

THE ASSOCIATION RULES FOR HIGH SCHOOL TEACHERS IN TAIWAN PARTICIPATING IN IN-SERVICE CONTINUING EDUCATION COURSES

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Abstract

This study examined the in-service training participation of Taiwanese high school teachers using data mining techniques. Analyzing data from the National Teacher In-service Training Information Web (2011–2020), it categorizes training courses into six domains: 1) Curriculum, Teaching, and Assessment, 2) Class Management and Tutoring, 3) Professional Development and Responsibility, 4) Emerging Education Policies, 5) School Administration and Leadership, and 6) Practical Knowledge and Life Literacy. Courses are further classified into four levels: Foundation, Advanced, Leadership, and R&D. The study identifies key factors such as gender, educational background, and region that influence participation, highlighting trends that can inform future professional development programs.

Keywords: Association rules, high school teachers, in-service continuing education courses.

1. Introduction

High school teachers in Taiwan engage in in-service training to enhance their professional competencies. The Ministry of Education has established 24 subject centers as platforms for professional learning and curriculum development. This study utilizes big data analytics to explore association rules among teachers' participation patterns, providing insights into training trends and needs.

Table 1. Number of Teacher Training Activities Courses Conducted by High School Subject Centers in Taiwan.

| Year | Total number of schools/units | Number of schools/units | Courses (Sessions) | Total Approved Hours (Hours) |
|------|-------------------------------|-------------------------|--------------------|------------------------------|
| 2020 | 518 | 495 | 24,810 | 80,969.50 |
| 2019 | 517 | 493 | 26,276 | 86,680.50 |
| 2018 | 514 | 496 | 25,140 | 86,286.50 |
| 2017 | 511 | 486 | 25,171 | 85,552.50 |
| 2016 | 355 | 340 | 18,193 | 52,431.00 |
| 2015 | 354 | 344 | 19,018 | 46,031.00 |
| 2014 | 352 | 345 | 18,898 | 52,485.50 |
| 2013 | 350 | 348 | 22,844 | 64,429.00 |
| 2012 | 346 | 336 | 17,641 | 49,343.00 |
| 2011 | 340 | 318 | 13,651 | 40,674.00 |

Source: Compiled from the Department of Teacher Training and Arts Education, Ministry of Education (2023). *Statistical Annual Report on Teacher Training in the Republic of China.*

2. Literature

In the process of teacher training under the rapid social changes, teachers must undergo on-the-job training at any time in order to meet the requirements of the profession (Wei et al., 2023). Greenwood (1957) emphasized that the so-called profession must have the following five things: complete and systematic knowledge, recognized intellectual authority by customers, sanctioned and praised by peers, strict professional ethics, and the establishment of a formal professional organization. Kornhauser (1982) proposes four professional criteria: expertise in intellectual aptitude, sufficient self-control, strong work ethic, and a sense of responsibility and influence in the use of expertise.

Xu & Wu (2014) showed that distance factors, inconvenient transportation, access hazards, and time factors were the main difficulties of teachers' professional development in remote areas. However, due to the rapid change of teaching environment, teachers need to supplement new knowledge from time to time in order to meet the learning needs of students, and rural schools lack educational resources and cultural stimulation due to their long distance and inconvenient transportation, so for rural teachers with a high proportion of novices, professional support and experience exchange are more needed (Zhan & Huang, 2017). Interestingly, according to Cai et al. (2020), teachers in remote areas were more

motivated to participate in in-service learning courses than teachers in general areas, and the more they participated, the more they could feel the effectiveness of teachers' professional growth, and the better their professional growth performance, the more they could improve their teaching effectiveness.

Teachers must first discover the distance relationship through data mining or database knowledge, and use machine learning, statistics and database systems to mine large databases, and the mining process is "pre-processing", preparing suitable datasets, removing meaningless data from the original data, and using the remaining data to build models. "Modelling" is about using a selected set of data and using appropriate techniques, while "Post-processing" is about applying the model to actual situations and new cases (Ketui, N. et al., 2019).

3. Study design

3.1. Algorithms for association rule mining

Using the Apriori algorithm, this study identifies association rules based on support, confidence, and lift values. The Important Association Rule Mining (IARM) algorithm is applied to assess rule significance.

3.2. Data sources

The dataset, drawn from the National Teacher In-service Training Information Web (2011–2020), includes attributes such as gender, education level, subject area, and training format.

4. Results

In this study, two different types of data were designed to carry out data exploration calculations: one is the teacher training record data of the "Teacher In-service Education Database", with a total of 138,384 in-service teacher training courses for exploration. The second is to divide the teacher training courses in the teacher in-service training database into regional groups of teaching schools, and divide the number of trainees into the northern group (1_N, counted as 67,548 people), the central group (2_M, counted as 34,891 people), the southern group (3_S, counted as 31,728 people), and the eastern and outlying island groups (4_R, counted as 4,217 people).

4.1. Data type 1: The total number of students taking courses in the database of teachers' in-service training was 138,384

The association rules found first must be greater than the minimum support level (0.1 and the minimum confidence level of 0.1, and the minimum length rule is limited to 2, a total of 35 association rules are found at this stage. Then, the 35 association rules were cut down to reduce the duplicate rule combinations, and a total of 12 rules were obtained from the positive association rule ($lift(X,Y) > 1$), and the positive association rule ($lift(X,Y) > 1$) and a support degree of 0.2 or higher. Calculate the negative association rules of positive and negative association rules, extract the positive association rules $\{X \Rightarrow Y\}$ and their corresponding negative association rules $\{\bar{X} \Rightarrow Y\}$, and calculate the importance indicators of the four positive association rules $Imp. (X \Rightarrow Y)$, as shown in Table 2.

Table 2. The importance index of positive correlation support of teacher in-service training is above 0.2.

| No. | LHS | => | RHS | Supp. | Conf. | lift | count | Imp. |
|-----|-----------------------------|----|---|--------|--------|--------|-------|--------|
| [1] | {Implementation - Lecture} | => | {The first stage of foundation-to understand and be familiar} | 39.72% | 90.39% | 1.0011 | 2102 | 91.22% |
| [2] | {Implementation - Workshop} | => | {The first stage of foundation-to understand and be familiar} | 37.95% | 80.17% | 0.9781 | 2008 | 85.13% |
| [3] | {Northern group} | => | {The first stage of foundation-to understand and be familiar} | 37.10% | 89.39% | 0.9901 | 2008 | 86.77% |
| [4] | {Southern group} | => | {The first stage of foundation-to understand and be familiar} | 25.25% | 81.43% | 0.9935 | 1336 | 77.53% |

In terms of the overall data, the rule with a support degree of 0.2 (20%) or more was discussed, and the positive association rule ($lift(X,Y) > 1$). There are a total of 4 rules with a support degree of 0.2 or more. Based on these 4 rules, the materiality indicator ($Imp.$) is further calculated. In this way, we can determine which rules are relatively important for the second-order advanced - application analysis, with the highest importance index being the implementation method - lecture (91.22%), followed by the implementation method - workshop (85.13%), the northern group (86.77%), and the southern group (77.53%). So in terms of overall data, the importance indicator (Imp) for the implementation method - teaching, implementation method - workshop, northern group, southern group; The results are consistent with the overall data of Wei et al. (2023) on the association rules of on-the-job continuing education courses, and the southern group is consistent with the part of the association rules and importance indicators.

4.2. Data type 2: Teachers grouped by the region of the school where they teach

The number of refresher courses was D_N 76,900 in the northern group, 39,567 in the central group and $46D_M D_S$ in the southern group, 206 and 5,555 (Eastern and Outlying Islands), for a total of 138,384. The attributes of the research database include the background information of teachers, the information of the teaching school, and the information of the continuing education course, which are the advanced education level, a total of 4 attributes, and the minimum support degree of the course data of the four regional groups in this study is set to 0.1 and the minimum confidence degree is 0.1, and the minimum length rule is limited to $2D_R D_N X_N Y_N D_N \cdot D_M \cdot D_S \cdot D_R$, and a total of 49 association rules are found in this stage. A total of 36 association rules were identified in this phase. A total of 41 association rules were identified in this phase. A total of 43 association rules were identified in this phase, $D_N D_M D_S D_R$ as shown in Table 3.

Table 3. The course of teachers' in-service education based on the rules of the four regional groups.

| City_Cluster | Counties and cities | Total number of rules | Remove duplicate rules | Number of rules available |
|--------------|-----------------------------------|-----------------------|------------------------|---------------------------|
| D_N | Northern group | 49 | 41 | 8 |
| D_M | Central group | 36 | 26 | 10 |
| D_S | Southern group | 41 | 32 | 9 |
| D_R | Eastern and offshore-island group | 43 | 33 | 10 |

4.2.1. The northern group is positively correlated with the rules. Northern Group D_N . There are 8 positive association rules ($lift(X,Y) > 1$), as shown in Table 4. There are a total of 4 rules with a support degree of 0.2 or more. The characteristics of the rules are listed in descending order of support: academic qualifications - master's degree, areas of study - practical knowledge and life literacy, areas of study - curriculum, teaching and assessment, and areas of study - emerging education policies. There are 4 importance indicators greater than 80%, from the highest order, to the field of further education - practical knowledge and life literacy, academic qualification - master's degree, first professional specialty - Chinese, field of study - curriculum, teaching and assessment.

Table 4. D_N Positive association rules ($lift(X,Y) > 1$) A total of 8 rules.

| No. | LHS | => | RHS | Supp | Conf. | lift | count | Imp. |
|-----|--|----|---|--------|--------|--------|-------|--------|
| [1] | {Education - Master's degree} | => | {The first stage of foundation - to understand and be proficient} | 24.85% | 100% | 1.1811 | 1209 | 92.66% |
| [2] | {Scope of Study - Practical Knowledge and Life Literacy} | => | {The first stage of foundation - to understand and be proficient} | 24.50% | 100% | 1.5557 | 1209 | 92.81% |
| [3] | {Areas of Study - Curriculum, Teaching and Assessment} | => | The first stage of foundation - to understand and be proficient | 24.22% | 100% | 1.3501 | 945 | 90.22% |
| [4] | {Continuing Education - Emerging Education Policy} | => | {The first stage of foundation - to understand and be proficient} | 23.57% | 84.02% | 1.3110 | 945 | 79.56% |
| [5] | {Areas of Study - Professional Development and Responsibility} | => | {The first stage of foundation - to understand and be proficient} | 18.94% | 91.11% | 1.7954 | 916 | 75.55% |
| [6] | {Subject Central Area - Language Field} | => | {The first stage of foundation - to understand and be proficient} | 18.59% | 93.44% | 1.6990 | 870 | 62.41% |
| [7] | {First-registered specialty - Chinese} | => | {The first stage of foundation - to understand and be proficient} | 17.94% | 92.52% | 1.4934 | 870 | 90.24% |
| [8] | {Non-credit Classes (On-campus Study)} | => | {The second stage of advancement - to apply and analyze} | 13.32% | 93.79% | 1.2584 | 870 | 61.16% |

4.2.2. The central group is positively correlated with the rule. The central group D_M . There are 10 rules in total, as shown in Table 5; There are a total of 4 rules with a support degree of 0.2 or more. The characteristics of the rules are listed in descending order of support: women, academic qualifications, master's degrees, areas of further education, emerging educational policies, and implementation methods. There were 7 indicators of importance greater than 84%, which were female, implementation method - workshop, age 35 to 39 years old, subject center area - language field, academic qualification - master's degree, field of study - curriculum, teaching and assessment, and field of study - emerging education policy.

Table 5. D_M positive association rules ($lift(X,Y) > 1$) 10 rules in total.

| No. | LHS | => | RHS | Supp | Conf. | lift | count | Imp. |
|------|---|----|---|--------|--------|--------|-------|--------|
| [1] | {Female} | => | {The first stage of foundation - to understand and be proficient} | 43.79% | 100% | 1.6363 | 2017 | 88.52% |
| [2] | {Education - Master's degree} | => | {The first stage of foundation - to understand and be proficient} | 34.47% | 100% | 1.6308 | 1824 | 82.37% |
| [3] | {Continuing Education - Emerging Education Policy} | => | {The first stage of foundation - to understand and be proficient} | 27.91% | 100% | 3.2563 | 1477 | 84.07% |
| [4] | {Implementation - Workshop} | => | {The first stage of foundation - to understand and be proficient} | 25.66% | 100% | 1.6480 | 1358 | 86.43% |
| [5] | {Subject Central Area - Language Field} | => | {The second stage of advancement - to apply and analyze} | 19.87% | 72.96% | 3.1932 | 1032 | 84.23% |
| [6] | {Age 35 to 39} | => | {The first stage of foundation - to understand and be proficient} | 8.69% | 74.89% | 3.2775 | 936 | 84.24% |
| [7] | {Age 30 to 34} | => | {The first stage of foundation - to understand and be proficient} | 15.36% | 64.20% | 1.6130 | 813 | 69.86% |
| [8] | {First-registered specialty- History} | => | {The first stage of foundation - to understand and be proficient} | 14.09% | 62.19% | 1.5626 | 746 | 68.76% |
| [9] | {The range of in-service education-curriculum · instruction & assessment} | => | {The first stage of foundation - to understand and be proficient} | 12.83% | 64.64% | 1.6240 | 642 | 84.12% |
| [10] | {First-registered specialty- Physics} | => | {The first stage of foundation - to understand and be proficient} | 12.90% | 72.22% | 3.1606 | 630 | 68.59% |

4.2.3. The southern group is positively correlated with the rules. The Southern Group D_S . There are 9 rules, as shown in Table 6; There are a total of 4 rules with a support degree of 0.2 or more. The characteristics of the rules are listed in descending order of support: women, mode of implementation-teaching, education-university, field of further education-emerging education policy; Among them, there are 4 indicators of importance greater than 84%, and the highest order is women, implementation method - teaching, academic qualifications - university, and field of further education - emerging education policy.

Table 6. D_S positive correlation ($lift(X,Y) > 1$) a total of 9 rules.

| No | LHS | => | RHS | Supp | Conf. | lift | count | Imp. |
|-----|--|----|---|--------|--------|--------|-------|--------|
| [1] | {Female} | => | {The first stage of foundation - to understand and be proficient} | 40.80% | 100% | 1.6260 | 1603 | 88.28% |
| [2] | {Practice-Lecture} | => | {The first stage of foundation - to understand and be proficient} | 30.29% | 100% | 3.2563 | 1267 | 85.77% |
| [3] | {Education - University} | => | {The first stage of foundation - to understand and be proficient} | 24.90% | 100% | 1.6364 | 1109 | 85.37% |
| [4] | {Continuing Education - Emerging Education Policy} | => | {The third stage of leadership - to integrated and evaluate} | 23.74% | 100% | 1.6364 | 1250 | 84.37% |
| [5] | {Age 30-34} | => | {The first stage of foundation - to understand and be proficient} | 15.36% | 67.20% | 1.6130 | 813 | 69.86% |
| [6] | {First-registered Specialty - Chemistry} | => | {The first stage of foundation - to understand and be proficient} | 12.75% | 84.75% | 1.6364 | 1249 | 81.37% |
| [7] | {Class size 13 to 24} | => | {The first stage of foundation - to understand and be proficient} | 11.21% | 74.79% | 1.6364 | 1309 | 82.37% |
| [8] | {School Administration & Leadership} | => | {The first stage of foundation - to understand and be proficient} | 10.34% | 84.27% | 1.6130 | 813 | 69.86% |
| [9] | {Scope of Study - Practical Knowledge and Life Literacy} | => | {The first stage of foundation - to understand and be proficient} | 9.47% | 86.73% | 1.6364 | 1539 | 81.84% |

4.2.4. The eastern and outlying islands are positively related to the rule. The eastern and offshore island group D_R . A total of 10 rules, as shown in Table 7; There are a total of 4 rules with a support degree of 0.2 or more. The characteristics of the rules are listed in descending order of support: "female, education-university, field of study-practical knowledge and life literacy, county and city of teaching - Taitung County"; Among them, there are 4 indicators of importance greater than 84%,

and the highest order is academic qualifications, universities, women, and further education fields, emerging education policies, implementation methods, and lectures.

Table 7. D_R positive association rule ($lift(X, Y) > 1$) a total of 10 rules.

| No | LHS | => | RHS | Supp | Conf. | lift | count | Imp. |
|------|---|----|---|--------|--------|--------|-------|--------|
| [1] | {Female} | => | {The first stage of foundation - to understand and be proficient} | 49.21% | 100% | 1.6183 | 2959 | 84.46% |
| [2] | {Education - University} | => | {The first stage of foundation - to understand and be proficient} | 39.25% | 100% | 1.7260 | 2221 | 84.98% |
| [3] | {Scope of Study - Practical Knowledge and Life Literacy} | => | {The first stage of foundation - to understand and be proficient} | 28.27% | 100% | 2.6180 | 1840 | 78.67% |
| [4] | {County and city of the teaching school - Taitung County} | => | {The first stage of foundation - to understand and be proficient} | 24.52% | 100% | 3.2573 | 1980 | 81.01% |
| [5] | {Subject Central Area - Language Field} | => | {The first stage of foundation - to understand and be proficient} | 17.87% | 92.58% | 1.6259 | 1011 | 78.88% |
| [6] | {Non-credit Classes (On-campus Study)} | => | {The first stage of foundation - to understand and be proficient} | 16.44% | 89.71% | 1.6360 | 916 | 64.57% |
| [7] | {Continuing Education - Emerging Education Policy} | => | {The third state of leadership-Integrated and evaluates} | 15.68% | 89.74% | 3.2492 | 883 | 80.07% |
| [8] | {Continuing Education - Emerging Education Policy} | => | {The first stage of foundation - to understand and be proficient} | 14.70% | 92.36% | 1.5897 | 822 | 84.87% |
| [9] | {Implementation - Workshop} | => | {The first stage of foundation - to understand and be proficient} | 14.53% | 91.22% | 3.2622 | 689 | 65.23% |
| [10] | {Implementation - Lecture} | => | {The third stage of leadership-Integrated evaluates} | 13.51% | 96.58% | 1.6621 | 621 | 84.43% |

5. Conclusions

- As a whole, the implementation method - teaching, implementation method - workshop, northern group, and southern group are related rules and importance indicators.
- The northern and central groups were associated with education-master's degree as the association rule and important index, while learn to associate rules and important indicators.
- Continuing Education Sector - Emerging education policies are relevant and important in the Central, Southern, Eastern and Outlying Islands groups Index.
- The area of study - Practical knowledge and life literacy are related rules and importance in the northern group, the southern group, the eastern group and the outlying islands group.
- The central area of the subject - the language field in the northern group, the central group, the eastern group and the outlying island group are all related rules and important indicators.

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