



Academic Path to a Genetic Genealogy Curriculum

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Abstract: *This work offers an academic path for studying genetic genealogy, complete with designed teaching modules. It is intended to assist a large and diverse segment of beginning and advanced learners in the field of genetic genealogy. Its specific goal is to provide an academic foundation for professionally acquiring the different types of DNA tests and assessing the impact of genetic genealogy on complex genealogy and its intersection with population genetics, human genomics, the evolution of human civilization, etc.*

1. SETTING

The purpose of this work is to offer an academic path for studying genetic genealogy, complete with designed teaching modules. It is intended to assist a large and diverse segment of beginning and advanced learners in the field of genetic genealogy. Its specific goal is to provide an academic foundation for professionally acquiring the different types of DNA tests and assessing the impact of genetic genealogy on complex genealogy and its intersection with population genetics, human genomics, the evolution of human civilization, etc.

The need for research is embedded in the emerging character of genetic genealogy thanks to the proliferation of well-funded genomic studies; the absence of a complete, published curriculum; and a broad tradition in the publication of genetic genealogy topics. Currently, numerous publications on population genetics are spread about in different published sources and in many cases without intersecting with other fields despite the similarity of topics. The academic course, in contrast, has the benefit of synthesizing the findings and offering critical theoretical models.

The research questions in this work reflect the willingness of the academic curriculum to serve a wide audience and to provide the most effective knowledge on genetic genealogy. The main research question is: What would be an effective approach for teaching genetic genealogy and what would such a curriculum look like? Sub-questions had to clarify the nature of which cutting-edge methodology should be used, the impact of learner-centered education on the curriculum, and the core content of the modules included in the proposed example of the academic course.

Constructivism grounded theory is chosen as the general methodology of the research since constructivism is the leading theoretical approach to studying how people teach and learn, while the grounded theory embeds the scientific method in the analyses of the data. As qualitative research, the study integrated the empirical evidence with the phenomenological approach to the problems of genetic genealogy to assist effective active learning with its two aspects: Learner-centered Instruction and Student Engagement.

This is a consecutive publication following the literature review (Nikolova, 2018a), problems of genetic genealogy (Nikolova, 2018b), cultural genomics and dynamics of changing cultural identity (Nikolova, 2018c) and the problems of origin in genetic genealogy (Nikolova, 2018d).

2. SIGNIFICANCE OF DNA TESTING FOR THE RESEARCH QUESTION AND CONNECTIVITY BETWEEN FINDINGS

DNA testing includes diverse, worldwide mapping of the genetically studied population, painting in some cases dramatic pictures of the limitation of the DNA labs to communicate the genetic data obtained in the individualized reports. Examining different companies' performances with the samples of the same participant allows us to compare the results and picture the limitation and

delimitation of the DNA results for genetic genealogy. The second method is examining the same company with the samples of different participants, including some with the same origin, to verify whether some of the conclusions of the DNA labs need serious improvement, thereby creating the theoretical base of the critical approach to genetic genealogy sources in the curriculum. In both cases, the matches based either on the same haplo group or on the number of shared centi Morgans are most relevant. For the time being, ethnical origin is at a very basic level of analysis by the DNA labs and in some cases refers to models that cannot be correlated with the individual family history.

It is very important for the research to integrate the different types of research, which complemented each other and allowed the researcher to follow the grounded theory. The narrative of the participants in the DNA tests, compiled through open-ended interviews, can be compared with the DNA test results and the information from the interviews can be used to critically analyze these results. Similarly, the answers from the open-ended interviews about the way the respondent learned about genetic genealogy assist in developing the curriculum modules of the course on genetic genealogy.

The research findings from the DNA testing improve the constructivism grounded theory in genetic genealogy, since they show that the DNA labs depart from this theory in some cases. They also created the platform for a critical approach to the DNA testing. The term “cousin,” which is popular in genetic genealogy, is misleading because the terminology of “cousin 1 or more times removed” is not popular among the wider audience. The term “genetic cousin” is proposed instead, with the term “genetic match” being embedded in genetic genealogy.

Ethnicity, the most critical part of the current most popular DNA labs models, is a research problem at two levels: 1) Absence of understanding of the chronological depth of the genetic origin (and existing layers), and 2) lack of willingness by the companies to individualize the results in mapping the “origin” and substituting the individual origin with model-maps, which either do not represent the origin correctly or include very broad areas of “origin”—broad, at least, according to the capabilities of DNA.

2.1. Outcomes Reached by Analysis and Synthesis of the Findings

The research on genetic genealogy for curriculum (Nikolova, 2018a-d) commonly supports genetic genealogy as a subfield of complex genealogy. The outcomes are multifaceted.

First, the research outcomes articulate problems that are relevant for genetic genealogy as DNA testing is hierarchically integrated with many other fields of knowledge. DNA testing is one step in genealogy research that may trace a line of research or may complement, support, or redirect other step(s) of genealogical research. It is never an independent form of research, even in the case of resolving health problems.

The second outcome is enriching the framework of the critical approach to DNA test results. By comparing the results of the same participant’s sample tested by different companies as well as the results of several participants tested by the same company (Nikolova, 2018d) the research revealed the strength of genetic research at the following levels: 1) high-value autosomal DNA matches, 2) matches within the same haplogroup, 3) matches that connect people with public genealogical trees and open new aspects of research based on indirect/collateral data, and 4) general insight into origin. At the same time, the research demonstrated that the ethnical aspects of DNA research are at a beginning level, often deemed ambiguous or even misleading when not following the methodology of the grounded theory. This creates distrust in the DNA testing results.

The third outcome is the opportunity to create a framework for open education. The modules provide examples and case studies that need to be updated regularly because of the changing character of DNA lab results. They also can be enriched with other case studies as a result of research conducted by instructors or students. In other words, the research results create a template for case studies and have strong methodological and theoretical value.

The fourth outcome is the opportunity for the curriculum to build a solid methodology of active learning by involving the students as researchers. This is particularly important since the emphasis is on “how to do” instead of only “what to do” to obtain the professional knowledge needed to develop expertise in genetic genealogy.

The fifth outcome is addressing students of different ages and with different preliminary experience.

The well-articulated methodology of the case studies and the chosen method of analysis based on the grounded theory makes the curriculum a subject of interest for beginners as well as those who are more advanced in the genetic genealogy realm. Beginners can learn the fundamentals of genetic genealogy while more advanced students can fill their own gaps in knowledge and enrich the curriculum with new case studies and new problems.

The sixth outcome is the developing theory of integrating genealogy, archaeology, and genetics for the study of origin. Cultural genomics was defined as a complex discipline for studying origin, and the theoretical, methodological, and empirical integration of genealogy, archaeology, and genetics creates future avenues for the modeling of origin that will be more precise, not misleading, and truly descriptive of the individual origin of those searching for genetic origin (Nikolova, 2018c).

The seventh outcome is use of the curriculum to professionally introduce genetic genealogy students to the fundamentals of traditional genealogy and archaeology, both fields that intersect with genetic genealogy problems. Both traditional genealogy and archaeology create solid and trustful diachronic paths to personal ancestry while the DNA test is a flattened cognitive map that requires very detailed interpretation and depends upon the subjective view. In other words, it depends exclusively on the expertise of those involved in analyzing the genetic data. The current stage questions the level of expertise related to origin of both the computer programs and the specialists and creates distrust, which concerns the ethical platform of genetic genealogy research. This is especially well demonstrated in the substitution of an individual map of origin with types of maps that, in some cases, are obviously lacking updated new data related to the individual test (Nikolova, 2018d).

The eighth outcome is the opportunity for the curriculum to be used for university-level courses, for open mass education, and in social media as a webinar, for instance. This broad character is due to the fact that the high level of research results with an embedded methodology of constructivism grounded theory competes with the most advanced university curricula, while the comprehensive approach to the main problems in genetic genealogy are of interest to a much broader segment of students in society.

Last but not least, the research also inferred the need to use more precise professional terminology and to develop the methodology of origin. It offered new terms for defining genetic similarity and a new way of describing the utilized method of defining ethnicity (Nikolova, 2018d).

2.2. Plausible Explanations for Inconsistencies or Contradictions between the Study's Results and Prior Research

The explanation for the inconsistency of the reported DNA results from the top DNA labs, which was revealed in the course of this study (Nikolova, 2018d), is in the unwillingness of the companies to embrace the grounded theory and the apparent unwillingness of the companies to connect with responsible researchers. The anonymity of the reported results creates a scientific and ethical gap—it is not a specialist but the company that is responsible for the product. The shadow looks less dark and the damage to science looks less remarkable. In the case of *Ancestry.com*, the enormous difference between the current status of the company as the top world archive of family history—without analogy in the world's historical and documentary records—and the nonconformity with the grounded theory in reporting ethnicity is remarkable and even shocking.

2.3. Example of Framework of the Syllabus Modules

The research design of the curriculum allows a teacher to develop a syllabus with eight modules that incorporate the learning content along with the adopted theoretical, methodological, and technological components of the curriculum. It is important to stress that the syllabus has only an exemplary function of application of the curriculum. Depending on the students' background and the immediate goals of the course, the syllabus can be developed and the content can be redesigned to best meet the needs of the students.

Module 1: State of Research

Current state of research and problems

Module 2: What is Genetic Genealogy?

Short history with focus on advancements

Subject of genetic genealogy
Methods of genetic genealogy—e.g. visual phasing
Genetic genealogy and genetics
Genetic genealogy and other social disciplines

Module 3: Genetic Genealogy and Direct Ancestors

Which genetic data are important for a family tree?
How do the genetic data interact with the data from traditional genealogy?
Paternal ancestry—Y-chromosome DNA tests
Maternal ancestry—mtDNA tests
Genetic matches, genetic identity, and origin—autosomal DNA tests

Module 4: Genetic Matches (Genetic “Cousins”)

Methods of identifying genetic “cousins”/genetic matches
Classification of genetic “cousins”/genetic matches
The meaning of genetic “cousins”/genetic matches
Peculiarities of genetic “cousins”/genetic matches

Module 5: Genetic Genealogy and Genetic Origin

Genetic data about origin
Differences between labs and research centers that identify origins
How do haplogroups relate to origin?
Coalescent theory
Genetic networks and origin

Module 6: Genetic Genealogy and Population Genetics

What is the subject of population genetics?
Global tendencies in population genetics research

Prehistoric migrations and genetics

How do the fields of genetic genealogy and population genetics interact?

Module 7: Genetic Genealogy and Health

Methods of interpreting the genetic data from the perspective of health
Success in genetic health research
The interrelation between genetic genealogy and health

Module 8: Conclusion

Genetic genealogy as an emerging complex discipline
Limitation and delimitation of genetic genealogy
The future of genetic genealogy

The modules are structured to implement two textbooks—the monograph of B. Bettinger (2016) and of L. Nikolova (2018d), along with the published open-access special research by Nikolova (2018, a, b, d). It also refers to the websites of the main DNA labs for genealogy – ancestry.com (Ancestry, 2018), 23&Me (2018) and Family Tree DNA (2018). In the near future the full text of Nikolova’s dissertation “Development of Curriculum for Genetic Genealogy” (Argosy University) will be available for further references, which includes comprehensive literature on the modules’ topics.

3. IMPLICATIONS FOR PRACTICE

3.1. Academic Curriculum

The main implications of the curriculum can be seen in university academic programs, open mass communication classes, webinars, seminars, and channels for online experts.

The study is based on literature review on the problem of genetic genealogy, which critically revealed problems and comprehensively gathered publications from diverse sources (Nikolova, 2018a). Although the research on human population genetics and ancient origin will need regular updates, the framework is sustainable and assists both beginning and advanced students in genetic genealogy.

The innovative nature of the research design and collection of data allows for implementation in student courses for beginners as well as those for more advanced students and professionals (Nikolova, 2018b).

The results of the collected data, along with the chosen methodology that relies on the constructivism grounded theory, not only provides content for study but serves as a template for further research based on new samples or on the updated information from the DNA labs of the samples used (Nikolova, 2018c).

Last but not least, the example of this course can be directly implemented in an academic curriculum or used in other courses that include genetic genealogy.

3.2. Secondary and Higher Education

The curriculum, used in conjunction with the PowerPoint presentation of the modules (unpublished) and the recommended textbooks, would be a great introduction to genetic genealogy in high school programs as part of elective anthropology classes, for instance. Since genealogy is not a subject in most high schools, the same implication refers to university courses within the general course requirements, or in bachelor's or master's programs in anthropology and genetics. The academic approach to the problems from the perspective of the grounded theory makes the curriculum a successful course within genomic specialization, as well, or in the programs related to cultural genomics.

3.3. Mass Open Online Course

The curriculum for the example course can be adapted for a mass open online course for a wide audience because of the comprehensive textbooks that accompany the course. The students will gain systematic knowledge that will help them understand their own DNA test results.

3.4. Webinars and Professional Practical Courses and Lectures

The webinar course or other types of lectures for professional genealogists or researchers of their own genealogy may incorporate the core of any of the modules as a one-hour lecture. The professional practical courses would focus on case studies to explore the revealed limitations and delimitations of DNA testing and to expand research into more well-developed problems.

3.5. DNA Labs

The DNA labs will find the literature review and the interpretation of the collected data (Nikolova, 2018a, 2018c) particularly beneficial, as well as any recommendations directed toward them in this study. All researchers and students depend on the DNA labs, but the labs need to move away from anonymous reports and continue to develop a strong process of employing the scientific method based on grounded theory. Using numeric data itself is not following the grounded theory. The numeric data on DNA come from genomic segments, which have variations. The phylogenetic tree also is not static. Using terms like “genetic cousins” as applied to uncles and aunts with the phrase “x times removed” is due to the limitation of the genetic results, but a change in terminology from “genetic cousins” to “genetic matches” is a base for scientific communication of important information to people who pay to learn the truth about their ancestors. Most people who order DNA tests believe that when they get results, they will learn more—sometimes considerably more—about their genealogy, and this is why they pay for the testing. They can be referred to scientific articles about mapping of ethnicity. However, being promised that they will learn about their own origin and receiving, for instance, a map of almost the entirety of Eastern Europe with Russia as a place of origin is more than disappointing since it does not represent the full picture of what genetic data can provide today to an individual searching for his or

her own ethnical origin.

Also, the flattened (non-chronologically determined) character of genetic data requires highly professional reports by real experts who are able to create a chronology of origin based on the personal data of the individual, not based on general collected data misrepresented as the data of the client.

One important recommendation to DNA labs that has come from this research is to increase sponsored tests from regions that are underrepresented and to report to the clients the current state of their database. Existing blind spots of research completely deformed the ethnical picture of many nationalities, including Bulgarians, as the research had showed (Nikolova, 2018d)

3.6. Professional genealogical research

The implication of the study for professional genealogical research is multidirectional. Specialists in genetic genealogy are able to find a methodology for interpreting the DNA test results for genealogy based on the grounded theory. They can enrich their methodology in their own research.

Traditional genealogists can use the study to gain academic knowledge and to begin to work with their own DNA data to complement their already-built pedigree results. The study shows genetic genealogy as a problem and, because of the comprehensive literature review (Nikolova, 2018a), it allows professional genealogists to gain knowledge that considerably increases their expertise.

3.7. Social Media and Webinars

The curriculum also can serve to develop a course as a single lecture on a youtube.com channel or public Facebook group, as well as Webinars. The youtube.com channel may include a live session with questions and responses or demonstration of new case studies.

4. THE INTERRELATION BETWEEN THE CASE STUDIES AND CURRICULUM

The analysis of the purposefully collected data from DNA tests enriched the curriculum with its own database and the author with her own research experience (Nikolova, 2018d). The interviews assisted in both creating a framework of the curriculum and in interpreting the genetic data obtained.

4.1. Theoretical and Methodological Parameters

The systematic analysis of the data allowed us to advance the theory of genetic genealogy by developing the terminology's progress toward more correct and precise terms. It was proposed that, instead of "ethnicity," the term "genetic identity" should be used and instead of "cousin," "genetic matches" is preferred (Nikolova, 2018d).

Comparing results for a single participant whose DNA was tested by different companies infers that the "ethnicity"/origin conclusions are very loose in terms of the grounded theories. The difference in the results is due to the diversity of the genetic data and the absence of a developed methodology implementing a diachronic articulated view. Instead, a deep diachronic view is used, whereby the participants receive a flattened view. For this reason, the difference may simply indicate different chronological spans of the analyzed data. Most critical are the "ethnical maps" titled "Story for _____" (with the name of the client inserted in the blank). The maps, which do not include the genealogical data of the participant, are either incomplete or, in some cases, completely misleading (Nikolova, 2018d).

4.2. Learning and Acquisition Parameters

The research results have extremely valuable learning and acquisition parameters because they shape the main body of case studies and examples in the modules of the curriculum. Among the learning benefits is a well revealed limitation of the genetic approach, the peculiarities of the differences between the genetic testing companies, and the ability of the students, through strong case studies, to understand the genetic results and the similarities and differences between autosomal DNA, mt-DNA, and y-DNA.

4.3. Scientific Perspectives

The scientific value of the research results is a contribution to both the theory and methodology of cultural genomic studies, in particular genetic genealogy, and to the interpretation of the genetic data from the perspective of genetic genealogy. The critical comparative analysis of the DNA sample

results for genealogy revealed pros and cons in the way the data were delivered to the clients and in the way the data were interpreted.

Most valuable are the data regarding shared cMs in the autosomal DNA tests. However, the use of the term “cousin” is vague and misleading since it includes not only cousins but aunts, uncles, and more distant indirect relatives. The term “cousin” was replaced in the curriculum by “genetic match,” specified as close (CGM) or distant (DGM).

It was also revealed that “Story for ___” is misleading and needs to be replaced by “Reference to the Story for ___” by including reference data updated for every client with the individual data from the test and from the matches. The way it is presented now is not only misleading, but it also breeds disappointment and distrust in the genetic data since everybody wants to know about his or her own cultural identity from the perspectives of the grounded theory, not pseudo-grounded theory.

4.4. Cultural Perspectives

The cultural perspectives of the results are enormous. The research shows the borderless opportunities of genetic genealogy to enrich one’s individual cultural identity as a present network of relatives and by discovering many new relatives, as well as representing a problem of origin. The genetic data and genealogical data interact to paint a much more detailed and articulated picture of an individual’s past as it is embedded in the thousands of years of human history.

4.5. Sociological and Anthropological Perspectives

Sociology studies people through social structures while anthropology studies society through group and individual cultural and social identity.

Genetic genealogy covers mostly modern and contemporary society from a historical perspective, but ancient DNA also creates unique opportunities to build models of ancient society through the genetic connections revealed between ancient populations. The research results of mt-DNA, with numerous analogies in the British Islands (*FamilyTreeDNA* results), may have traced even very ancient movement from the Balkans to the British Islands and North/Northwest Europe, which archaeologically are typically connected with Neolithization.

However, the dynamics of female haplogroup T is very complex, meaning the similarity in the distribution may reflect more complex processes, the research of which is complicated by the absence of a satisfactory number of samples from all parts of Eurasia. Most curiously, *Ancestry.com* deleted this part of “The story for ___” section and replaced it with much more ambiguous statements about eastern Europe with a map spread over all of Eurasia.

The research results from case studies also show (Nikolova, 2018d) that genetic genealogy gathers a huge database for anthropological research of kinship and society, migrations, mutations and health, etc.

4.6. Social Perspectives

The research results (Nikolova, 2018d) include very impressive examples of how genetic genealogy connects unknown relatives by discovering close genetic matches. Despite the misleading “cousin” terminology, it also confirms the kinship relationships of nephews/nieces and uncles/aunts through very impressive examples.

Genetic genealogy may also confirm the dual origin of the test participant’s parents, coming from distant places or located in the same place.

4.7. Global perspectives

Genetic genealogy is a global science from the point of view of origins. Genetic genealogy increases the database for study of migrations and for discovering ancestors in distant homelands. The genetic data also include ancient strata that are important for researching origin, but only in cases when the researchers follow the grounded theory.

5. RECOMMENDATIONS

5.1. Further Research

The curriculum provides a sustainable foundation for the study of genetic genealogy. Further research

can focus on in-depth articulation of the detailed peculiarities of the different types of tests, collecting a compendium of new case studies that critically follows the updates of the different DNA labs. It is especially interesting to conduct in-depth research on how the genetic network software (e.g. Nodexl, Gephi, and Rootsfinder) complement the search for close and distant ancestors.

5.2. DNA Labs

The main recommendation to the DNA labs is to advance their methodology in presenting and interpreting DNA test results following the grounded theory methodology and strictly answering the inquiries of the testers. Because genetic genealogy is based on personal inquiry, substituting the personal inquiry with type-like research and personal mapping with types of mapping that may not even include the personal data of the testers is a problem with scientific, ethical, and cognitive consequences. It breaks down the trust in genetic research and devolves the science.

It is very important that a responsible expert from each lab sign the response to every personal inquiry. Personal responsibility has to dominate in the reports and not hide behind the names of the popular companies.

The DNA labs also need to provide scientific reports for their methodology and publish them in top peer-reviewed scientific journals in order to foster wide scientific debate.

One significant improvement that would increase the quality of DNA lab reports is the mapping of the existing database and the development of the methodology of variative interpretations by offering more than one interpretation based on what exists and what does not exist in the database.

5.3. Secondary and Higher Education

Institutions of both secondary and higher education need to incorporate genealogy—genetic genealogy, in particular—into their curricula as soon as possible. Genealogy is a strong cultural identity construct (Nikolova, 2018c) and an important component of national identity. It also develops analytical thinking. The increased online database, including the world's largest digital archives at *Ancestry.com*, makes genealogy a priority subject within general course requirements (independently or as a branch of anthropology) or as a specialization.

The recommendation to both academic leaders and students is to interact and facilitate expansion of academic programs through the incorporation of genealogy, and genetic genealogy, in particular.

5.4. Mass Open Online Course

The curriculum would attract numerous audiences within the mass open online course system because of the popularity of genealogical research among those interested in their own family history. A course on genetic genealogy would also attract professionals from other fields of research who would search for collateral methodologies or comparative curricula in the social sciences.

In this case, the recommendation is to the author to submit the curriculum, with adapted course material, to the various open course platforms, asking the managers of these platforms to research the curricula and draw conclusions that would favor acceptance of the course in its current form or after updates.

5.5. Webinars and Professional Practical Courses and Lectures

Webinars are typically organized by associated organizations. The leaders of these organizations may prefer more traditional topics, but because the curriculum has many practical learning values, they can offer it as a webinar according to their specific needs. The recommendation to the presenters of single lectures or instructors of professional practical courses is to study the curriculum and extract for their content those parts that correspond to their own curricula. Some lecturers may prefer to use the whole curriculum by enriching it with their own examples.

5.6. Social Media

The recommendation to social media leaders is to increase the academic value of online genealogy offerings and use the curriculum both for development of theoretical knowledge and for practical courses.

6. CONCLUSION

This work approaches genetic genealogy as an emerging complex discipline for the study of origin

and kinship and offers an academic path based on the grounded theory. Primary sources (interviews, DNAtests of participants, various forms of feedback) are the first concern for the development of the curriculum (Nikolova, 2018a-c), in conjunction with secondary sources (case studies from literature, GEDmatches, and interpretive studies) (Bettinger, 2016; Nikolova, 2018c) and software in order for a diverse learning community to obtain an innovative and comprehensive foundation of knowledge on genetic genealogy. The framework of the syllabus modules comprehensively embraces the main problems of genetic genealogy and allows educators to adopt, modify, transform, and execute the class for beginners and advanced students alike.

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