# AC 2010-1288: IN-SERVICE PROFESSIONAL FIELD EXPANSION MODEL OF VOCATIONAL SENIOR-HIGH TECHNOLOGY TEACHERS IN TAIWAN

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# In-service Professional Field Expansion Model of Vocational Senior-high Technology Teachers in Taiwan


## Abstract

Coping with rapid knowledge growth, career expansion become an important consideration for technology teachers. By getting teacher license of the second professional field, teacher might survive when ever he or she can not find job in the first teaching major. In Taiwan, most of technology teachers get their cross-discipline teaching license through in-service education. The purpose of this study was to identify an in-service teaching professional field expansion model of middle school technology teachers in Taiwan. Based upon analyzing teacher license records, the growth trends of the second license were explored. The populations of this study were vocational senior high school technology teachers at 2009 school year. Totally, 7978 teacher-records were reviewed.

It was argued that there might be a decision tree model of professional areas expansion. Teachers in certain professional fields might have higher potential to have multiple licenses. There might be some categorized model for predicting the behavior of crossing professional fields. Based on these arguments, statistical hypothesis were established for verifying according to empirical data. For testing research hypothesis and establishing model, SPSS and Clementine software were applied.

Descriptive statistics of in-service teachers' licenses would be presented to show the distribution of teachers' professional fields. A decision tree model would be constructed as a classification system to predict and classify future observations based on a set of decision rules. This approach showed several advantages. First, the reasoning process behind the model is clearly evident when browsing the tree. Second, the process will include in its rule only the attributes that significantly in making a crossing-professional-fields decision. According to the research finds, conclusion of in-service professional field expansion would be drawn directed from statistical evidence.


## Introduction

Teacher is the soul in a learning environment. A capable teacher could provide learners ensured foundation of erudition. Since the learning needs are changing, teacher should check upon their professions all the time. The market of teaching jobs is also shifting[1]. Especially, technology teachers are coping with rapid knowledge growth and teaching subjects innovating. To a high school technology teacher, there always is a potential need of teaching career expansion. On the other hand, the population percentage of age under fourteen is decreasing at minus 0.6% each year in Taiwan[2]. The number of teaching jobs could be decrease if the ratio of students per teacher was kept constant. This potential of teaching job market also plays a force to move teachers getting new licensees.

Pre-service teacher education provides teachers with basic teaching ability. In-service teacher education provides teachers with professional development. Through professional development, it is not only improving students' achievement, but also providing teachers with knowledge crossing teaching areas.

The purpose of this study was to identify an in-service teaching professional field expansion model of middle school technology teachers in Taiwan. Based upon analyzing teacher license records, the growth trends of the second license were explored.

## Images of Taiwan

Taiwan is an island in eastern Asia and the western Pacific. It ranges approximately from 120° to 122° east longitude and from 22° to 25° north latitude. When Portuguese navigators sailed to the island 450 years ago, they were so attracted by its beauty that they exclaimed, "Ilha Formosa," meaning "beautiful island." That is how Europeans first came to know about Taiwan.

Taiwan's land territory is 36,000 square kilometers and its sea territory, about three times as large as its land. As far as the land territory is concerned, Taiwan ranks 141st, larger than 41% of the rest of the countries. With 23 million people living on it, Taiwan has a population that ranks it as one of the largest, at 48th in the world.

The latest statistics indicate that Taiwan's GDP ranks 23rd of all nations. In November, 2006, Taiwan's foreign reserves totaled over US$ 250 billion which were the third largest in the world. Taiwan's electronic industry, as is widely known, has been occupying an important niche in the global market, with its TFT-LCD and semiconductor industries leading the world. We'd believe the 3C products you are using now must contain parts which were made in Taiwan.

## Liberalization of Education

It is noteworthy change for the teacher training programs. Formerly, teacher training was monopolized by a teachers college system. The ruling KMT party realized the powerful impact exerted by teachers on students; hence, it exercised particularly severe control over schools for teacher preparation. Consequentially, institutions for training prospective teaches, namely, teachers colleges for primary school teachers and teachers' universities for high school teachers, despite their differences in size and structure, used to be rather parochial, conservative and uniform in their milieu. They were often criticized at having to provide training programs and education modes which had to cater to the authoritarian government's policies. It was only natural that the teachers were thus trained as most able to serve as the rulers' tools.

In the 1990s, the movement demanding the liberalization of education opened up the channel for teacher preparation. Upon approval, any university is now allowed to set up its own teacher training program and to offer it to interested students. As a result, the sources for school teachers have become diversified. Some prospective teachers may have already completed their own major programs before entering teacher-training programs. As they embark on their teaching careers, they, naturally, can enliven their teaching by creatively bringing in other branches of knowledge.

As far as students' access to higher levels of school choices is concerned, more channels have now become available for them to choose from. Ever since the 1990s, several reforms have been made in order to open up more diverse ways for admitting students. The decades-old method to admit either junior high school students to senior high schools or senior high school students to universities, via annually held joint entrance examinations, is no longer the only option. That is to say, students' futures will no longer be determined by, or at the mercy of, one single entrance examination. Under the new multiple-channel entrance system, students can now apply for admission based on their performance on the Academic Achievement Test as well as

records of their other talents. Naturally, they may also gain access to higher levels of schooling by taking traditional unified entrance examinations.

The liberalized and pluralistic educational environment in Taiwan has made our youngsters more articulate, more creative, more curious, more adventurous and more daring than their older generation. The liberation of education has soon brought about fruitful results, as clearly manifested by Taiwanese students' excellent performance in various international competitions, such as academic-oriented International Olympiads on mathematics, physics, and chemistry; skills-based International Technical Competitions, creativity-focused International IF Competitions, and the International Animation Competitions. It is generally believed that because of the liberalization and diversification of education, students' abundant potentials can and are induced to their full development. Teacher training programs are available at higher education level and usually last four years. Those programs fall into two categories:
(1) Programs for training teachers of secondary education; and
(2) Programs for training teachers of primary schools and kindergartens.

The former are primarily offered by normal universities while the latter are chiefly offered by education universities.

However, educational reform is not merely a reform that takes place on a campus. More importantly, it is also a social reform, even a challenge to cultural traditions. The changes in the education system, curriculum design and teaching methods will absolutely exert a great impact on the general public's customary or fixed modes of thinking, or even their traditional value systems. Teaching job in Taiwan was stable, but not now.

For understanding professional growth path of high school technology teachers, there is a need to further explore licensing records of teachers.

**Methodology**

The purpose of this study was to identify an in-service teaching professional field expansion model of middle school technology teachers in Taiwan. Based upon analyzing teacher license records, the growth trends of the second license were explored.

The populations of this study were vocational senior high school technology teachers at 2009 school year. The license records were based upon database of the “Yearbook of Teacher Education Statistics” published by Ministry of Education in Taiwan[3].

It was argued that the time spend for second license of crossing different professional areas should be different from the first one. Teachers in certain professional fields might have higher potential to have multiple licenses. There might be some categorized model for predicting the behavior of crossing professional fields.

Based on these arguments, statistical hypothesis were established for verifying according to empirical data. For testing research hypothesis and establishing model, SPSS and Clementine software were applied[4].

**Research Finding**

The research finding would be described according to “subject areas distribution of the first license”, “subject areas distribution of overall license”, “license numbers of professional areas”, “licensing days of professional areas”, and “decision tree model of professional area growth”.

Table 1 Distribution of teachers' first license subject areas

| First license subject areas | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Civil & Construction | 161 | 2.01805 | 2.01805 | 17.20983 |
| Chemistry Cluster | 65 | 0.814741 | 0.814741 | 18.02457 |
| Power Machinery Cluster | 295 | 3.697669 | 3.697669 | 21.72224 |
| Electronics & Electrical Cluster | 1059 | 13.274 | 13.274 | 34.99624 |
| Machinery Cluster | 646 | 8.097267 | 8.097267 | 43.09351 |
| Practical skill in Beauty & Hair | 3 | 0.037603 | 0.037603 | 43.13111 |
| Practical skill in food production | 1 | 0.012534 | 0.012534 | 43.14365 |
| Nursing | 15 | 0.188017 | 0.188017 | 43.33166 |
| Home Economics Cluster | 232 | 2.907997 | 2.907997 | 46.23966 |
| Hospitality Cluster | 219 | 2.745049 | 2.745049 | 48.98471 |
| Fishery Food Cluster | 57 | 0.714465 | 0.714465 | 49.69917 |
| Fishery Cluster | 27 | 0.338431 | 0.338431 | 50.0376 |
| Foreign language Cluster | 25 | 0.313362 | 0.313362 | 50.35097 |
| Business & Management Cluster | 1389 | 17.41038 | 17.41038 | 67.76134 |
| Design Cluster | 218 | 2.732514 | 2.732514 | 70.49386 |
| Food Cluster | 120 | 1.504136 | 1.504136 | 71.99799 |
| Agriculture Cluster | 212 | 2.657308 | 2.657308 | 74.6553 |
| Arts Cluster | 27 | 0.338431 | 0.338431 | 74.99373 |
| Secondary | 42 | 0.526448 | 0.526448 | 0.526448 |
| Kindergarten | 20 | 0.250689 | 0.250689 | 0.777137 |
| Science & Technology Area | 641 | 8.034595 | 8.034595 | 8.811732 |
| Society Study Area | 276 | 3.459514 | 3.459514 | 12.27125 |
| Special Education | 233 | 2.920531 | 2.920531 | 15.19178 |
| Health and Physical Education | 209 | 2.619704 | 2.619704 | 77.61344 |
| Primary | 181 | 2.268739 | 2.268739 | 79.88218 |
| Integrative Activities | 372 | 4.662823 | 4.662823 | 84.545 |
| Language Arts | 796 | 9.977438 | 9.977438 | 94.52244 |
| Mathematics | 266 | 3.334169 | 3.334169 | 97.85661 |
| Vocational culture | 2 | 0.025069 | 0.025069 | 97.88167 |
| Arts and Humanities | 169 | 2.118325 | 2.118325 | 100 |
| | 7978 | 100 | 100 | |

## Subject areas distribution of the first license

The original profession area of each teacher was identified and the distributions of their profession areas were listed in Table 1. Shading items are those areas of technology teacher professional subjects. There are 796 teachers originally prepared for language arts. These

teachers were expansion their teaching area into technology. Total 3207 teachers with the first specialty other than technology have become a technology teacher via professional development.

In Figure 1, the pie chart with percentage information of distribution of teachers' first license subject area was illustrated. The "business & management cluster" occupied 17.41% belonging to 1389 teachers' license.

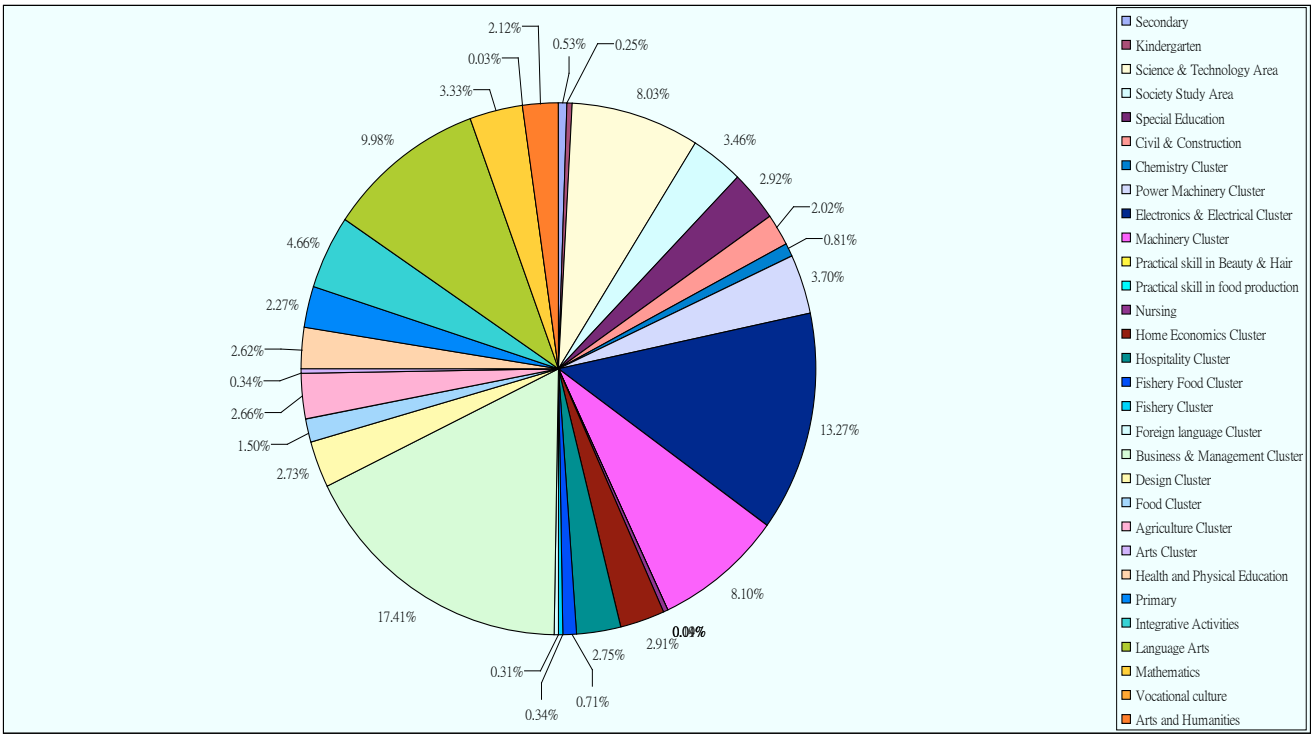


Figure 1 Pie chart of distribution of teachers' first license subject areas

## Subject areas distribution of overall license

For exploring the overall licenses hold by those 7978 technology teachers, the frequency, percent, valid percent, and cumulative percent values were listed as following Table. For each licensing subject area, there are several possible sub-area licenses. This made teacher might have more than one license in a certain subject area for fulfilling the teaching requirement.

In table 2, the frequency of total licenses was displayed according to licensing subject area. Total 7978 teachers hold 56897 licenses. There are 16535 licenses of "business & management cluster".

The second high value of frequency is 10286. The subject area is the "Electronics & Electrical Cluster. The percentage of this subject area is 18.07%.

The third high value of frequency is 9564. The subject area is the "Power Machinery Cluster". The percentage of this subject area is 16.8%.

The fourth high value of frequency is 5075. The subject area is the "Machinery Cluster". The percentage of this subject area is 8.9% and is less than 10%.

Table 2 Distribution of teachers' total licenses

| Licensing Subject Area | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Civil & Construction | 1324 | 2.327012 | 2.327012 | 2.327012 |
| Chemistry Cluster | 756 | 1.328717 | 1.328717 | 3.655729 |
| Power Machinery Cluster | 9564 | 16.80932 | 16.80932 | 20.46505 |
| Electronics & Electrical Cluster | 10286 | 18.07828 | 18.07828 | 38.54333 |
| Machinery Cluster | 5075 | 8.919627 | 8.919627 | 47.46296 |
| Practical skill in cloth production | 42 | 0.073818 | 0.073818 | 47.53678 |
| Practical skill in Beauty & Hair | 42 | 0.073818 | 0.073818 | 47.61059 |
| Practical skill in food processing | 26 | 0.045697 | 0.045697 | 47.65629 |
| Practical skill in Marine Tourism | 2 | 0.003515 | 0.003515 | 47.65981 |
| Practical skill in Animals | 2 | 0.003515 | 0.003515 | 47.66332 |
| Practical skill in Business | 16 | 0.028121 | 0.028121 | 47.69144 |
| Practical skill in Industrial Arts | 3 | 0.005273 | 0.005273 | 47.69672 |
| Practical skill in Chemistry | 4 | 0.00703 | 0.00703 | 47.70375 |
| Practical skill in Machinery | 4 | 0.00703 | 0.00703 | 47.71078 |
| Practical skill in Construction | 3 | 0.005273 | 0.005273 | 47.71605 |
| Practical skill in food production | 148 | 0.260119 | 0.260119 | 47.97617 |
| Nursing | 1179 | 2.072165 | 2.072165 | 50.04833 |
| Home Economics Cluster | 3048 | 5.357049 | 5.357049 | 55.40538 |
| Hospitality Cluster | 2099 | 3.689122 | 3.689122 | 59.0945 |
| Fishery Food Cluster | 267 | 0.469269 | 0.469269 | 59.56377 |
| Fishery Cluster | 199 | 0.349755 | 0.349755 | 59.91353 |
| Foreign language Cluster | 627 | 1.101991 | 1.101991 | 61.01552 |
| Business & Management Cluster | 16535 | 29.06129 | 29.06129 | 90.07681 |
| Design Cluster | 3195 | 5.61541 | 5.61541 | 95.69222 |
| Food Cluster | 680 | 1.195142 | 1.195142 | 96.88736 |
| Agriculture Cluster | 1289 | 2.265497 | 2.265497 | 99.15286 |
| Arts Cluster | 482 | 0.847145 | 0.847145 | 100 |
| Total | 56897 | 100 | 100 | |

In Figure 2, the pie chart with percentage information of distribution of teachers' first license subject area was illustrated. The "business & management cluster" occupied 29.06% of overall licenses.

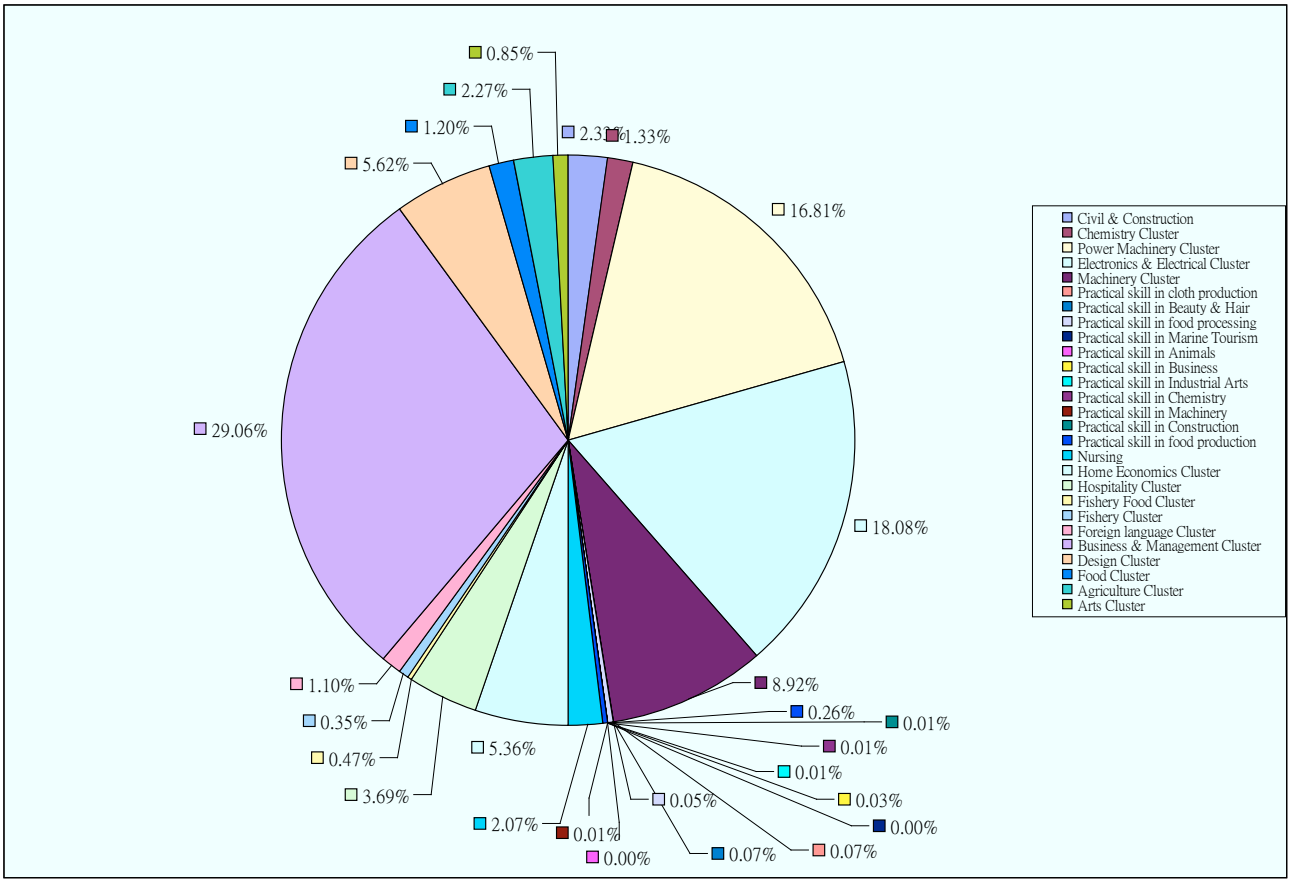

Figure 2 Pie chart of distribution of teachers' total licenses

## License Numbers of Professional Areas

For exploring whether existing significant different numbers of licenses between professional areas, one way ANOVA statistical procedure was conducted. In Table 3, vocational high group is with highest value of license numbers. Primary teacher group is with lowest value of license numbers.

Table 3 Descriptive information of testing license numbers between professional areas

**Descriptives**

License(s)

| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Kindergarten | 20 | 3.10 | 1.447 | .324 | 2.42 | 3.78 | 2 | 7 |
| Primary | 181 | 2.88 | 1.208 | .090 | 2.71 | 3.06 | 2 | 10 |
| Secondary | 2773 | 2.63 | 1.203 | .023 | 2.58 | 2.67 | 2 | 21 |
| Vocational High | 4771 | 3.11 | 1.530 | .022 | 3.07 | 3.15 | 2 | 18 |
| Special Ed. | 233 | 3.06 | 1.444 | .095 | 2.88 | 3.25 | 2 | 8 |
| Total | 7978 | 2.94 | 1.433 | .016 | 2.90 | 2.97 | 2 | 21 |

In Table 4, the ANOVA table was shown significant difference among professional areas. It was found that vocational high technology teachers are with significant high value of licenses.

Table 4 One way ANOVA test of license number of professional areas

| ANOVA | | | | | |
|---|---|---|---|---|---|
| License(s) | | | | | |
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 417.818 | 4 | 104.455 | 52.148 | .000 |
| Within Groups | 15970.195 | 7973 | 2.003 | | |
| Total | 16388.013 | 7977 | | | |

Between secondary and vocational high, there exists significant difference according to the Table 5. Between secondary and kindergarten, there also exists significant difference.

Table 5 Duncan test of homogeneity subsets of license numbers

| License(s) | | | |
|---|---|---|---|
| Duncan | | | |
| | | Subset for alpha = 0.05 | |
| area_group | N | 1 | 2 |
| Secondary | 2773 | 2.63 | |
| Primary | 181 | 2.88 | 2.88 |
| Special Ed. | 233 | 3.06 | 3.06 |
| Kindergarten | 20 | | 3.10 |
| Vocational High | 4771 | | 3.11 |
| Sig. | | .059 | .354 |
| Means for groups in homogeneous subsets are displayed. | | | |

## Licensing Days of Professional Areas

For exploring whether existing significant different days of licensing between professional areas, one way ANOVA statistical procedure was conducted. In Table 6, primary group is with highest value of licensing days. Special education teacher group is with lowest value of licensing days.

Table 6 One way ANOVA test of licensing days of professional areas

| Descriptives | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Day_Mean | | | | | | | | |
| | | | | | 95% Confidence Interval for Mean | | | |
| | N | Mean | Std. Deviation | Std. Error | Lower Bound | Upper Bound | Minimum | Maximum |
| Kindergarten | 20 | 1775.99 | 1876.892 | 419.686 | 897.57 | 2654.40 | 107 | 7277 |
| Primary | 181 | 2472.07 | 1676.022 | 124.578 | 2226.25 | 2717.89 | 14 | 7100 |
| Secondary | 2773 | 1649.54 | 1812.572 | 34.421 | 1582.05 | 1717.04 | 0 | 12147 |
| Vocational High | 4771 | 1434.77 | 1649.359 | 23.879 | 1387.96 | 1481.59 | 0 | 11032 |
| Special Ed. | 233 | 508.95 | 654.898 | 42.904 | 424.42 | 593.48 | 3 | 3613 |
| Total | 7978 | 1506.77 | 1706.818 | 19.109 | 1469.31 | 1544.23 | 0 | 12147 |

In Table 7, the ANOVA Table was shown significant difference among professional areas. It was found that primary group teachers are with significant high value of licenses.

Table 7 One way ANOVA test of licensing days of professional areas

| ANOVA | | | | | |
|---|---|---|---|---|---|
| Day_Mean | | | | | |
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 4.833E8 | 4 | 1.208E8 | 42.338 | .000 |
| Within Groups | 2.276E10 | 7973 | 2854067.416 | | |
| Total | 2.324E10 | 7977 | | | |

Between primary and kindergarten, there exists significant difference according to the Table 8. Between primary and secondary, there exists significant difference. Between primary and vocational high, there exists significant difference. Between primary and special education, there exists significant difference. In Table 8, three subsets of homogeneity were listed.

Table 8 Duncan test of homogeneity subsets of licensing days

| Day_Mean | | | | |
|---|---|---|---|---|
| Duncan | | | | |
| | | Subset for alpha = 0.05 | | |
| area_group | N | 1 | 2 | 3 |
| Special Ed. | 233 | 508.95 | | |
| Vocational High | 4771 | | 1434.77 | |
| Secondary | 2773 | | 1649.54 | |
| Kindergarten | 20 | | 1775.99 | |
| Primary | 181 | | | 2472.07 |
| Sig. | | 1.000 | .222 | 1.000 |
| Means for groups in homogeneous subsets are displayed. | | | | |

## Decision Tree Model of Professional Area Growth

A decision tree of professional area growth was constructed based upon **C&R Tree** model of Clementine. In Table 9, the rules were listed according to variables of Day_mean, licenses, and areas.

Table 9 Rules of professional area growth

**Licences <= 2.500 [ Mode: 1 ]**
**areas in [ "Secondary" ] [ Mode: 1 ]**
**Licences <= 1.500 [ Mode: 1 ] => 1.0**
**Licences > 1.500 [ Mode: 2 ] => 2.0**
**areas in [ "Primary" "Kindergarten" "Special Ed." "Vocational High" ] [ Mode: 2 ]**
**Day_Mean <= 383.500 [ Mode: 1 ] => 1.0**
**Day_Mean > 383.500 [ Mode: 2 ] => 2.0**
**Licences > 2.500 [ Mode: 2 ]**
**areas in [ "Secondary" ] [ Mode: 2 ]**
**Day_Mean <= 1119.042 [ Mode: 2 ] => 2.0**
**Day_Mean > 1119.042 [ Mode: 1 ] => 1.0**
**areas in [ "Primary" "Kindergarten" "Special Ed." "Vocational High" ] [ Mode: 2 ] => 2.0**

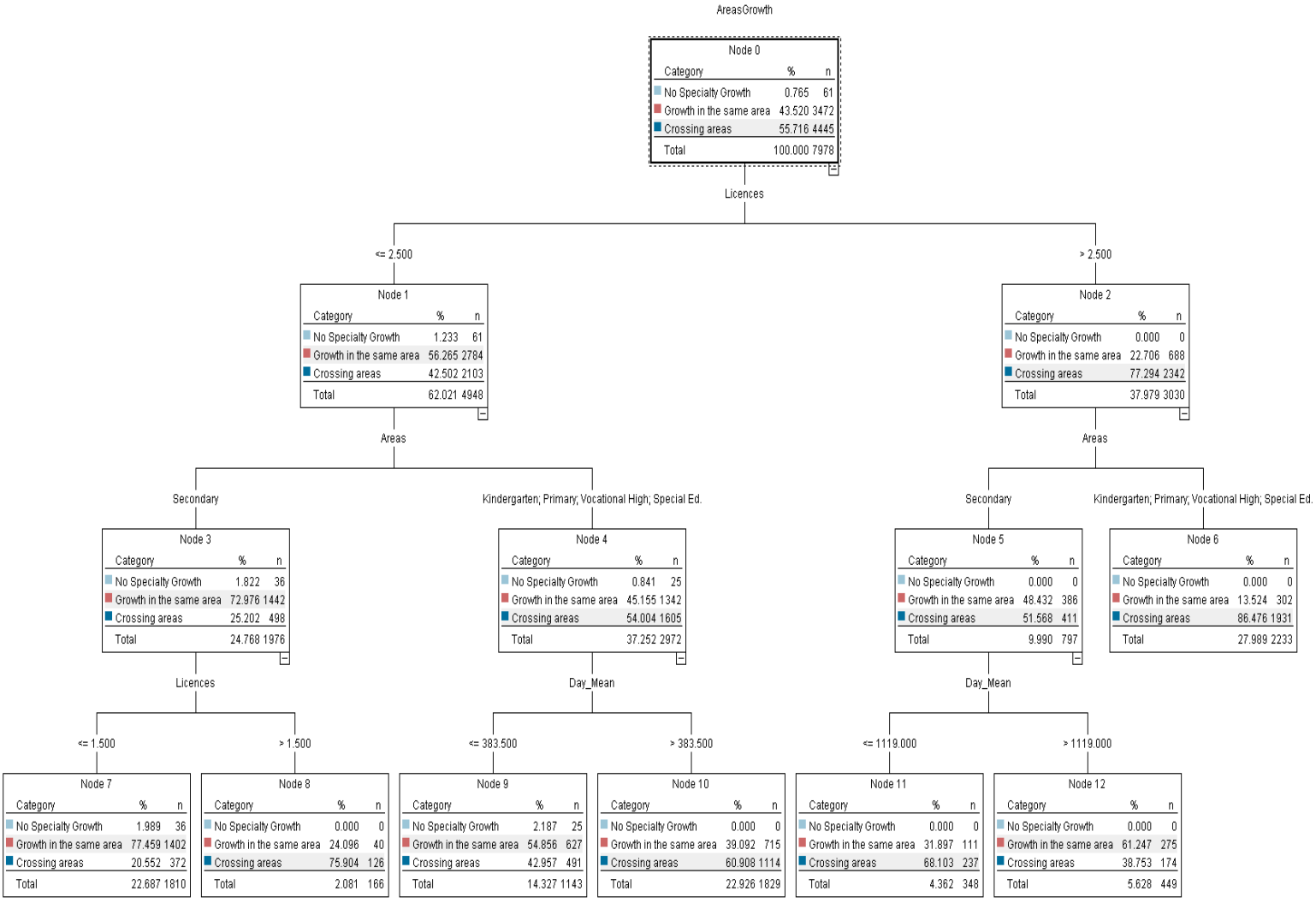


Figure 3 Decision tree of professional areas growth

## Conclusions

Based upon research findings, three conclusions could be derived:

1. There is a tendency to expand professional area expertise for all technology teachers.
2. Those who were trained as a vocational high school technology teacher have more significant number of licenses than those who were trained as a secondary teacher.
3. It is possible to have a decision tree model for predicting professional area growth based on various parameters of interest, such as the number of licenses obtained, the areas in which the licenses were obtained, and the duration for which these licenses were held.

Coping with rapid knowledge growth, career expansion become an important consideration for technology teachers. By getting teacher license of the second professional field, teacher might survive when ever he or she can not find job in the first teaching major. In Taiwan, most of technology teachers get their cross-discipline teaching license through in-service education.

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