

A Study on Mechanisms for Interdisciplinary Integration in Teachers' Professional Development and Pathways for Competency Enhancement Under the Guidance of Ideological and Political Education in the Curriculum

Jianxiu Zhao ^{1,*}

¹ School of Education Science, South China Normal University, Guangzhou, Guangdong, 510631, China

* Correspondence author: 18520963395@163.com

Abstract: The new curriculum reform has set higher standards for teachers engaged in interdisciplinary instruction as part of the “Curriculum-based Ideological and Political Education” initiative. This empirical study involved 15 participating teachers. Using grounded theory, interview data were coded and analyzed; the composite elements of interdisciplinary literacy were extracted through open coding, axial coding, and selective coding. A fuzzy set qualitative comparative analysis was conducted on the teachers’ interdisciplinary literacy, yielding corresponding simplification solutions and intermediate solutions, from which the corresponding configuration paths were derived. The results show that axial coding yielded 8 main nodes and 95 source nodes, and selective coding identified five core categories: abilities, knowledge, beliefs, traits, and motivation. Using fsQCA to analyze the obtained competency codings, the coverage of 0.912504 and consistency of 0.841211 for the intermediate solution indicated that all five categories are core conditions. Based on this, four configuration paths were derived, with an overall coverage of 0.824. According to the results of the above empirical study, enhancing teachers’ interdisciplinary literacy requires efforts focused on both stimulating their interdisciplinary traits and motivation.

Keywords: Grounded Theory; interdisciplinary literacy; fuzzy set qualitative comparison; configuration paths

1. Introduction

In the current educational context, integrating ideological and political education into the curriculum has become one of the key directions of educational reform [1–2]. This approach aims to guide students in establishing correct ideological and political concepts, thereby fostering their sense of social responsibility and spirit of innovation [3–5]. As a teacher of specialized subjects, one must possess a certain level of ideological and political literacy and teaching competence in order to better serve students. However, the subject knowledge of many teachers currently remains confined to the framework of a single discipline, and they lack the ability to integrate across disciplines [6–7]. Although some teachers are able to occasionally incorporate knowledge from ideological and political disciplines into their classrooms, these attempts are mostly superficial and lack depth and systematic integration [8–9]. Due to traditional ways of thinking in subject-specific teaching, teachers often view disciplines as isolated entities, lacking a holistic perspective and finding it difficult to achieve genuine interdisciplinary integration in their instruction [10–11]. This necessitates that teachers enhance their professional competence by engaging in interdisciplinary learning that combines specialized coursework with ideological and political education [12–13].



Interdisciplinary integrated learning is by no means a simple superimposition of subject knowledge; rather, it involves uncovering the intrinsic connections between different disciplines to achieve the organic integration of knowledge and the transfer of skills [14–15]. Effective interdisciplinary learning should revolve around real-world problem scenarios—problems that not only stimulate students’ higher-order thinking but are also sufficiently open-ended to allow for the incorporation of perspectives from different disciplines [16–18]. The continuous improvement of teachers’ professional competence is a core component of ensuring educational quality. In today’s educational environment, characterized by accelerating knowledge iteration and diverse student needs, teachers must achieve coordinated development across multiple dimensions, including interdisciplinary knowledge systems, teaching practice skills, and ideological and political literacy [19–21].

As a scientific and objective qualitative method, grounded theory demonstrates significant feasibility in research on teachers’ interdisciplinary literacy. Recognizing the lack of robust empirical evidence in qualitative research, this study combines the fuzzy set qualitative comparison method to construct a comprehensive empirical analytical framework. By collecting interview data from the sample teachers and employing open coding, axial coding, and selective coding in sequence, the corresponding core categories of interdisciplinary literacy were identified. Fuzzy set qualitative comparison was employed to analyze the teachers’ coding patterns, verify the necessary and sufficient conditions of the influencing variables of interdisciplinary literacy, and derive the final conditional configuration path.

2. Coding Methods Based on Grounded Theory

2.1. Theoretical Foundation and Data Collection

2.1.1. Grounded Theory

Grounded theory has a comprehensive set of operational procedures [22–23]. The specific steps of the grounded theory process primarily include: reading the raw data; transcribing; identifying “indigenous concepts”; and establishing a coding and filing system. “Coding” is one of the most important concepts in qualitative research. “Coding” involves assigning codes to the collected data at the finest level of phrasing to identify patterns; it is “an operational process of breaking down the collected data, assigning concepts and meanings to it, and then reassembling it in a new way.” The most central process involves repeatedly comparing and analyzing the collected data through “three-level coding,” namely open coding, axial coding, and selective coding.

Guided by grounded theory, the researcher employed interviews, observation, and artifact analysis to collect primary data, and utilized Nvivo 14.0 software to code and analyze all interview transcripts. Throughout the research process, the author adhered to the “cultural subjectivity” principle, striving to understand the textual data from the perspective of a “local” and conducting a thorough exploration and analysis of the material. At the same time, guided by the “cultural objectivity” principle, the author set aside personal assumptions and value judgments, coding the textual data from an “outsider’s” perspective while interpreting and explaining the relationships among the codes from a theoretical standpoint. Through continuous comparison, categorization, and analysis, conceptual categories, main categories, and core categories were gradually identified, ultimately leading to the construction of a structural diagram of elementary school teachers’ curriculum competencies.

2.1.2. Data Collection

Since qualitative research emphasizes the richness and diversity of information provided by the sample, this study employed purposive sampling to select research participants who were most relevant and aligned with the research topic during the data collection process, thereby purposefully collecting relevant data. This study conducted field observations at multiple secondary schools, selecting 15 interviewees from each of two typical school management systems. Table 1 presents the basic information on the teachers selected as research subjects in this study. The 15 interviewed teachers were selected from three core subject areas—Chinese, mathematics, and English—with teaching experience ranging from 2 to 9 years, and interview transcripts ranging in length from 3,347 to 5,477 characters.

Table 1. Basic information of the study subjects

Code	Subject	Professional Title	Teaching Experience (Year)	Interview Transcript (Characters)	Educational Management
T1	Mathematics	Intermediate	3	5386	Publicly
T2	Mathematics	Advanced	6	3534	Publicly
T3	Mathematics	Advanced	7	5409	Private
T4	Mathematics	Advanced	7	4089	Private
T5	Chinese	Intermediate	5	4846	Private
T6	Chinese	Intermediate	2	4987	Publicly
T7	Chinese	Intermediate	4	3361	Publicly
T8	Chinese	Intermediate	4	5477	Publicly
T9	Chinese	Advanced	8	4012	Private
T10	English	Intermediate	2	4959	Private
T11	English	Intermediate	3	4234	Private
T12	English	Intermediate	3	3347	Private
T13	English	Advanced	9	3365	Publicly
T14	English	Advanced	7	4234	Publicly
T15	English	Advanced	6	4722	Private

Before the interviews began, the researcher explained the purpose of the study and how the data would be used to the participants. In accordance with academic research ethics, recordings were made only after obtaining the participants' consent. Due to work and practical constraints, a combination of online and in-person methods was used for the interviews. During the interviews, the researcher acted as a listener, responding to the participants and asking appropriate questions and follow-ups to ensure they had ample opportunity to express themselves.

This study primarily employed the interview method, supplemented by observation and document analysis. The observation method involved detailed recording of teachers' classroom performance and behavior, as well as their post-class activities; the document analysis method focused on collecting teachers' teaching logs, lesson plans, and other work-related records. The researcher conducted on-site observations in over 40 of the participants' classes. With the teachers' consent, the researcher collected more than 60 lesson plans and other teaching notes. The collected interview recordings were transcribed into textual data totaling over 60,000 characters. The research data consists of three parts: interview transcripts, classroom observation records, and teachers' work logs. Interview transcripts serve as the primary material for data analysis, while classroom observation records and collected documents function as supporting evidence.

2.2. Coding Process

Drawing on the three-level coding approach of grounded theory and using the NVivo qualitative analysis software [24], this section conducts a tiered analysis to identify the competencies that frontline interdisciplinary teachers need in their actual teaching practices, as revealed in the interviews. These competencies are then categorized based on competency model theory to validate the interdisciplinary competency model for teachers.

2.2.1. Open-ended coding

Open-coding is the first step in analyzing interview data, involving the analysis and processing of extensive raw data. It consists of two specific steps. First, select passages relevant to the research question. Second, abstract and generalize the selected content and assign labels to it, which are referred to as nodes. In this section, NVivo software was used to select and analyze over 60 raw interview transcripts on a word-by-word, line-by-line, paragraph-by-paragraph, and event-by-event basis, manually performing open coding on the interview texts according to the coding method described above.

2.2.2. Spindle Encoder

The second step is axial coding. The task of axial coding is to compare and analyze the nodes identified above, further generalizing and merging related or similar nodes to clarify the relationships between them and enhance the explanatory power of the concepts. The results of the axial coding in this paper are shown in Table 2. A total of 8 axial coding nodes were identified, yielding 95 nodes and comprising 196 reference points (a reference point refers to the number of times a single node appears).

“Source count” refers to the number of interviewees who share the same view on a given node; the number of sources reflects the importance of that node. “Reference points” refer to the number of times interviewees mention a given node. The number of reference points is always greater than or equal to the source count.

Table 2. The main axis encoding result of this article

Node	Node name	Source of materials	Reference point
N1	Interdisciplinary teaching methods and abilities	18	26
N2	Professional knowledge	8	18
N3	Interdisciplinary practical skills	12	31
N4	Understanding and acceptance of interdisciplinary concepts	11	19
N5	Practical skills and learning abilities	13	20
N6	General knowledge	12	29
N7	Interdisciplinary interests, enthusiasm and sentiments	9	21
N8	Collaboration skills	12	32

2.2.3. Selective Coding

The purpose of selective coding is to generalize the nodes obtained through axial coding using more general and explanatory concepts. Through continuous analysis and synthesis, the results of selective coding for teachers’ interdisciplinary competencies are presented in Table 3. This study identified five core categories to generalize the 95 open-ended codes and eight axial codes.

Table 3. Selective coding of interdisciplinary literacy

Node	Node name	Source of materials	Reference point	Selective encoding	Source of materials	Reference point
N1	Interdisciplinary teaching methods and abilities	18	26	Interdisciplinary ability	18	75
N2	Professional knowledge	8	18			
N3	Interdisciplinary practical skills	12	31			
N4	Understanding and acceptance of interdisciplinary concepts	11	19	Interdisciplinary knowledge	11	39
N5	Practical skills and learning abilities	13	20			
N6	General knowledge	12	29	Interdisciplinary belief	12	29
N7	Interdisciplinary interests, enthusiasm and sentiments	9	21	Characteristics	9	21
N8	Collaboration skills	12	32	Motivation	12	32

3. Assessment of Teachers’ Interdisciplinary Competencies Based on fsQCA

After deriving coding indicators for teachers’ professional interdisciplinary competencies under the framework of course-based ideological and political education using grounded theory, we employed fuzzy set qualitative comparative analysis (fsQCA)—a configurational analysis method—to assess teachers’ interdisciplinary competencies [25–26], thereby laying the foundation for mechanisms and pathways to enhance interdisciplinary integration in learning.

3.1. Validation of the Interdisciplinary Competency Scale

3.1.1. Exploratory Factor Analysis

First, an exploratory factor analysis was conducted on the formal assessment data. The results showed that the KMO value was 0.9214 and the significance level of Bartlett's sphericity test was less than 0.001, indicating that the sample was well-suited for factor analysis. This study identified a total of five factors, which accounted for 68.325% of the cumulative variance. Specifically, the variance contributed by the teachers' interdisciplinary competence dimension was 17.652%, the interdisciplinary knowledge dimension was 13.240%, the interdisciplinary beliefs dimension was 11.203%, the interdisciplinary traits dimension was 10.063%, and the motivation dimension was 8.362%. The factor loadings for each item ranged from 0.65 to 0.92, all exceeding the standard value of 0.6, indicating that the scale effectively reflects the latent traits of each dimension.

3.1.2. Confirmatory Factor Analysis

When χ^2/df is between 0.5 and 3.5, GFI, AGFI, TLI, and CFI are all greater than 0.920; the closer these values are to 1, the better the fit between the data and the model, and values greater than 0.820 indicate that the model is acceptable. When RMSEA is less than 0.075, it indicates that the model has a good degree of fit. The results of the confirmatory factor analysis of the formal assessment data show that $\chi^2/df = 1.421$, GFI = 0.925, AGFI = 0.922, TLI = 0.924, CFI = 0.931, and RMSEA = 0.045. This demonstrates that the formal scale has a good model fit.

3.2. Qualitative Comparative Analysis Using Fuzzy Sets

The factors influencing objective phenomena are often not singular but result from the combined effects of multiple variables. While research typically examines the relationship between two variables, fuzzy set qualitative comparative analysis primarily analyzes the combined effects of variables; it can serve as a supplement to structural equation modeling, further enhancing the explanatory power for the dependent variable. In addition to quantitative research, this study conducts qualitative research through a multi-case comparative analysis based on questionnaire data. By applying fuzzy set qualitative comparative analysis to the sample data on teachers' interdisciplinary competencies, we can further elucidate the patterns influencing these competencies and provide more detailed data and empirical evidence to support improvements in collaborative teaching.

3.2.1. Data Calibration

Calibrate the questionnaire data. According to the standards for Likert-scale data, the 95th, 90th, 75th, 55th, 45th, 30th, and 10th percentiles are typically selected as anchor points. The results of this selection are shown in Table 4. Next, the anchor values for each antecedent variable were entered into the Calibrate function in the fsQCA software to perform preliminary calibration of the data. To improve model performance, 0.002 was uniformly added to the calibrated values to avoid generating fuzzy membership values of 0.55, thereby completing the data calibration.

Table 4. Selection of anchor points

Percentile	PU	IQ	SQ	EC	SA	ES
10%	2.0179	2.2303	2.5014	2.0501	2.2718	2.2322
15%	2.1555	2.2617	2.6864	2.6122	2.3873	2.3514
20%	2.1875	2.3515	3.1208	2.6271	2.5313	2.3736
25%	2.2946	2.4567	3.4239	2.6291	2.6336	2.4698
30%	2.5631	2.6094	3.4732	2.7021	2.8589	2.5288
35%	2.5912	2.9727	3.6268	2.7628	2.8843	2.5949
40%	2.6531	3.3702	3.7292	2.9341	3.4229	3.0188
45%	2.6989	3.5291	4.2133	3.0619	3.5477	3.0997
50%	2.7035	3.9165	4.3884	4.0346	3.9654	3.5469
55%	3.0355	4.2076	4.5341	4.4863	4.0566	3.7728
60%	3.3072	4.2461	4.5903	4.4997	4.2626	3.8045
65%	3.5247	4.4971	4.6441	4.6377	4.5078	4.6284
70%	3.5576	4.5098	4.6908	4.7563	4.8746	4.8822
75%	3.6255	4.8909	4.9285	4.9158	4.9221	5.0466
80%	4.1251	5.1559	4.9582	4.9932	4.9268	5.0839
85%	4.1303	5.331	5.1109	5.164	5.1718	5.1139
90%	4.5426	5.4386	5.1858	5.1963	5.1787	5.1398
95%	4.8984	5.4765	5.1918	5.4107	5.2535	5.3995

3.2.2. Needs Analysis

Data analysis using fsQCA begins with an assessment of the necessity of antecedent conditions to determine whether certain conditions consistently influence the formation of intentions to engage in sustained behavior. To this end, this study imported the questionnaire data into the fsQCA software via editing, set “intentions to engage in sustained behavior” as the outcome variable, and calculated the consistency and coverage of the other variables. The results regarding necessity, derived from the data analysis, are shown in Table 5. It is generally accepted that a consistency coefficient greater than 0.92 indicates that a variable is a necessary condition influencing the outcome variable. As shown in the table, only teachers’ interdisciplinary collaboration ability has a consistency coefficient of 0.93233, which is greater than 0.92; therefore, interdisciplinary collaboration ability is a necessary condition influencing the intention to engage in sustained behavior.

Table 5. Necessity Result

	Consistency	Coverage
Interdisciplinary teaching methods and abilities	0.88935	0.88564
Professional knowledge	0.88601	0.85825
Interdisciplinary practical skills	0.89103	0.87307
Understanding and acceptance of interdisciplinary concepts	0.90653	0.89193
Practical skills and learning abilities	0.91404	0.88842
General knowledge	0.90650	0.86371
Interdisciplinary interests, enthusiasm and sentiments	0.91165	0.88468
Collaboration skills	0.93233	0.86193

3.2.3. Sufficiency Analysis

A truth table must be constructed prior to configuration analysis. This study primarily involves five antecedent conditions for choice coding, resulting in $2^5=32$ possible configurations. The truth table results obtained for configuration analysis are shown in Table 6. Following preliminary induction, the outcome variable codes corresponding to configurations with excessively low consistency in the truth table are set to 0, indicating that they do not exist. The consistency threshold is set at 0.82 to ensure the validity of the conclusions. Based on the premise that perceived entertainment value is a necessary condition, this study conducted a truth table assignment analysis of the data. The software analysis results include complex solutions, reduced solutions, and intermediate solutions; most studies rely primarily on intermediate solutions to understand the impact of configuration combinations of antecedent conditions on the outcome variable. By analyzing and combining the reduced and intermediate solutions (Table 7), this study identified core and peripheral conditions. Using a weighted average calculation method, the coverage rate of the intermediate solution was determined to be 0.912504, with a solution consistency of 0.841211. Further calculations revealed that interdisciplinary competence, interdisciplinary knowledge, interdisciplinary beliefs, traits, and motivation are the core conditions influencing the intention to engage in sustained behavior.

Table 6. The true value results of the configuration analysis

N1	N2	N3	N4	N5	Count	CIFZ	raw	PRI	SYM
0	1	0	1	1	64	1	0.1927	0.4948	0.6592
0	0	1	1	0	1	1	0.7606	0.3662	0.2105
0	0	0	0	0	1	1	0.4702	0.5871	0.9372
1	1	0	1	0	1	1	0.9463	0.4800	0.9067
1	0	1	1	0	1	1	0.9708	0.8143	0.0401
1	1	1	0	0	1	1	0.3877	0.8439	0.2743
0	1	1	0	1	1	1	0.4073	0.7326	0.5834
1	1	0	1	1	1	1	0.1016	0.7928	0.9600
0	0	1	0	0	5	1	0.5558	0.7526	0.4451
0	0	1	0	0	2	1	0.9259	0.2408	0.9834
1	1	1	1	1	0	0	0.6629	0.9408	0.0398
0	0	1	1	0	0	0	0.3055	0.8388	0.3489

Table 7. Simplistic solution and intermediate solution

	Raw consistency	Unique coverage	Consistency
N1	0.52510	0.01807	0.86017
N2	0.64385	0.05178	0.81741
N3	0.80534	0.03317	0.83822
N4	0.74185	0.01911	0.81127
N5	0.46343	0.03718	0.81016
N1*~N2*~N3*~N4*~N5	0.69089	0.02292	0.86205
~N1*N2*N3*~N4*~N5	0.51383	0.03046	0.82721
~N1*~N2*N3*~N4*N5	0.67827	0.05164	0.82984
N1*N2*N3*N4*N5	0.62204	0.04884	0.87296
N1*N2*N3*N4~N5	0.91703	0.02830	0.81854
N1*N2~N3~N4*N5	0.83199	0.02851	0.92296
~N1*~N2*~N3*~N4*N5	0.71282	0.01129	0.87390

3.2.4. Configuration Analysis Results

The results of the fsQCA software analysis yielded three types of solutions: complex solutions, reduced solutions, and intermediate solutions. According to the rules of QCA's qualitative comparative analysis, if a causal condition appears in both a reduced solution and an intermediate solution, that condition is considered a core causal condition and has a significant impact on the outcome variable; if a causal condition appears only in an intermediate solution, it is considered a peripheral condition and plays a supporting role in influencing the outcome variable. The specific results of the fsQCA qualitative analysis are shown in Table 8. In the table, “√” and “×” indicate the presence and absence of core causal conditions, respectively, while “√” and “×” indicate the presence and absence of auxiliary causal conditions, respectively. A blank cell indicates that the presence or absence of the condition has no effect on the outcome.

The results from the fsQCA software show that both “traits” and “motivation” appear in both the minimal solution and the intermediate solution, indicating that these two antecedent conditions are core conditions that play a significant role in the interdisciplinary competencies of teachers engaged in ideological and political education through the curriculum. The table lists four configuration paths: Configuration I(N1*~N2*~N3* ~N4*~N5), Configuration II(~N1*~N2*N3*~N4*N5), Configuration III(~N1*~N2*N3*~N4*N5), and Configuration IV(N1*N2~N3~N4*N5). The consistency for each configuration is greater than 0.92, with an overall consistency of approximately 0.904 and an overall coverage of approximately 0.824, indicating that the combinations of antecedent conditions identified through qualitative analysis provide a strong explanation for the outcome variable.

Table 8. The qualitative analysis results of fsQCA

Preceding conditions	Teacher's interdisciplinary competence			
	Configuration I	Configuration II	Configuration III	Configuration IV
N1	√	√	×	×
N2		×	×	×
N3	×	×		
N4	×	×	×	
N5	×		√	√
Raw Coverage	0.30025	0.23512	0.19827	0.17663
Unique Coverage	0.25153	0.20397	0.32615	0.26318
Consistency	1	1	0.824	1
Overall coverage of the plan			0.82441	
Overall consistency of the plan			0.90362	

4. Discussion

Based on the four configuration pathways described above, it can be seen that interdisciplinary characteristics serve as core causal conditions in both Configuration I and Configuration II; therefore, these two configurations can be classified as interdisciplinary characteristic-based configurations. Similarly, based on the characteristics of Configurations III and IV, they can be classified as interdisciplinary motivation-based configurations.

To enhance teachers' interdisciplinary competence under the framework of integrating ideological and political education into the curriculum through the interdisciplinary trait-based approach, the

following steps should be taken. First, for teachers who exhibit insufficient classroom interaction, low teaching impact, and poor interdisciplinary competence, we must fully leverage their strengths—such as a sense of responsibility, self-discipline, honesty and integrity, and self-confidence—and design strategies to enhance their interdisciplinary competence based on these teaching traits. Although many teachers have limited knowledge of professional interdisciplinary development, they can still effectively carry out online teaching tasks thanks to their years of teaching experience and strong teaching qualities—primarily due to their high sense of responsibility. Therefore, enhancing teachers' interdisciplinary competence can fully leverage the advantage of teaching characteristics to provide targeted measures for teachers with lower levels of instructional interaction and impact. Incentive mechanisms for interdisciplinary teaching should be introduced as soon as possible to institutionally ensure the enhancement of teachers' interdisciplinary competence.

When enhancing teachers' interdisciplinary competence under the framework of curriculum-based ideological and political education through an interdisciplinary motivation-driven approach, it is essential not only to incentivize teachers' interdisciplinary motivation but also to strengthen rigorous evaluations of their teaching qualities and establish higher assessment standards. This ensures that students not only experience teachers' proficient pedagogical skills but also feel the charm of their personal qualities—which is the best way to implement curriculum-based ideological and political education and spread positive energy.

5. Conclusion

This paper combines grounded theory and the fsQCA qualitative analysis method to empirically examine the factors influencing teachers' professional interdisciplinary competence, and consequently proposes corresponding integrated learning mechanisms and pathways for competency development. The research conclusions are as follows:

Using grounded theory, the study identified 8 main coding nodes, 95 node sources, and 196 reference nodes related to teachers' interdisciplinary competence. Through selective analysis, five core categories were derived: interdisciplinary ability, interdisciplinary knowledge, interdisciplinary beliefs, traits, and motivation. The study revealed the interrelationships among these categories and constructed a comprehensive definition of teachers' interdisciplinary competence under the context of curriculum-based ideological and political education.

By applying fuzzy set qualitative comparison to the assessment of teachers' interdisciplinary literacy, this study verified that teachers' interdisciplinary collaboration ability is a necessary condition for the sustainable development of their interdisciplinary literacy, with a consistency coefficient of 0.93233—exceeding the threshold of 0.92. Regarding sufficient conditions, interdisciplinary ability, interdisciplinary knowledge, interdisciplinary beliefs, traits, and motivation were all found to be core conditions for sustainability.

Based on the four final configuration paths identified, this paper summarizes two major categories of development pathways—the interdisciplinary trait-oriented and motivation-oriented approaches—to support the enhancement of interdisciplinary literacy among teachers of ideological and political education in the curriculum.

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About the Author

Jianxiu Zhao was born in Anyang, Henan, P.R. China, in 1982. She is currently pursuing her Ph.D. at South China Normal University, P.R. China. Her research interests include secondary vocational school teacher learning and curriculum ideological and political education.