data exploration, there were 8 association rules with a lift value greater than 1 and an importance index greater than 80%, as shown in Table 1. If the importance index is greater than 80%, in the highest order, it is education = bachelor's degree, first inspection and then practice, education inspection passed, gender = female, fresh graduate, age = 20-24 years old, number of participations in education inspection 1-time, public attribute, age = 25-29 years old, age = 30-34 years old.

Table 1. Positive association rules for teacher training students participated in data exploration of teaching inspection database.

No.	LHS	=>	RHS	supp.	Conf.	lift	count	Imp.
[1]	{Gender = Female}	=>	{Group 1-Teacher/Educational University}	88.51%	88.68%	1.9953	3665	89.91%
[2]	{Age = 20-24}	=>	{Group 1-Teacher/Educational University}	87.92%	84.31%	1.1454	3296	89.47%
[3]	{Fresh graduate}	=>	{Group 1-Teacher/Educational University}	80.58%	69.29%	1.1235	3109	87.02%
[4]	{The inspection was passed}	=>	{Group 1-Teacher/Educational University}	80.41%	61.43%	1.0070	2849	85.21%
[5]	{Certified first, then practice}	=>	{Group 1-Teacher/Educational University}	78.57%	54.27%	1.0008	2710	84.92%
[6]	{Public attribute}	=>	{Group 2-College/ university with teacher education program}	90.31%	98.82%	5.7430	2568	93.29%
[7]	{Fresh graduate}	=>	{Group 2-College/ university with teacher education program}	82.34%	83.49%	1.0295	2489	90.51%
[8]	{The inspection was passed}	=>	{Group 2-College/ university with teacher education program}	78.96%	60.69%	1.1807	5039	87.17%

4.2. Data type 2: Teacher training students are grouped according to the school attributes of the teacher training university

The number of participants in the education inspection was $D_{Normal-u}$10,585 (teacher training and education universities), D_{Tt-cM}10,022 (teacher training centres), and 2,761 (D_{STt-d}teacher training departments), totalling 23,368 people. The attributes of the research database include the background information of teacher training students, the information of the school where they teach, and the data of participating in the teaching inspection, which are$D_{Normal-u}X_N$Y$_N$ teacher/education universities, with a total of 4 attributes, and the minimum support degree of the course data of the three attribute groups in this study is set to be 0.1 and the minimum confidence level is 0$D_{Normal-u}$、D_{Tt-c}、D_{Tt-d}4. When the minimum length rule is limited to 2$D_{Normal-u}$, a total of 16 association rules are found in this stage; A total ofD_{Tt-c} 12 association rules were identified at this stage. D_{Tt-d}A total of 11 associated rules were identified in this phase, as shown in Table 2.

Table 2. Teacher training students participated in the teaching inspection based on the three-attribute groups $D_{Normal-u}$、D_{Tt-c}、D_{Tt-d} rules of the school attribute cluster.

School attributes Cluster	School attribute of college/university with teacher education programs	Number of rules	Remove duplicated rules	Number of available rubles
$\boldsymbol{D_{Normal-u}}$	Normal university / Educational college	16	10	6
$\boldsymbol{D_{Tt-c}}$	Center for Teacher Education programs	12	7	5
$\boldsymbol{D_{Tt-d}}$	Department/ graduated school with teacher education programs	11	7	4

Normal University or College with Teacher Education Program$D_{Normal-u}$ There are 16 rules, and in the case of the first attribute (group 1 - teacher training/education university), the positive correlation rule ($D_{Normal-u}$*lift*(X,Y)>1) has a total of 6 rules Table 3 shows; Discuss the rules of association with rules that have a degree of support (60%) or more. Therefore, the positive correlation rule ($D_{Normal-u}$*lift*(X,Y)>1) and the degree of support is 0There are a total of 4 rules with 6 or more, and the characteristics of the rules are listed according to the degree of support from large to small "gender = female, pass the education inspection, age = 20-24 years old, fresh graduate". There are 4 importance indicators greater than 80%, and the highest order is gender = female, pass the education examination, fresh graduate, age = 20-24 years old.

Table 3. $D_{Normal-u}$ Normal/ Educational Universities positively related to the rules.

No.	*LHS*	=>	*RHS*	*Supp*	*Conf.*	*lift*	*count*	*Imp.*
[1]	{Gender=female}	=>	{Group 1-Teacher/Educational University}	87.38%	90.40%	2.9677	1577	89.13%
[2]	{The inspection passed}	=>	{Group 1-Teacher/Educational University}	74.35%	90.27%	2.4778	1541	88.50%
[3]	{Age 20-24}	=>	{Group 1-Teacher/Educational University}	64.15%	89.47%	2.1284	8127	81.27%
[4]	{Fresh graduate}	=>	{Group 1-Teacher/Educational University}	63.97%	88.55%	1.9142	7945	83.51%
[5]	{Check first, then practice}	=>	{Group 1-Teacher/Educational University}	32.94%	62.22%	1.8807	4956	64.40%
[6]	{Education = Bachelor's degree}	=>	{Group 1-Teacher/Educational University}	30.46%	51.36%	1.8602	1042	42.41%

Center for Teacher Education Program $D_{\boldsymbol{Tt-c}}$A total of 12 rules were generated, and the positive association rules ($D_{\boldsymbol{Tt-c}}$*lift*(X, Y)>1) were 5 rules, as shown in Table 4. Continued with association rules to support the degree of 06 (60%) or more, so the positive correlation rule ($D_{\boldsymbol{MTt-c}}$*lift*(X,Y)>1) and the support is 0A total of 3 rules with 6 or more.

$\boldsymbol{D_{Tt-c}}$Positive correlation rule (*lift*(X, Y)>1) with 0There are a total of 3 rules with 6 or more (inclusive), and the rules are listed according to the support degree from large to small: "public attributes, fresh graduates, and education inspection passed". There are 3 items with an importance index greater than 80%, which are passed by public attributes, fresh graduates, and education inspections in the highest order.

Table 4. D_{Tt-c} Positive Association rules for Center for Teacher Education Program.

No.	*LHS*	=>	*RHS*	*Supp*	*Conf.*	*lift*	*count*	*Imp.*
[1]	{Public attribute}	=>	{Group 2 – Center for Teacher Education Program}	88.24%	94.63%	6.3232	1678	82.94%
[2]	{Fresh graduate}	=>	{Group 2 – Center for Teacher Education Program}	82.09%	85.94%	6.1071	1564	80.82%
[3]	{The inspection passed}	=>	{Group 2 – Center for Teacher Education Program}	60.96%	83.72%	4.5051	1809	80.66%
[4]	{Check first, then practice}	=>	{Group 2 – Center for Teacher Education Program}	43.17%	60.19%	1.4380	1842	75.23%
[5]	{Number of times to participate in the teaching and inspection_ once}	=>	{Group 2 – Center for Teacher Education Program}	22.39%	53.49%	1.0843	2417	70.42%

School with Teacher Education Program$D_{\boldsymbol{Tt-d}}$A total of 11 rules were generated, including 4 positive association rules ($\boldsymbol{D_{Tt-d}}$*lift*(X,Y)>1), as shown in Table 5. Continued with association rules to support the degree of 06 (20%) or more, so the positive correlation rule ($\boldsymbol{D_{Tt-d}}$*lift*(X,Y)>1) and the support is 0A total of 3 rules with 6 or more.

$\boldsymbol{D_{Tt-d}}$Positive correlation rule (*lift*(X,Y)>1) with 0 A total of 3 rules with 6 or more (inclusive), the characteristics of the rules are listed in descending order of support: "fresh, age = 20-24 years old, gender = female; Among them, there are 3 importance indicators greater than 80%, which are fresh graduates, age = 20-24 years old, and gender = female.

Table 5. D_{Tt-d} *Positive Association rules for Department/ Graduate School with Teacher Education Program.*

No.	LHS	=>	RHS	Supp	Conf.	lift	count	Imp.
[1]	{Fresh Graduate}	=>	{Group 3 – Department/ Graduate School with Teacher Education Program}	81.94%	83.14%	2.0512	15117	82.26%
[2]	{Age 20-24}	=>	{Group 3 – Department/ Graduate School with Teacher Education Program}	81.23%	81.43%	1.8531	9159	81.63%
[3]	{Gender=female}	=>	{Group 3 – Department/ Graduate School with Teacher Education Program}	61.27%	80.44%	1.5656	8324	80.88%
[4]	{Check first, then practice}	=>	{Group 3 – Department/ Graduate School with Teacher Education Program}	34.26%	51.02%	1.2110	5473	60.92%

5. Conclusions

(1) The overall data are based on gender = female, age = 20-24 years old, [3] fresh graduates, [4] passed the education inspection, first inspection before practice, public attributes, [7]. [8] The examination is passed as the relevant rules and importance indicators.

(2) Normal/educational universities take gender = female, pass the education examination, age = 20-24, and fresh internship and examination as the relevant rules and important indicators.

(3) The teacher training center shows the public attributes, the internship and verification of the current year, and the passing of the education inspection as the relevant rules and important indicators.

(4) For the faculty training department, fresh graduates, age = 20-24 years old, and gender = female are the relevant rules and important indicators.

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