

An Exploratory Study of the Subject Ontogeny of Eugenics in the *New Classification Scheme for Chinese Libraries* and the *Nippon Decimal Classification*

Wan-Chen Lee

University of Washington, Information School, Box 352840, Mary Gates Hall,
Ste. 370, Seattle, WA 98195-2840, <leew23@uw.edu>



Wan-Chen Lee is a PhD student at the Information School of the University of Washington where she received her MLIS degree in 2014. Her main research interest is culture and classification, which includes classification schemes, comparison, and issues concerning globalization and localization of classification schemes.

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Abstract: This study explores the subject ontogeny of "eugenics" by documenting the class numbers for "eugenics" in all thirteen editions of the *New Classification Scheme for Chinese Libraries* (CCL), and all fourteen editions of the *Nippon Decimal Classification* (NDC). The CCL and the NDC are the major classification schemes used in Taiwan and Japan respectively. We observe the relative stability and concentration of class numbers assigned to "eugenics" in the CCL and the NDC comparing to DDC (Tennis 2012), and the semantic changes of class numbers over time.

Using two union catalogs, Taiwan's National Bibliographic Information Network (NBINet) and Japan's National Diet Library (NDL) Search, we retrieve bibliographic records with "eugenics" (優生學 and 優生学) as subject heading. We compare the class numbers extracted from the bibliographic records and the numbers assigned in the schemes of corresponding editions. It shows the difference between the theoretical frameworks of the schemes and the catalogers' applications. This study highlights the temporal aspect of classification schemes and how it may influence the organization and retrieval of information. It also sheds light on some limitations of current catalogs.

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1.0 Introduction and rationale

Classification schemes provide theoretical structures that organize information and support retrieval. Classificationists work to revise classification schemes to accommodate new knowledge, and to reflect the current perspectives about the relationships between subjects through, for instance, fitting classes into appropriate places in the scheme. All this is done within the scopes of the schemes. As a result, different editions of a classification scheme present snapshots of how editors of the scheme deal with subjects over time. Subject ontogeny, "the life of a subject over time" (Tennis 2012, 1351), emphasizes the temporal aspect of a subject and reminds us of how libraries as growing organisms accumulate and organize collections over time. Subjects may be added, removed, resumed and shifted in a classification scheme. A class number may represent differ-

ent and multiple concepts across editions. When browsing a collection, the arrangement and collocation are based on several editions of classification schemes. The scheme changes, which include the ontogeny of subjects, differences between editions of schemes and the evolving meanings of class numbers are not explicitly represented in current information systems.

There is much discussion about scheme change in previous research. Furner (2007) looks at the revisions about race-related topics in the *Dewey Decimal Classification* (DDC) through the lens of critical race theory. He talks about the significance and challenges of the changes, and how the subject ontogeny of race and race-related classes can be an approach to examine the context and impact of the changes. Salah et al., (2012) look at how the Universal Decimal Classification (UDC) evolves over time, and observe growth of the main classes to reflect new knowledge,

and over-proportional increase in the common auxiliaries, which are used for language, form or cultural origin. The authors consider this to be a reflection of the increasing cultural sensitivity of the UDC.

Recognizing the ontogeny of subjects and scheme change provides context that is helpful for us to interpret anomalies in information systems. It surfaces related subjects and points to old classes where the subjects used to be placed. Representation of subjects' ontogeny could improve information retrieval by pointing to other possible locations and old spots in a scheme. Not directly addressing ontogeny, per se, Buckland (2012) identifies the Janus-like nature of subject interpretation and representation. While the meaning of a subject is tied with context in the past, subject representation takes both the past and future usage, such as retrieval and browsing in the future, into account. From this we might claim that comprehensive subject interpretation relies on understanding of a subject's ontogeny.

To date, some research has pointed to particular phenomena in subject ontogeny. Tennis (2002; 2012) observes that the subject "eugenics" is a strange case, because there are many changes—namely interruptions, erasures and movement—in its ontogeny in the *DDC*. This can be contrasted with other stable subjects like "anatomy." In the study of transforming the current conceptualization of the *DDC* to be more suited to the architecture of the semantic web, and referenceable by URI, Panzer (2008) points out that a subject's ontogeny will persist even if the concept of printed edition and its concomitant naming conventions do not. Not focusing on subjects in classification schemes, Turner (2015) looks at the ontogeny of the description standard in the National Museum of Natural History. Here, the concept of subject ontogeny is used as a jumping off point in observing the changes in guidelines and practices over time. Further, it helps Turner identify the embedded and persistent biases against indigenous knowledge.

From these studies, we can ask whether the same phenomenon appears in schemes outside of the English language and outside of the North American cataloging and classification tradition. Because the science of eugenics shifts in the twentieth century, and is so presented in *DDC* (Tennis 2012), we are interested in observing the ontogeny of eugenics in other schemes, and how catalogers assign class numbers to reflect the perspectives about eugenics in Taiwan and Japan. We also want to observe and collect examples of the scheme change and see whether Tennis's categories of scheme change (2007) and the diachronic semantics mechanisms outlined by Cupar (2015) borrowed and modified from linguistics, appear in the *New Classification Scheme for Chinese Libraries* (*CCL*) and Japan's *Nippon Decimal Classification* (*NDC*).

This study looks at the subject "eugenics" in the *CCL* and the *NDC* in order to examine and compare with previous research about eugenics in the *DDC* (Tennis 2002; 2012; Tennis et al. 2012). With three cases, we can look not only at the subject ontogeny of eugenics in the three schemes respectively, but we also can compare the cases across the *DDC*, the *CCL* and the *NDC*. The emergence and earlier development of the latter two schemes were based heavily on *DDC* (Lee 2016), and they deal with the same subjects, including eugenics. By examining similar cases, we are following Bowker and Star in looking for potential "silences" (Bowker and Star 1999, 86) in an information infrastructure that are less likely to be noticed without comparison. In the next section, we outline the methods used for data collection and analysis of the *CCL* and the *NDC*.

2.0 Research design

In order to do a comparison across the three classification schemes, we need a comparable set of data. The *DDC* findings are available in journal articles (Tennis 2012; Tennis et al. 2012), at least at the summary level. For our work, there are two major tasks in this study. One is to examine the ontogeny of eugenics in the *CCL* and the *NDC*. The other is to compare the classes for eugenics in the two schemes with the classes catalogers assigned to materials about eugenics, that is, the class numbers in the bibliographic records with "eugenics" as the subject heading. The following section introduces the methods we used to collect and analyze the data and provides some context and history of the *CCL* and the *NDC*.

2.1 Context and history of the *CCL* and the *NDC*

The *CCL* was created by Kwoh-Chuin Liu, and the *NDC* was created by Kiyoshi Mori. Both schemes were published in 1929. Neither China nor Japan had national classification standards at the time. Some libraries developed their own classification schemes, which hindered inter-library collaboration. Some Chinese libraries used old classification schemes like the *Sì kù quan shū*, which Liu found problematic and deficient in representing new knowledge. Some Chinese libraries used one scheme for old books and another scheme for new books without a consensus of the definition of old and new books. Acknowledging the lack of a national classification standards, Liu and Mori had a common goal to develop a scheme that organizes materials written in different languages and improves inter-library collaboration. Liu proposed the *CCL* based on the collection of the University of Nanking Library. He established it as a classification standard for books published in all eras (Liu 1929). Mori

emphasized the importance of prioritizing materials related to Japan when proposing the *NDC* (Mori 1929).

When developing the *CCL*, Liu referenced both Chinese and Western classification schemes, but drew primarily from the *DDC* (Liu 1929). He created and revised the first four editions of *CCL* from 1929 to 1958, and Yimin Xiong added a relative index to the 1958 edition. Following Liu, Yongxiang Lai revised eight editions of *CCL* from 1964 to 2001. Succeeding Lai's efforts, the editorial committee led by the National Central Library continues to maintain the *CCL* and published the most recent edition in 2007. To design the *NDC*, Mori adapted the class sequence of Cutter's *Expansive Classification* and the structure and notation of the *DDC*. He also referenced some Chinese classifications for their approaches of adapting *DDC* notations (Mori 1929). The *NDC* has gone through several revisions. Mori edited nine editions from 1929 to 1949. Starting from 1950, the Japan Library Association (JLA) has been maintaining and revising the *NDC* and published the latest edition in 2015.

2.2 *CCL* and *NDC* as datasets

There are thirteen editions of *CCL*, ranging from 1929 to 2007, and there are 14 editions of *NDC*, ranging from 1929 to 2015. We examined all the editions of the two schemes to record the class number(s) for eugenics in each edition, and documented the meanings of the classes in the hierarchy to observe scheme change. Since not every edition of both schemes has a relative index, we either used the relative index when an edition had one or browsed the class tables to locate eugenics. The two datasets represent the editors' perspectives on where eugenics sits in the theoretical structure of the schemes. The datasets show us the ontogeny of eugenics in the *CCL* and the *NDC*. We are able to see the number of classes for eugenics in each edition and the meanings of those classes. We can also observe how the classes shifted or remained consistent over time.

2.3 Bibliographic records using the *CCL* and the *NDC*

We collected bibliographic records with "eugenics" as a subject heading to see how catalogers classify materials about eugenics in practice. For records using the *CCL*, we used NBNiNet, a union catalog maintained by the National Central Library (NCL) in Taiwan. The catalog went online in 1998. As of July 1, 2016, it provides access to more than twelve million bibliographic records of both book and non-book materials in Chinese, English, Japanese, and other languages from eighty-two libraries, including the NCL, public libraries, academic libraries, and special libraries.

It also provides access to more than twenty-one million holding records (NBNiNet 2010; 2016). To collect records using the *NDC*, we used NDL Search, a union catalog that inventories the collections of the NDL (National Diet Library), public libraries, special libraries, academic libraries, archives, museums, and research institutions in Japan as well as e-book websites, publishers' catalogs of publications, legislative information, databases, and the collections of the National Library of Korea. The NDL Search provides access to more than eighty million bibliographic records of materials in Japanese, English, Chinese, Korean, and other languages (NDL 2012; NDL 2016a).

We did a subject search of "eugenics (優生學)" in NBNiNet and "eugenics (優生學)" in NDL Search and retrieved two hundred forty-four and four hundred ninety records respectively. The records retrieved from the NBNiNet were created between 1985 and 2015; and records retrieved from the NDL Search used the 1950 edition to the 1995 edition of the *NDC*. About the limitation of coverage of records in the union catalogs, please see section 3.6. Each bibliographic record lists the libraries that have the material and the class each library assigned. Based on the list, we accessed individual libraries' OPACs to extract more information from their bibliographic records, such as record creation date, and to verify the presence of "eugenics" as a subject heading. We documented record creation date to infer the edition of *CCL* used to create the record, based on the assumption that catalogers use the most current edition of *CCL*. We also checked the subject heading, since some libraries do not assign subject headings, and some libraries assign different subject headings to the same material. Records must have a record creation date and "eugenics" as a subject heading to be included in our dataset for analysis. In addition, in order to explore the level of agreement between catalogers, we included all the records that meet the criteria stated above. Thus, records with identical information but provided by different libraries were all included. We extracted the following information from the records: record creation year/record edited year, publication year, *CCL* number, title, subject heading, and source (the library that created the record). Twenty-two records were excluded from the dataset due to the lack of a record creation date. Two hundred twenty-two records were analyzed.

Similar to the previous approach, in each record we followed the list of libraries that have the material about eugenics and collected more detailed information using individual libraries' OPACs. We collected the publication year, *NDC* number, title, subject heading, source (the library that created the record), and the *NDC* edition used to create the record. Unlike the bibliographic records using the *CCL*, most of the records specify the *NDC* edition used. As a result, we did not have to collect record

creation year. For the purpose of our analysis, we only include records with “eugenics” as subject heading and *NDC* edition information. For serial publications, instead of collecting data for each issue, we included one record for each serial publication. Records provided by different libraries with identical information were all included for analysis of the agreement among catalogers. A total of four hundred ninety records were collected for analysis.

3.0 Results

The following section presents the ontogeny of eugenics in the *CCL* and the *NDC* by documenting the classes for eugenics in all editions of both schemes and the meanings ascribed to those classes. We then look at the bibliographic records with “eugenics” as a subject heading and the class numbers assigned in the records. We highlight the numbers and meanings of the classes that are frequently assigned in the records but not “sanctioned” by the schemes. In order to show the degree of agreement between the theoretical framework of the schemes and the catalogers’ perspectives, we match the classes in the schemes and the classes assigned in the records. At the end of this section, we present our comparison of the *DDC*, the *CCL*, and the *NDC* and discuss the possible silences in the schemes (Bowker and Star 1999, 86).

3.1 The classes for eugenics in the *CCL*

The classes for eugenics in all editions of the *CCL* are presented in Table 1.

Class 363.5 “Eugenics” is a subclass of “Natural sciences/sciences.” It has been consistently used for eugen-

ics since the first edition of the *CCL*. Class 411.91 “Eugenics including birth control and abortion” is under “Applied sciences.” It was added in the 2001 edition, but replaced by “Genetic health” in the 2007 edition. Class 544.4 and 544.45 are under “Social sciences.” 544.4 meant “eugenics” in the first four editions. Starting from the fifth edition published in 1964, 544.4 changed its meaning to “Birth.” 544.45 became the class for eugenics and continues to the latest edition.

Looking at the ontogeny of eugenics in the *CCL*, we identify examples for the three categories of scheme change introduced by Tennis (2007), which are structural change, word-use change, and textual change. Structural change refers to changes that influence the navigation of a scheme through changing the relationships between values in a scheme. An example of structural change is class 544.4. In the first four editions, 544.4 was the class for eugenics. However, starting from the 1964 edition, the class “Birth” was added between class 544 and “Eugenics,” which became 544.45. This change reflects the need of further dividing class 544. Class 544.4 is also an example of generalization, a mechanism of semantic change introduced by Cupar (2015). According to her definition, generalization refers to semantic change of which the new class number has a more general meaning than the old class number. In this case, the new 544.4 (Birth) is more general than the old 544.4 (Eugenics).

Word-use change happens when new words are added or replaced, or the definition of a value changes. It does not affect the structure and navigation of a scheme (Tennis 2007). There are word-use changes in class 300 and class 544. Class 300 was “Natural sciences” until the 2001 edition when it was changed to “Sciences.” Class 544

	1929	1936	1940	1958	1964	1968	1971	1976	1977	1981	1989	2001	2007
363.5													
411.91													
544.4													
544.45													
363.5: 300. Natural sciences (1929-1989 ed.); Sciences (2001-) > 360. Biology; Natural history (1929-1977 ed.) / Life science (1981-1989 ed.) / Biological science (2001-) > 363. Genetics; Heredity (1929-1977 ed.; 2007 ed.) / Genetics; Heredity; Variation (1981-2001 ed.) > 363.5 Eugenics (1929-)													
411.91: 400. Applied sciences > 410. Medical sciences > 411. Hygiene > 411.9 Special topics > 411.91. Eugenics (including Birth control and Abortion) (2001 ed.) / Genetic health (including Birth control, Induced abortion, and Family planning) (2007 ed.)													
544.4 and 544.45: 500. Social sciences > 540. Sociology (1929-) > 544. Family (1929-1958 ed.) / Family and its members (1964-1981 ed.) / Family and kinship (1989-) > 544.4. Eugenics (1929-1958 ed.) / Birth (1964-) > 544.45 Eugenics (1964-)													

Table 1. Classes for eugenics in the *CCL*. Class numbers marked gray are authorized numbers for eugenics in the *CCL*.

meant “Family” from the 1929 edition to the 1958 edition. It was changed to “Family and its members” in the 1964 edition and has been referring to “Family and kinship” since the 1989 edition. We consider the two cases as word-use change, because the sub-classes do not change correspondingly. There is no structural change. The name changes of class 300 and class 544 do not immediately signal to the cataloger that there are different types of materials under the two classes. One other word-use change is class 363. Class 363 was “Genetics; heredity” from the 1929 edition to the 1977 edition. In the 1981 to the 2001 editions, it became “Genetics; heredity; variation.” It changed back to “Genetics; heredity” in the current 2007 edition. Looking at class 363 alone, it seems “variation” was added and removed, thus broadening and then limiting the scope of the class. However, if we look at the hierarchy of class 363 over time, we see that “variation” first appeared in the 1936 edition as 363.1, and has been a sub-class of 363 since then. Whether it appears in the class name of 363 or not, the class for variation (363.1) has not changed. Adding “variation” to the class name of 363 only highlights this concept among other sub-classes of the same level, such as 363.2 “Breeding; conjugation” and 363.3 “Reproduction and sex.” Nevertheless, it does not indicate posting-up “variation” to 363. It is important to examine the entire hierarchy when exploring the ontogeny of a class. If we only focus on the name changes of class 363, we may misunderstand the change and categorize it as a structural change instead.

Another interesting case is class 411.91 “Eugenics” in the “Applied sciences.” This “eugenics” (優生學) was added as one of the “special topics” under class 411 “Hygiene” in the 2001 edition with a note saying the class includes topics about birth control and abortion. In the 2007 edition, “eugenics” was removed, and the name of 411.91 changed to “Genetic health” (優生保健) with a note specifying that topics about birth control, induced abortion, and family planning are under this class. Based on the notes in the 2001 and 2007 editions, we may infer that the change from “eugenics” to “genetic health” is a word-use change like adding a synonym, because the old and the new classes include very similar topics. However, when we broaden our focus from the class 411.91 to the ontogeny of “eugenics,” we have a different explanation. This change is similar to but different from word-use change (Tennis 2007) and splitting (Cupar 2015). In the 2001 edition, “eugenics” represents three document-sets in classes 363.5, 411.91, and 544.45, which correspond to the natural sciences, applied sciences, and social sciences aspects of the subject. In the 2007 edition, “Eugenics” still appears in the “Natural sciences” and the “Social sciences,” but its spot in the applied sciences is taken by “Genetic health.” The change is not splitting because the materials about

“eugenics” did not split into two groups represented by “eugenics” and “genetic health” in the 2007 edition. We can say that the word-use change happened in the “applied sciences” but not at the other two areas. The lack of a mechanism to present this subject ontogeny including the relationship between eugenics and genetic health undermines the *CCL*’s performance in information retrieval. Users who do a subject search on “eugenics” would not retrieve materials about “eugenics” in “applied sciences” that are classified using the 2007 edition of *CCL*, unless the subject headings were coupled with “genetic health.” Based on the data, and the relatively short life span of class 411.91 as “eugenics,” we cannot tell whether the name change of 411.91 influences cataloging practices. Among the two hundred twenty-two records created from 1985 to 2015, only one bibliographic record uses 411.91 as class number. The data show low application of the class, but the reason for this and its relationship with scheme change remains unknown.

Textual change refers to changes of relationships between an edition of the scheme and a set of texts. Texts can refer to either 1) resources used and often cited to create a class in a particular scheme; or 2) materials assigned under a specific class. The former type of textual change is textual warrant change, and the latter is document-set change (Tennis 2007). In class 360, we see both document-set change and word-use change. The class name is “Biology; natural history” from the 1929 to the 1977 editions. It became “Life science” in the 1981 edition, and changed again in the 2001 edition to “Biological science.” In order to arrive at the assessment that we observe two types of change, we examine the hierarchy of class 360 in the 1977, 1981, and 2001 editions. The classes of 361 to 369 are identical in the latter two editions. In the 2001 edition, the scheme explicitly marks the new class name of 360 as a synonym of the old name. We thus consider the change from “life science” to “biological science” to be a word-use change. However, when we compare the hierarchies of class 360 in the 1977 and 1981 editions (Table 2), we identify changes that would affect the types of materials classed under a specific class. For instance, class 367 changed from “Natural history; natural research” to “Ecology.” The former has two sub-classes while the latter has eight sub-classes with subdivisions. We can anticipate that the document-set classed under 367 will change drastically after the scheme change. If a library migrated from a 1977 or older edition of the *CCL* to a 1981 or newer edition, there would be two document-sets sharing the same class number. Without a mechanism to present the ontogeny of the subjects this class inventories, confusion can arise and hinder navigation through the scheme.

1977 edition	1981 edition
360. Biology. Natural history	360. Life science
361. Systems biology; biogenesis	361. General biology
362. Evolution	362. Evolution
363. Genetics; heredity	363. Genetics; heredity; variation
364. Cytology	364. Cytology (cell biology)
365. Biological economics	365. Biological economics
366. Biogeography	366. Biogeography
367. Natural history; natural research	367. Ecology
367.1. Natural museums	367.1. General ecology
367.2. Biological specimen	367.2. Organisms and non-biological environments
368. Microbiology	367.3. Organisms and biological environments
369. Bacteriology	367.4. Pollution
	367.5. Adaptions
	367.6. Synecology
	367.8. Ecosystems
	367.9. Exobiology
	368. Microbes (生物學技術 [biotechnology])
	369. Microbes (微生物)

Table 2. The hierarchies of class 360 in the 1977 and 1981 editions of the *CCL*.

3.2 Classes for eugenics in the bibliographic records but not “sanctioned” by the *CCL*

In this section, we shift our focus from the *CCL* to the bibliographic records using the scheme. Besides the authorized classes for eugenics listed in Table 1, we identify classes assigned to materials about eugenics in the records that are not “sanctioned” by the scheme. The most frequently assigned unsanctioned classes are listed in Table 3. Class 429.12 appears in thirty-five records. It is under “Applied sciences” and its sub-class “Domestic arts; home economics.” the meaning of this class is “health of pregnant women” in the 1989 and 2001 editions and “pregnancy” in the 2007 edition. Class 412.58 is assigned to seventeen records. also under “Applied sciences,” it is a sub-class of “Medical sciences.” This class means “genetic health; maternal-child health and hygiene” in the 2001 edition. In the 2007 edition, the editors remove “genetic health.” Class 417 and 417.3 are assigned thirteen times. under “applied sciences,” class 417 is a sub-class of “Medical sciences.” The meaning is “obstetrics and gynecology; children and elders” in the 1989, 2001, and 2007 editions. Five records use class 417 while eight records further divide the class to 417.3, meaning “obstetrics” in the 1989 and the 2001 editions.

The unsanctioned classes are extracted from records with “Eugenics” as a subject heading. Instead of assigning one of the classes for eugenics in the scheme, catalogers chose the unsanctioned classes. These classes show us how eugenics is applied in cataloging practices. They

Class	Occurrence	Meaning
429.12	35	400. Applied sciences 420. Domestic arts; Home economics 429. Domestic health 429.1. Medical knowledge about marriage 429.12 Health of pregnant women (1989 & 2001 eds.); Pregnancy (2007 ed.)
412.58	17	400. Applied sciences 410. Medical sciences 412. Public health 412.5. Citizen's health care 412.58 [not specified] (1989 ed.); Genetic health; Maternal-child health and hygiene (2001 ed.); Maternal-child health and hygiene (2007 ed.)
417	5	400. Applied sciences 410. Medical sciences 417. Obstetrics and gynecology; Children and elders (1989, 2001, & 2007 eds.) 417.3. Obstetrics (1989 & 2001 eds.)
417.3	8	
	13	

Table 3. The most frequently assigned unsanctioned *CCL* classes for eugenics in the bibliographic records.

point us to places in the scheme that the catalogers find appropriate for the subject. The unsanctioned classes shed light on potential needs for scheme revision, which is a force influencing the ontogeny of a subject.

In order to explore the degree of agreement between the theoretical structure of the scheme and catalogers' perspectives, we matched the classes in the records with the authorized classes in corresponding *CCL* editions based on record creation year. The results are presented in Table 4. Among the two hundred twenty-two records with “eugenics” as a subject heading and created since 1985, there are seventy-four matches and one hundred forty-eight mismatches. The match rate is 33.33%, and the mismatch rate is 66.67%.

Figure 1 shows the classes in the two hundred twenty-two bibliographic records as points and presents the authorized classes for eugenics as squares. We can see when the classes match (when data points fall within the squares or sit horizontally with the squares moving left to right) and where the unsanctioned classes are. Looking at this figure, we can identify data points of the popular unsanctioned classes introduced above and see how the points form what seems like a desire line for potential scheme revision.

Record Creation Year	Number of Records	Number of Match between the <i>CCL</i> and the records	Number of Mismatch between the <i>CCL</i> and the records	Match rate	Mismatch rate
1985	4	0	4		
1992-2000	97	40	57		
2001-2006	68	16	52		
2007-2015	53	18	35		
1985-2015	222	74	148	33.33%	66.67%

Table 4. Match between classes in the bibliographic records and classes for eugenics in corresponding editions of the *CCL*.

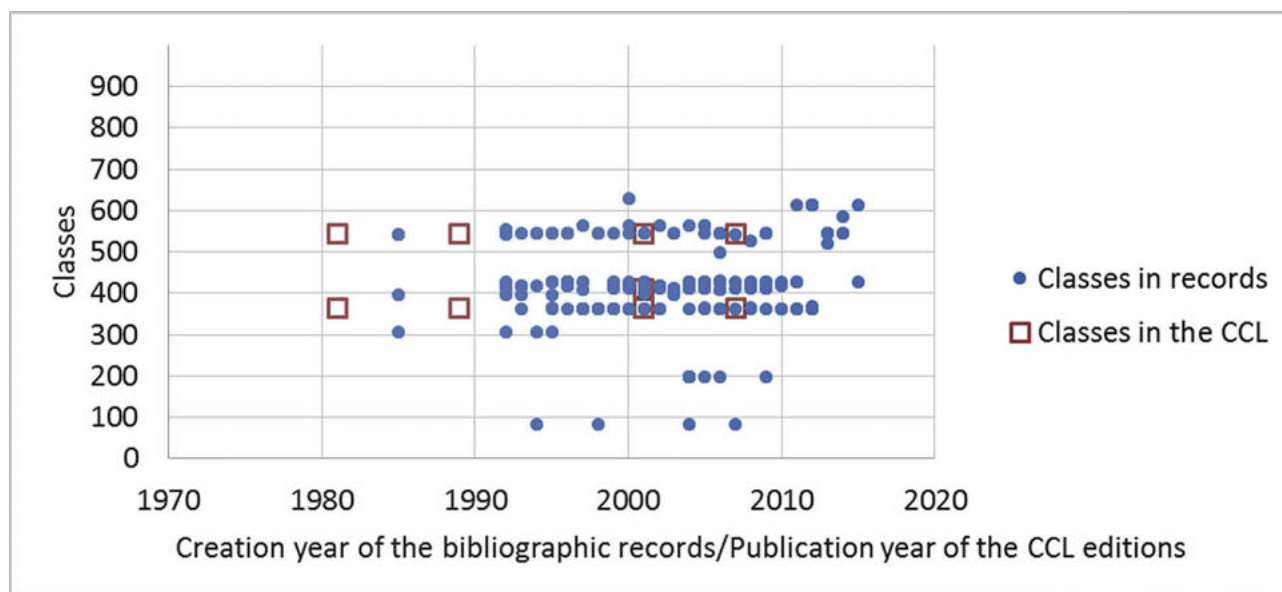


Figure 1. Classes for eugenics in the 1981, 1989, 2001, and 2007 editions of the *CCL* and classes in the bibliographic records with “Eugenics” as a subject heading since 1985.

Since we can only use the record creation date to infer the edition of *CCL* used, we risk underestimating the match rate, because catalogers may use older editions of *CCL* to catalog. To prevent counting records that match with classes of older editions of *CCL* as mismatches, we matched the classes for eugenics in all the editions of *CCL*, which are 363.5, 411.91, 544.4, and 544.45, with the classes in the two hundred twenty-two records collected. The result is shown in Table 5. There are seventy-five matches and one hundred forty-seven mismatches. The match rate is 33.78%, and the mismatch rate is 66.22%. This is a negligible improvement on matching if we account for older classes. As shown in Figure 2, only one record assigns an old class number and causes the slight increase of match rate. Comparing the result of Table 4 and Table 5, we see that most of the mismatches result from assigning unsanctioned classes and not by assigning classes in older editions.

3.3 The Classes for eugenics in the *NDC*

The classes for eugenics in all editions of the *NDC* are presented in Table 6.

Class 464 was the class for eugenics in “Natural science” from the 1929 to the 1949 edition. It meant “genetics; eugenics” in the 1929 edition and changed to “eugenics” from the 1931 to 1949 edition. In the 1950 edition, “Biochemistry” was ascribed to class 464, and “Eugenics” was shifted to 498.2, which has been the class for “Eugenics” since then. Class 498.2 is a sub-class of “Science/natural science(s).” It means “eugenics; sterilization” (including contraception (避孕), segregation, dissolution of marriage, and sterilization) in the 1950 edition. It changed meaning to “Eugenics; sterilization” (including birth control (産児制限), contraception, segregation, dissolution of marriage, and sterilization) in the 1951 edition and became “Racial hygiene (National eugenics); eugenics (including birth control (family planning), contraception, segregation, and dissolution of marriage)” in the 1961 edition. It changed again in the 1978 edition to “Racial hygiene; eugenics; family planning; birth control” and continues with this meaning up to the latest edition.

In the fourteen editions of *NDC*, there are only two classes for eugenics. Class 464 was the only authorized class for eugenics from the 1929 to the 1949 edition. In the 1950 edition, the class 464 becomes “Biochemistry,” and

MATCH		MISMATCH			
Match with a class for eugenics in the most current edition of <i>CCL</i> as of the data creation date	Match with an old class for eugenics	No match with any class for eugenics in all editions of <i>CCL</i>	Match rate	Mismatch rate	
74	1	147			
33.33%	0.45%	66.22%	33.78%	66.22%	

Table 5. Match between classes in the bibliographic records and classes for eugenics in all editions of *CCL*.

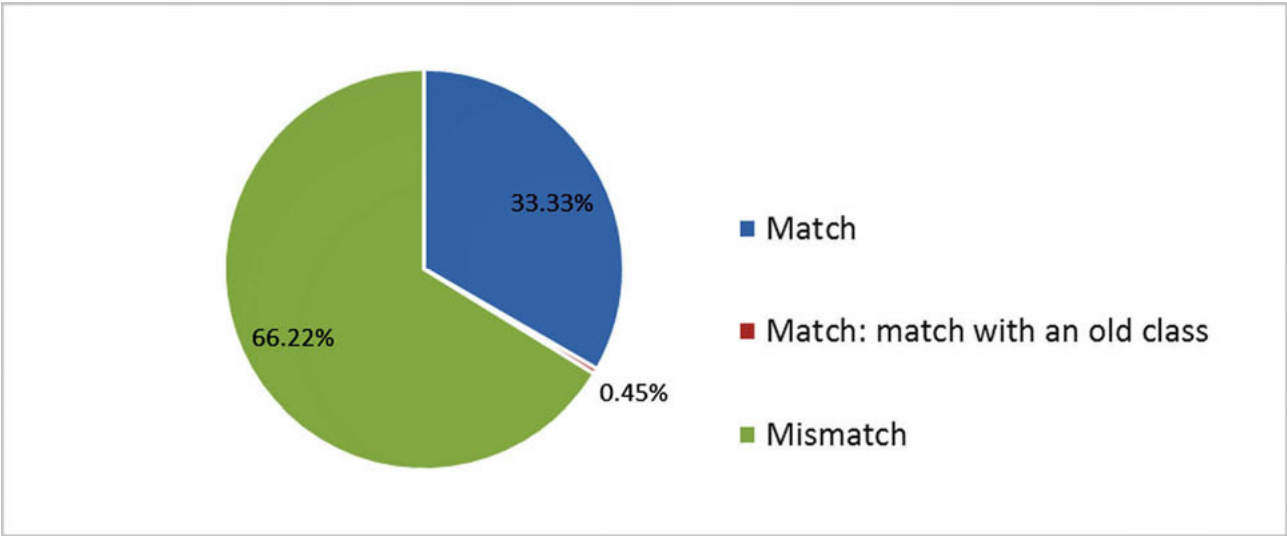


Figure 2. Match between classes in the bibliographic records and classes for eugenics in all editions of *CCL*.

	1929	1931	1935	1939	1942	1947 a	1947b	1949	1950	1951	1961	1978	1995	2014
464														
498.2														
464: 400. Natural science (1929-1949 eds.) 460. Biology (1929-1949 eds.) / Biology; Natural history (1935-1949 eds.) 464. Genetics; Eugenics (1929 eds.) / Eugenics (1931-1949 eds.)														
498.2: 400. Science (1950 ed.) / Natural science (1951-1978 eds.) / Natural sciences (1995-) 490. Medical science (1950 & 1951 eds.) / Medical sciences (1961-) 498. Hygienics (including Public health, Social medicine, and Preventive medicine) (1950 & 1951 eds.) / Hygienics (Public Health); Preventive medicine (1961 ed.) / Hygienics; Public health; Preventive medicine (1978-) 498.2. Eugenics; Sterilization (including Contraception (避孕), Segregation, Dissolution of marriage, and Sterilization) (1950 ed.) / Eugenics; Sterilization (including Birth control (産児制限), Contraception, Segregation, Dissolution of marriage, and Sterilization) (1951 ed.) / Racial hygiene (National eugenic); Eugenics (including Birth control (Family planning), Contraception, Segregation, and Dissolution of marriage) (1961 ed.) / Racial hygiene; Eugenics; Family planning; Birth control (1978-)														

Table 6. Classes for eugenics in the *NDC*.

“Eugenics” is shifted to 498.2. “Obstetrics and gynaecology,” which occupied that class in the 1949 edition, was displaced. 498.2 has been the only authorized class for eugenics since 1950. The ontogeny for eugenics in the *NDC* seems relatively stable. Nevertheless, when we look at the hierarchies of the two classes, we can identify scheme changes.

There are word-use changes in classes 400 and 490. Class 400 means “Science” in the 1950 edition. It became “Natural science” in the 1951, 1961, and 1978 editions and changed again in the 1995 edition to “Natural sciences” (including Mathematics, Science (理学), and Medical sciences). And while mathematics and medical science were always part of this class, it was not until 1995 that they be-

came part of the class name. The meaning of class 490 changed from “Medical science” in the 1950 and 1951 editions to “Medical sciences” in the 1961 edition. Since we do not identify structural change resulting from these name changes, we view the two cases as word-use changes. Another example is class 498. It means “Hygienics” (including public health, social medicine, and preventive medicine) in the 1950 and 1951 editions. The first change happened in the 1961 edition in which the meaning of class 498 changed to “Hygienics (public health); preventive medicine.” Both public health and preventive medicine were emphasized and added to the class name, but social medicine was removed. The second change happened in the 1978 edition. The class name changed to “hygienics; public health; preventive medicine” and continues to the latest edition. After identifying the changes, we examine the hierarchies of class 498 in the 1951, 1961, and 1978 editions (Table 7). While we expect the removal of “Social medi-

cine” in class 498 to be a textual change that limits the scope of the class, we do not see the influence in the sub-classes of 498 in the 1961 edition. In addition, adding “Public health” and “Preventive medicine” to the class name of 498 may emphasize the two topics, but it does not necessarily mean the topics are posted up. We can still match “Preventive medicine” with class 498.6 after it was added to the class name of 498. As a result, we categorize these changes as word-use change.

There are textual changes in class 460 and 469. Class 460 means “biology” in the 1929 and 1931 editions. It changed to “Biology; natural history” in the 1935 edition and continued to the 1949 edition. Unlike class 498, the sub-classes in 460 reflect the concept added to the class name (Table 8). Two concepts were added to class 465, and this caused a textual change. Class 466 had a new meaning in the 1935 edition, and the old meaning became one of the three concepts in the new 465 class. Class 467

1951 edition	1961 edition	1978 edition
498: Hygienics (including Public health, Social medicine, and Preventive medicine) 498.1: Health administration 498.2: Eugenics; Sterilization (including Birth control, Contraception, Segregation, Dissolution of marriage, and Sterilization) 498.3: Personal hygiene; Stamina; Fatigue; Staying healthy 498.4: Environmental health 498.5: Chemical hygiene 498.6: Epidemiology; Epidemic prevention 498.7: Child hygiene; Maternal-infant problem 498.8: Labor hygiene (Industrial hygiene) 498.9: Legal medicine	498: Hygienics (Public Health); Preventive medicine 498.1: Health administration 498.2: Racial hygiene (National eugenic); Eugenics (including Birth control (Family planning), Contraception, Segregation, and Dissolution of marriage) 498.3: Personal hygiene; Staying healthy 498.4: Environmental health 498.5: Chemical hygiene (Nutrition and Food) 498.6: Epidemic prevention (Infectious disease prevention); Epidemiology 498.7: Child hygiene 498.8: Industrial hygiene (Occupational hygiene) 498.9: Legal medicine (Forensic medicine)	498: Hygienics; Public health; Preventive medicine 498.1: Health administration; Welfare administration 498.2: Racial hygiene; Eugenics; Family planning; Birth control 498.3: Personal hygiene; Staying healthy 498.4: Environmental health 498.5: Food; Nutrition; Chemical hygiene 498.6: Epidemiology; Epidemic prevention (including epilepsy prevention, tuberculosis prevention, trachoma prevention, venereal disease problem, and helminths prevention) 498.7: Child hygiene; Hygiene of mother and child 498.8: Labor hygiene; Industrial hygiene 498.9: Legal medicine

Table 7. The hierarchies of class 498 in the 1951, 1961, and 1978 editions of the NDC.

1931 edition	1935 edition
460: Biology 461: Systematic and comparative biology 462: Life; Vital phenomenon; Living matter 463: Evolution theory 464: Eugenics 465: Bacteriology 466: Microscopy 467: Taxidermy; Collector's manuals 468: Anthropology; Ethnology 469: Archeology (including Prehistoric archaeology and Protohistoric archaeology. Historic archaeology is under the histories of specific countries)	460: Biology; Natural history 461: Systematic and comparative biology 462: Life; Vital phenomenon; Living matter 463: Evolution theory 464: Eugenics 465: Microscopy; Microbiology [Microbiology]; Bacteriology 466: Natural monuments 467: Herbals 468: Anthropology; Ethnology 469: Prehistoric archaeology

Table 8. The hierarchies of class 460 in the 1931 and 1935 editions of the NDC.

also changed. The old meaning was either removed, or shifted to other part of the scheme without noting. Class 469 is a case of textual change and specification. We can tell from the old meaning (archeology) that prehistoric archaeology was a sub-topic, but it replaced the more general term and became the class name of 469 in the 1935 edition. The name change of class 460 and the corresponding changes in its sub-classes show generalization. Thus, we expect to see document-set change in the history of this scheme change.

We also see textual change in class 464. In the 1929 edition, class 464 means “Genetics; eugenics,” but “Genetics” was removed in the 1931 edition, and the class has been “Eugenics” since then. We view this as specification and textual change including structural change, because the removal of “Genetics” eliminates this relationship between “Eugenics” and “Genetics” in the scheme. It narrows the scope of class 464, and as a consequence, we expect document-set change. One other example of textual change is class 498.2. It is a complex case that went through three changes (see Table 6). The first change happened in the 1951 edition in which the class changed its name from “Eugenics; sterilization” (including contraception, segregation, dissolution of marriage, and sterilization) to “Eugenics; sterilization” (including birth control, contraception, segregation, dissolution of marriage, and sterilization). Birth control was added to the topics listed. This is a textual change and generalization. The scope of the class broadened. The second change is in the 1961 edition. Comparing to the 1951 edition, two concepts, racial hygiene (national eugenics) and family planning, were added to the class name, which became “Racial hygiene (national eugenics); eugenics” (including birth control (family planning), contraception, segregation, and dissolution of marriage). In addition, “Sterilization” was shifted from 498.2 to the newly divided sub-class 498.25, named “Sterilization (the Race Eugenic Protection Law¹).” This change is a textual

change which involves adding and posting down concepts. The third change is in the 1978 edition. The class became “Racial hygiene; eugenics; family planning; birth control.” If we only focus on the class name, we see that some terms (e.g., “national eugenics,” “contraception,” “segregation” and “dissolution of marriage”) were removed, and “family planning” and “birth control” were posted up. We can then examine the hierarchy to compare our observations of the class name changes over time. In both the 1961 and the 1978 editions, there are two sub-classes of 498.2, which are 498.25 (“Sterilization (the Race Eugenic Protection Law)”) and 498.28 (“Management of citizens’ stamina”). The name change at 498.2 does not seem to influence the sub-classes (e.g., we see no additional name changes at the subclass level). In addition, the stability of the sub-classes tells us little about the removed concepts, because they do not seem to represent those concepts now removed. It remains unclear whether the concepts removed were excluded from the scope of 498.2, or whether they were still within the scope but not emphasized in the class name.

3.4 Classes for eugenics in the bibliographic records but not “sanctioned” by the *NDC*

Besides the two authorized classes for eugenics in the *NDC*, catalogers assign other class numbers to the bibliographic records with “Eugenics” as a subject heading. From the four hundred ninety records created using the 1950 and later editions of *NDC*, we can list the most frequently used unsanctioned classes. These are listed in Table 9.

490.15 is the most frequently assigned unsanctioned class, which appears in sixty-five records. We checked its meaning in the *NDC* editions. It is a sub-class under “Natural sciences” and “Medical sciences,” meaning “Medical sciences and ethics” in the 1961 and later editions. Also under “Medical sciences” is one other unsan-

Class	Occurrence	Meaning
490.15	65	400. Natural Sciences 490. Medical Sciences 490.15. Medical Sciences and Ethics (1961-)
495.6	25	400. Natural Science 490. Medical Sciences 495. Gynecology. Obstetrics 495.6. The Biology, Hygienics, and Pathology of Pregnancy (1978, 1995 eds.)
234.074	17	200. History (1961, 1978 eds.) / History [(History, Biography, Geography)] (1995 ed.) 230. Europe (1961 ed.) / General History of Europe (1978, 1995 eds.) 234. Germany and Central Europe (1961, 1978 eds.) / Germany; Central Europe (1995 ed.) 234.074. Hitler Nazi and the second World War (1933-45) (1961 ed.) / Nazi. Germany (the Third Reich). The Second World War 1933-45 (1978 ed.) / Nazi. Germany 1933-1945. The Second World War 1939-45 (1995 ed.)

Table 9. The most frequently assigned unsanctioned *NDC* classes for eugenics in the bibliographic records.

tioned class for eugenics. 495.6 is used in twenty-five records. It means “the biology, hygienics, and pathology of pregnancy” in the 1978 and 1995 editions. Class 234.074 is an unsanctioned class assigned in seventeen records. It is a sub-class of “History” and refers to “Hitler Nazi and the Second World War (1933-45)” in the 1961 edition. It changed to “Nazi; Germany (the Third Reich); the Second World War 1933-45” in the 1978 edition and changed again in the 1995 edition to “Nazi; Germany 1933-1945; the Second World War 1939-45.”

As mentioned in the *CCL* section, matching the authorized classes for eugenics with the classes in the bibliographic records can show us the degree of agreement between the theoretical structure of the scheme and catalogers’ perspectives. We present the matching result in Table 10. Among the four hundred ninety records with “Eugenics” as a subject heading, there are three hundred twenty

matches and one hundred seventy mismatches. The match rate is 65.31%, and the mismatch rate is 34.69%. There is no change in sanctioned classes, so there is no match for an old class in this data. Figure 3 shows the classes in the records as points and the authorized classes for eugenics as squares. The records in the population only use the 1950 to 1995 editions of the *NDC*, thus we see five squares in the figure. We can see when the classes match and what the unsanctioned classes are. The frequently assigned unsanctioned classes introduced above are also shown in the figure.

3.5 Comparison across the *DDC*, the *CCL* and the *NDC*

We have looked at the classes for eugenics in the *CCL* and the *NDC* and the classes assigned to materials about

<i>NDC</i> Edition	Number of Records	Number of Match between <i>NDC</i> and Records	Number of Mismatch between <i>NDC</i> and Records	Match rate	Mismatch rate
1950	21	14	7		
1951	8	6	2		
1961	18	12	6		
1978	200	132	68		
1995	243	156	87		
Total	490	320	170	65.31%	34.69%

Table 10. Match between classes in the bibliographic records and classes for eugenics in the *NDC*.

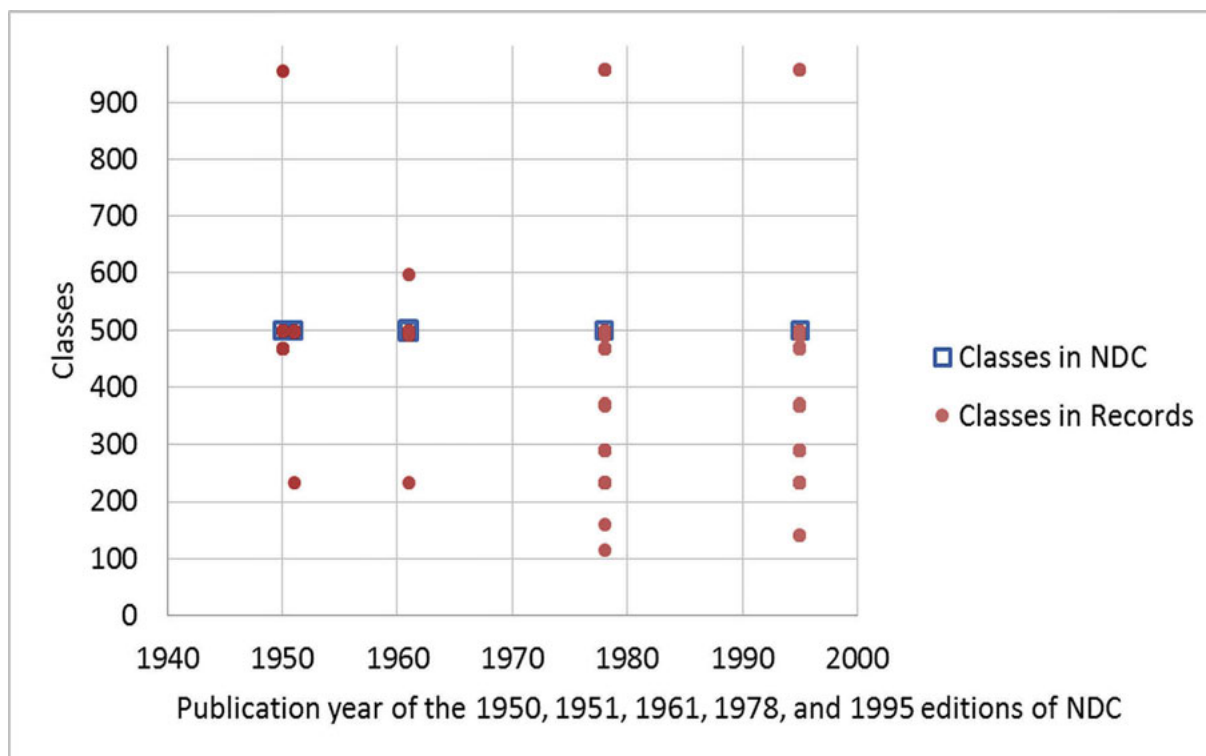


Figure 3. Classes for eugenics in the 1950, 1951, 1961, 1978, and 1995 editions of the *NDC* and classes in bibliographic records with eugenics as a subject heading.

eugenics in the bibliographic records. Based on the findings and previous research on the ontogeny of eugenics in the *DDC* (Tennis 2002; 2012; Tennis et al. 2012), we can compare across the *DDC*, the *CCL* and the *NDC*. The following section compares the number of authorized classes for eugenics and the scheme changes in the three schemes. We then look into the meanings of the authorized classes and unsanctioned classes in the three schemes to explore possible silences (Bowker and Star 1999).

The authorized classes for eugenics represent those places in the scheme for materials about eugenics as recommended by the editors. If literary warrant is faithfully represented in the scheme, each material should match with an authorized class. The more classes for eugenics in any given edition of the scheme, the more authorized options a cataloger has. In Figure 4, we can see the number of authorized classes in each scheme and in each edition. The *DDC* has a range of one to eleven classes across its editions. The *CCL* always has two to three classes, and the *NDC* consistently has only one class at a time. Given this data, it is possible for us to ask whether schemes with more classes for eugenics have higher match rate with the classes in the bibliographic records. In other words, would catalogers have higher degree of agreement with schemes which have more authorized classes for a subject? Based on our data and previous study, it does not

seem to be the case. As shown in Tables 10 and 5, the match rate between the classes in the schemes and the classes in the records is 65.31% in the *NDC* and 33.78% in the *CCL*. According to Tennis (2013), the match rate is 28% in the *DDC*. However, the *DDC* has the most classes for eugenics, and the *NDC* has the fewest. The result suggests that factors other than the number of authorized classes influence the match rate. When catalogers assign unsanctioned classes, many factors may affect a cataloger's judgment. Some possible factors are classes in other records on a similar topic, local cataloging practices, and the old classes that collocate existing collections. The data in this study cannot determine which factors are at play, but this comparison of different classification schemes generates new research questions.

The comparisons above shed light on potential silences in the schemes. Following the method of Bowker and Star (1999), we can look for what is present and what is absent in a comparison across schemes. Since the three schemes deal with the same subject over time, we can look into the meanings of the authorized classes, and examine whether there are viewpoints present in one scheme but not present in the other scheme(s). As shown in Figure 4, the *DDC* has more authorized classes than the *CCL* and the *NDC*. They are sub-classes of "Philosophy/philosophy and psychology," "Social sciences," "Sci-

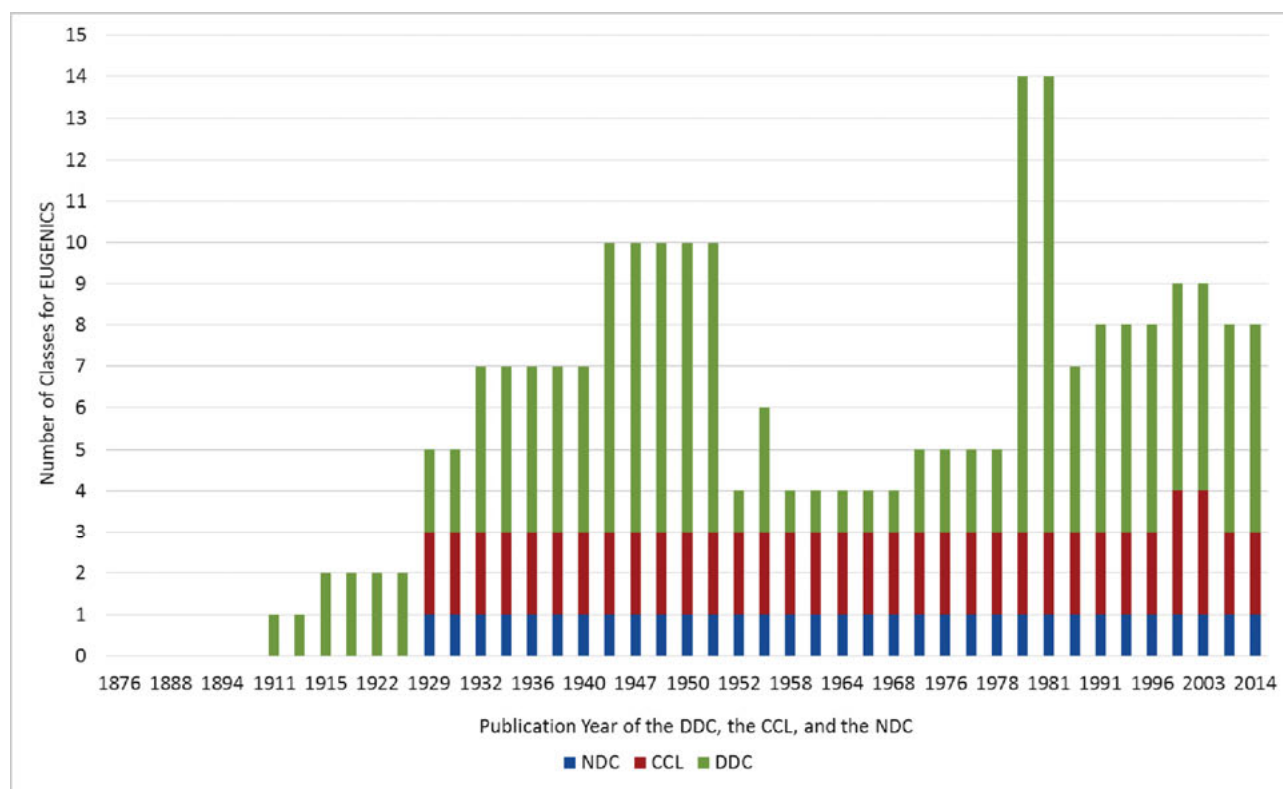


Figure 4. Number of classes for eugenics in all editions of the *DDC*, the *CCL* and the *NDC*.

ences,” and “Useful arts/technology” (Tennis 2012). We wonder whether the *CCL* and the *NDC* also present the four aspects of eugenics. In other words, are the classes in the two schemes sufficient for classifying materials about eugenics? In the *CCL*, the authorized classes are sub-classes of “Natural sciences/sciences—biology;” “Natural history/life science/biological science,” “Applied sciences—medical sciences” and “Social sciences—sociology.” The authorized classes in the *NDC* are both under “Natural science(s)/science.” One is a sub-class of “Biology/biology;” “Natural history;” and the other is a sub-class of “Medical science(s).” Upon comparison, we identify that all of the three schemes present eugenics in the sciences/natural sciences and the social sciences. However, eugenics in philosophy/philosophy and psychology and useful arts/technology are potentially rendered silent in both the *CCL* and the *NDC*. We can interrogate those silences by looking at catalogers’ decision-making in the context of *CCL* and *NDC*. Did the catalogers using the *CCL* and the *NDC* assign unsanctioned classes to surface the silences in the schemes? The frequently used unsanctioned *CCL* classes are under “Applied sciences—domestic arts;” “home economics” and “Applied sciences—medical sciences” (Table 3). The popular unsanctioned *NDC* classes are sub-classes of “Natural science(s)—medical sciences” and “History—Europe/general history of Europe” (Table 9). We see emphasis of eugenics in the medical sciences in both cataloging practices. The notion of the relationship between eugenics and history in the *NDC* stands out as unique. However, the silences remain. Considering it is unlikely that the subjects of the document sets cataloged using the three schemes differ drastically, there seem to be other factors contributing to the silences.

3.6 Limitations

Some limitations surface during the data collection of this study. The union catalogs (NBINet and the NDL Search) are helpful in searching across multiple libraries, and narrowing down the list of libraries that have records of materials about eugenics. However, for the purpose of a union catalog, the systems only show one record for one bibliographic manifestation, and list libraries that own the material, and the class number assigned by each library. Without detailed records from the listed libraries, we have to use the OPAC of each listed library to retrieve the information we need for analysis. For instance, we have to retrieve records from individual libraries to make sure that eugenics is a subject heading, because catalogers may not assign the same heading to the same material. Libraries that own a resource about eugenics, but do not assign eugenics as a subject heading, may still be listed in the un-

ion catalog. When examining the records, we encounter another challenge. Some libraries do not share MARC records with the public, and some libraries only present brief records that do not have all the information we need. For instance, some records do not have subject headings, and some *CCL* records do not have record creation years. None of the NBINet records provide the *CCL* edition information in the bibliographic record, so we use record creation date to infer the edition used. We based the chronology of record creation on the assumption that the catalogers use the most current edition available at the time. We also notice that some *NDC* records do not specify the edition used, and some translation works have *DDC*, Library of Congress *Classification*, and/or *NDLC* numbers² but do not have *NDC* numbers. These records are excluded from the dataset and analysis. A common challenge in both union catalogs is the lack of access to older records. According to the data collected, the oldest *NDC* edition used was the 1950 edition. The oldest book in the *CCL* data was published in 1985, and the record was created in the same year. The availability of information in the records directly affect the number of records we collect and analyze.

Another challenge surfaces when we examine scheme changes. There is little, if any, information about subject ontogeny in the schemes. We see very few notes that explain a change, or link, between the old and the new classes of a subject. In most cases, we have no way of knowing the reasons for change. For instance, in both the *CCL* and the *NDC*, we see cases of confusing word-use change. Selective topics from the sub-classes are added to a class name. While we may assume these changes of class names indicate the posting-up of concepts, it was not the case. We find in both schemes that despite the naming of the classes, the hierarchies do not change accordingly. Cases like this highlight the lack of scheme change information in the schemes. It adds to the complexity of identifying the categories of scheme change, which are already complicated, because they are not mutually exclusive (e.g., we can have textual changes that have word-use changes as well). The information we can retrieve from the catalogs and the limited scheme change information present in the schemes introduce some challenges to this study and influence the questions we can answer.

4.0 Conclusion

In this exploratory study, we have looked at the subject ontogeny of eugenics in the *DDC*, the *CCL* and the *NDC*, and identified different categories of scheme change. The exploration and comparison of the three schemes generate questions for further research. First, future research can further interrogate the relationship between the total num-

ber of authorized classes in schemes and the cataloger match rate. Can we consistently observe a relationship between number of classes and degree of mismatch? Future research can explore why having more authorized classes for a subject may not necessarily lead to higher degree of agreement between the schemes and catalogers. We can also ask why and how do catalogers assign unsanctioned classes and perhaps begin to link our observations with studies of cataloger behavior (Šauperl and Saye 1998).

Second, the three schemes in this study are well established and used in divergent and different cultural regions. From previous research, we know there is a mutually engendering and reinforcing relationship between culture and classification schemes (Lee 2015). Future work can look into how and where culture influences subject ontogeny and its representation in classification schemes. The cultural history of eugenics as a subject has not been addressed here. In addition, as we observed some potential silences in these classification schemes when they were compared, we must further question the source or rationale for those silences, including historical and cultural contexts and test or expand on the assertions outlined by Bowker and Star on this phenomenon (Bowker and Star 1999).

Given these new questions and this comparative context, we can affirm some of the assertions made in the extant work on ontogeny. Based on the cases of three schemes, the findings of this study affirm the categories and mechanisms of scheme change in previous research (Tennis 2007; Cupar 2015). More counter examples can help us refine our understanding of change and consistency in classification.

Notes

1. The National Eugenics Law (国民優生法) was promulgated in 1940 and replaced by the Eugenic Protection Law (優生保護法) in 1948. In 1996, the Eugenic Protection Law went through the 12th revision and changed its name to Mother's Body Protection Law (母体保護法) (NDL 2016b).
2. NDLC numbers are the class numbers of the *National Diet Library Classification* (NDLC), a classification scheme developed and maintained by the National Diet Library (NDL 2016c).

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