

CHOOSING THE BEST COURSE: CULTURAL AND SOCIAL INFLUENCES ON
THE FEMALE MATHEMATICS GRADUATE STUDENTS AT
THE UNIVERSITY OF KANSAS IN THE 1890s

AN INTERPRETIVE PLAN IN
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ABSTRACT

The interpretive plan for the exhibit, “Choosing the Best Course: Cultural and Social Influences on Female Mathematics Graduate Students at the University of Kansas in the 1890s” covers women’s education and women in STEM fields in the nineteenth century. While many historians focus on exceptional women scholars who never married, this exhibit discusses a few women who got advanced degrees and then married. This exhibit explores the social and cultural influences of gender on women in academia by examining the experiences of Annie MacKinnon, Bessie Growe and Mary Rice, who studied at the University of Kansas in the 1890s. They were exceptional students in an era with limited life choices for women. This exhibit concludes that these women’s lives exemplify issues facing women in academia in the nineteenth century. Their stories demonstrate that in academia, scholarly research, and professional choices, women faced bias because of their gender. This bias was mainly based on society’s ideal of women and womanhood. This ideal focused on women being dependent on men and having children. Social ideas gave women fewer life choices and made it impossible for them to be truly

independent. This played a role in what they studied in terms of field of study and degree level. This exhibit's 12 panels use materials from the University of Kansas and other institutions to discuss nineteenth century women's education through the stories of Annie MacKinnon, Bessie Growe and Mary Rice's successes and struggles.

Literature Review

This exhibit is about women in higher science education in the late nineteenth century and focuses on three women who were enrolled in the graduate mathematics program at the University of Kansas (KU) in the 1890s. An examination of the experiences of Annie MacKinnon, Bessie Growe and Mary Rice exposes the problems and situations faced by women in higher education and the sciences during this period. As women in Science, Technology, Engineering and Mathematics (STEM) fields today still face challenges due to their gender, this project argues that women in higher educations face many problems because of social ideals of gender and the social expectation put on women. The women profiled in this exhibit all achieved success in academics by receiving advanced degrees and publishing articles, yet they also followed the traditional female paths of marriage or motherhood. My research fills in the gap in historiography that looks at women in the nineteenth century by examining the experiences of women who followed the paths of higher education but also marriage.

Social expectations of women in late nineteenth century America are a well-covered topic. For academic women, however, gendered social codes were often laid bare when these women tried to work against them. I found that women at KU interacted with these expectations in ways that historians have not fully examined. Historian Charlotte Williams Conable focuses on the policy restrictions made by co-educational universities that were informed by social expectations. In *Women at Cornell: The Myth of Equal Education*, she explores the experiences of women at Cornell and describes how women

were limited by policies and regulations at an eastern co-educational institution.¹ She argues that women in this co-educational sphere had more restrictions put on them than male students, including rules that limited where they lived and the activities in which they could engage. Women were also pushed into what faculty considered to be female appropriate programs, such as hygiene or teaching. My research and this exhibit examine the other challenges women faced when they were not limited by official sex-based policies. Other limitations stemmed from the social expectations that women fit into the stereotypes of proper womanhood, which in turn limited them from achieving personal goals that challenged these structures.

In her text, *Femininity, Mathematics, and Science, 1880-1914*, Claire Jones discusses how students' gender influenced their experience in mathematics education at British colleges around the turn of the twentieth century.² Because Britain did not have the same co-education opportunities as in the United States, the argument is structured differently than researchers looking at American schools. Jones's work explores the opportunities for women in collegiate mathematics but also how mathematics as a field was gendered. She argues that mathematical language was gendered, particularly, how certain topics promoted feminine ideals or were considered more abstract and less scientific. While I have found no evidence of this gendered language at work with women at KU, this research informs on co-education, Americans' gender ideals, and how they influenced women who participated in academic mathematics. Women's educational opportunities were shaped by changes in American society and also academic

¹ Charlotte Williams Conable, *Women at Cornell: The Myth of Equal Education* (Ithaca and London: Cornell University Press, 1977).

² Claire Jones, *Femininity, Mathematics, and Science, 1880-1914* (Palgrave Macmillan, 2009), 5-6.

professionalization (the reshaping of standards in academia to allow for formal organization and lines of authority).

This project also argues that the three KU graduate students did not follow trends noted by other historians who studied women in higher education. Their demographic profiles fit those of traditional female undergraduate students but did not fit the typical profile of women who pursued advanced degrees. These particular women married and had children after they finished their degrees, which was not the norm for women who received advanced degrees during this period. Historians Lillian Faderman and Patricia Ann Palmieri documented high trends of women with advanced degrees who opted out of marriage and remained single.³ Of women's colleges in the 1890s, 57 percent of Bryn Mawr graduates remained single. At Wellesley College, 51 percent of graduates remained single. Co-educational institutions had about a 50 to 60 percent rate of female graduates who married. Though the majority married, a high number of women, 40 to 50 percent, remaining single.⁴ Faderman's comments that in some cases, those women opting out of marriage with men engaged in varied relationships with other women, either long term romantic relationships or long term friends and roommates. MacKinnon, Grove and Rice do not follow this path. Although the KU sample is small, it shows that there were women who adhered to the social expectations of women while also pursuing an advanced education.

³ Lillian Faderman, *To Believe in Women: What Lesbians Have Done For America—A History* (Boston and New York: Houghton Mifflin, 1999); Patricia Ann Palmieri, *In Adamless Eden: The Community of Women Faculty at Wellesley* (New Haven and London: Yale University Press, 1995).

⁴ Faderman, *To Believe in Women*, 184.

My research and exhibit adds to the historiography on KU and mathematics because there was only one history written by G. Baley Price about KU's Department of Mathematics.⁵ His work covers changes in the department from the school's founding to 1970. Baley believes that KU's mathematics department went through a renaissance in the 1890s under the guidance of Henry Bryson Newson. Price mentions the women profiled in this study but in no detail and with no context. Annie MacKinnon is included in a class list alongside her male classmates in a class taught by Professor Newson but Price does not conclude anything else about the students. Price also uses Bessie Growe as an example of the rigor of the program because successful students often dropped out. He does not acknowledge that the year Growe dropped out, she got married and her husband had a job in Seattle, Washington. Price looks at these women through the same lens as the male students, ignoring the other pressures and struggles they faced because of their gender. In contrast, this research and exhibit expand the work of Annie MacKinnon, Bessie Growe and Mary Rice in the context of their lives as women and scholars.

Mathematics is an excellent field in which to explore how women were treated in an academic setting because even today it is considered a male field. Judy Green and Jeanne LaDuke in *Pioneering Women in Mathematics* claim this is because of the invisibility of women in the field, not because of a lack of women mathematicians.⁶ They argue that the field's assumed masculinity leads society to assume that there are few female mathematicians. This gendering of the field makes the active female

⁵ G. Baley Price, *History of the Department of Mathematics of the University of Kansas 1866-1970* (Lawrence, KS: Kansas University Endowment Association and University of Kansas, 1976).

⁶ Judy Green and Jeanne LaDuke, *Pioneering Women in Mathematics: The Pre-1940 PhD's* (American Mathematical Society, 2009).

mathematicians invisible to the public. Margaret Rossiter's *Women Scientists in America* examines the experiences of women in the sciences, whom she argues also have been rendered invisible because of gendered ideas of sciences. Exploring the experiences of female mathematics scholars at KU reveals that mathematics, as it was becoming a professional field in America, was not as consistently gendered male or female. Though their participation was not as equal or prestigious as that of male students, female students were given opportunities to participate academically. Women were able to step into academia because this was a time of flux in education and professionalization that allowed them new opportunities. This exhibit examines these ideas in relation to the social expectations for women in higher education to show the victories but also the struggles of women in the late nineteenth century.

Project Description

This project will be a 12-panel exhibit. I used various kinds of materials and sources to create this exhibit, such as photographs and published articles. It includes photographs of students, as well as photographs of the University of Kansas campus in Lawrence, Kansas from the school's University Archives. The exhibit also features excerpts from the published works of the graduate students. There are many examples of demographic information created by the University of Kansas in the 1890s about women students, which is often in the form of lists showing the number of female students versus male students. There are also excerpts and quotes in the panels from famous figures and scientists to understand society's wide held ideas about women. The audience can read the personal stories of these women in conjunction with the more general information about women in higher education during the nineteenth century. The exhibit will be interactive. The last panel asks the audience to solve a math problem as a way to understand exactly what kind of research these women were doing. This panel will also have examples from MacKinnon and Grove's works to show their research.

The target audience for this project is college students and so placement of the exhibit on a college campus would be ideal. A possible home is at the University of Kansas's University Archives. This project is an iterative project that could be improved or modified depending on new aspects that might be highlighted. This project also could be expanded to include female students in different fields who attended KU during this period. It would be an easy expansion to create additional panels if more research is conducted on women in other programs at KU. If it is determined that these women faced

similar or other interesting challenges like the female mathematicians profiled in the exhibit, then it would be appropriate to include this additional material in the exhibit.

My exhibit follows the best practices of Beverly Serrell 's *Exhibit Labels: An Interpretive Approach*.⁷ I kept the word limits on the main text and labels within the maximum word limits. I have used images that I feel match with the themes of the panels or help illustrate further points I presented in the panels. I also have kept in mind the potential audience of my exhibit. Best practices says to write at about a 6th to 8th grade reading level for the general public but I chose to write at a high school to undergraduate level as most of the ideal audience will be college students. My exhibit only includes two panels without images, the introduction and conclusion panels. For my design layout, I have used mathematic formulas written by these women as the backdrop of the panels. They are faded in color to make text easier to read. This element makes their work a focal point of the exhibits, as it is included on every panel. I also use the fonts Snell Roundhand, which resembles handwriting, and American Typewriter. While the two fonts are contradictory, I think both relate to the stories of these women. The handwriting-like font suggests the personal aspects of these women's lives while the typewriter-like font represents the academic writing in which these women engaged. I have also used colors that are reminiscent of KU's colors of red and blue to connect the women's stories back to the university.

⁷ Beverly Serrell, *Exhibit Labels: An Interpretive Approach* (Walnut Creek, CA and Landam, MD: AltaMira Press, 1996).

Outreach Plan

The first part of the outreach plan will be to start outreach at the institution that is housing the exhibit. Ideally, this will be at the University of Kansas in the Kenneth Spencer Research Library for either the Special Collections or the University Archives. I also will plan to talk to the Women in STEM organizations at KU, like the Association of Women in Mathematics, University of Kansas Student Chapter. I will then reach out to the women's organizations on campus, like the University Women's Club. I want to gain their support and share my exhibit with the students at KU. These organizations will help me advertise the exhibit through their organizational materials both in print and online formats. I also will look into the programs of large national organizations to connect my exhibit to their efforts. Organizations that support the research and education of Women in STEMs include the American Association of University Women, National Girls Collaborative Project, and the Association for Women in Science. While I might not get a lot of support from these large organizations, I can obtain some information or be able to get some outreach through their more local chapters. I also plan a social media presence, and I will attach my exhibit to popular trends that support women in STEM. I will capitalize on Twitter, Facebook, and writing a blog would be an easy way to connect to my audience and get public support for my exhibit.

Project Script

Panel 1: Title: Choosing the Best Course: Cultural and Social Influences on the Female Mathematics Graduate Students at University of Kansas in the 1890s

Along with my title, I will have a caption that gives credit to Annie MacKinnon and Bessie Grove for the equations used as backgrounds for the panels.

Caption Text

The equations on this panel and the following panels are excerpts from Annie MacKinnon's 1894 dissertation "Concomitant Binary Forms in Terms of the Roots" and Bessie Grove's 1901 article "Removal of Any Two Terms from a Binary Quantic by Linear Transformations."

Panel 2: Introduction

This exhibit examines the lives of three women who studied in the University of Kansas's graduate mathematics program during the 1890s: Annie MacKinnon, Bessie Grove and Mary Rice. Their experiences show the influence of society's ideas of womanhood on women's academic pursuits. These women were exceptional students and successful scholars. They spent their academic careers redefining the idea that women should only marry and have children, but with the limited choices offered to women in this period, they all ultimately decided to end their careers to marry.

The stories of these women will explain, in part, the history of women's education during the nineteenth century. Because these women were also in the field of

mathematics, this exhibit looks into how women in the sciences had struggles that women in other fields of study did not.

These women are examples of some of the challenges faced by white women in higher education in late nineteenth century America but this exhibit also highlights their success as scholars. These issues are still faced by women in education and STEM today, as many of the ideas about women's roles have not changed. Therefore, this exhibit will use these women's stories to look at the past but also the present of women's experiences in education and STEM fields.

Panel 3: The Two Choices for Women

Annie MacKinnon, Bessie Growe and Mary Rice knew their options were limited. In the scope of their lives, women could either marry or remain single but each option had problems. MacKinnon, Growe and Rice all chose to marry instead of remaining single. As talented scholars, they could have worked in academia. Annie MacKinnon worked at the women's college, Wells College, after she received a PhD at Cornell University in 1894. During this time, if a woman decided to marry in most cases that meant that she could not work. Women were expected to quit work or school once they married in order to care for their husbands and their homes. Some workplaces barred married women from employment, or fired women once they married. Bessie Growe left KU in 1901 without finishing her degree to follow her husband to his job as a professor at the University of Washington.

If a woman decided to remain single, she faced the problem of not being able to support herself. Many female job opportunities did not pay a living wage, or pay enough

for a woman to survive alone. One way that woman worked around this problem was a “Boston marriage.” In this situation, two women lived together to help pay for rent and other expenses. This was also how many women in romantic relationships with other women lived together. Though, in other situations, these arrangements were about two women living together to beat a system that made it hard for women to live without a man.

Object 1

The object for this panel will be an illustration called “*The two paths--What will the girl become.*”⁸

Caption text for Object 1

While this illustration is from 1903, it perfectly captures what society saw as the only paths for women during the nineteenth century: amoral spinster or happily married. It shows a girl and the two paths to her life. One path starts with reading the wrong books, growing up to flirt and seduce men, and ultimately becoming a social pariah. The other path paints the image that marriage and children is the perfect life for a woman. In their academic studies, MacKinnon, Grove and Rice were reading and learning a wide array of topics, like the girl in the illustration on the wrong path. The illustration notes that the right kinds of readings were those focused on manners, “Study and Obedience.”

⁸ *The two paths--What will the girl become?* 1903, Library of Congress, <https://lcn.loc.gov/2002716768>.

Panel 4: Education, The Female Tightrope

By the late nineteenth century, most Americans believed in educating women. They reasoned an educated woman would be a better mother because she could teach her children. Society only considered it a problem when women had too much education. It was feared that women who did not follow the traditional path could be independent, though it was almost impossible for women to obtain jobs to make them financially independent. It was also believed that women would waste a degree if she decided to marry later on. This logic rejected the notion of education merely for education, but it also discouraged many women from pursuing higher degrees for fear of wasting the degree if they married.

All three of the KU graduate students worked for higher degrees; MacKinnon even went on to complete her doctorate in the field. These women would have felt the pressure to choose marriage while working for graduate and doctorate degrees. Each of them chose to marry after most of their schooling was complete; Bessie Growe even left KU before she finished her degree because she married. This pressure from society could be one reason these women felt that marriage was a good choice for them, but the reality was that it was one of their only choices.

Object 1

The first object will be a quote from a speech given by Teddy Roosevelt in which he states that a women's duty is to be a mother and that she should not be educated to the same degree as a man. The quote is: "The woman should have ample educational

advantages; but save in exceptional cases the man must be, and she need not be, and generally ought not to be, trained for a lifelong career as the family breadwinner; and, therefore, after a certain point, the training of the two must normally be different because the duties of the two are normally different.”⁹

Caption Text for Object 1

Many Americans shared the belief that women’s education should be unequal to men’s because they believed women should be educated to make them good mothers or wives. Teddy Roosevelt shared this belief in a 1905 speech in which he states that the only purpose women have is to be mothers and “helpmates” to men. Roosevelt references the same belief that took away women’s choices and limited how they could participate in the academic or professional world.

Object 2

The second object is a chapter from Edward Clarke’s *Sex in Education* (1875). I will display the chapter of this book called “Co-education” on the panel. The pages will be available for the viewer to flip through like a book so they can read Clarke for themselves. Here is a quote from the chapter as an example of Clarke’s ideas: “[Co-education] means, that boys and girls shall be taught the same things, at the same time, in the same place, by the same faculty, with the same methods, and under the same regimen. This admits age and proficiency, but not sex, as a factor in classification. It is against the co-education of the sexes, in this sense of identical co-education, that physiology

⁹ Teddy Roosevelt, “On American Motherhood,” 1905, <http://www.nationalcenter.org/TRooseveltMotherhood.html>.

protests; and it is this identity of education, the prominent characteristic of our American school-system, that has produced the evils described in the clinical part of this essay, and that threatens to push the degeneration of the female sex still farther on.”¹⁰ I will highlight these quotes in the chapter for easy access for the viewer.

Caption Text for Object 2

In the nineteenth century, scientists researched women’s reactions to higher education. This is a chapter from a famous study by Edward Clarke in 1875 entitled *Sex in Education or, A Fair Chance for Girls*. Here, Clarke argues that for women to have a “fair chance” in education they cannot have the same education as men. He stated that women could not physically or mentally handle the same type of education as men. It was feared that a woman who learned too much (or on the same level as a man) would be in danger of turning into a man. It was assumed that if women did not save their energy to be used for reproduction, though it was unclear how to do this, then their reproductive organs would waste away. MacKinnon, Grove and Rice would have been very aware of these assumptions about learned women and these ideas could have been a factor in why all of them married.

Panel 5: The World of KU

MacKinnon, Grove and Rice went to a school where female students were not rare. When the University of Kansas opened its doors for its first academic semester in 1867, the only two students enrolled during that year were women. Women never were

¹⁰ Edward Clarke, *Sex in Education or, A Fair Chance for Girls*, Project Gutenberg EBook (Boston: James R Osgood and Co., 1875), 122-123.

barred from an education at KU. In fact, KU was a leader in co-education since its creation. Co-education was a standard in the Midwest and KU followed the pattern of co-education previously set by the public secondary schools and private academies in the region. Kansans supported co-education when the area was still a territory with the Wyandotte Constitution of 1859 that made co-education mandatory in all Kansas schools.

The East Coast kept their tradition of male-only universities. Instead of changing these older universities into co-educational institutions, women's colleges were created when it became more acceptable for women to be educated at a college level. However, co-education did not always look like it does today. KU's creators conceived co-education differently. Their idea, when the school was being constructed, was to create two different branches of KU -- a female and a male branch. Fortunately for the female students, however, the university's lack of funds made it difficult to implement this separation of students.

Object 1

One of the objects in this panel will be a photo print of the first buildings on campus.¹¹ This will give the audience a look at the appearance of KU during the nineteenth century.

¹¹ *University of Kansas From the North*, 1890s, University Archives, Spencer Research Library, University of Kansas, http://luna.ku.edu:8180/luna/servlet/detail/kuvc1ua~1~1~3769555~339670:University-of-Kansas-From-the-North?sort=Creator_Name%2CTitle%2CDisplay_Date&qvq=q:1890s%2Bcampus;sort:Creator_Name%2CTitle%2CDisplay_Date;lc:kuvc1ua~1~1&mi=2&trs=4.

Caption Text for Object 1

This print shows the University of Kansas campus during the 1890s, where MacKinnon, Grove and Rice worked on their degrees.

Object 2

The other objects will be photographs of KU classes from the 1890s. I have selected three photographs that fit the themes of the exhibit well and feature women. The photographs are from 1890, 1895 and 1897.¹²

Caption Text for Object 2

These images are of KU's classes of 1890 (top), 1895 (bottom right), and 1897 (bottom left). As you can see, women appeared as students. KU was the right place for MacKinnon, Grove and Rice to excel, as they did not have to fight to be included into programs.

Panel 6: The Midwestern University Student

The typical Midwestern university female student looked a lot like MacKinnon, Grove or Rice. These three women were white and middle class. They came from

¹² *1890s Class Picture*, 1890s, University Archives, Spencer Research Library, University of Kansas, http://luna.ku.edu:8180/luna/servlet/detail/kuvclua~1~1~3609744~326039:1890s-Class-Picture?sort=Creator_Name%2CTitle%2CDisplay_Date;1895%20Class%20Picture,1895,University%20Archives,Spencer%20Research%20Library,University%20of%20Kansas,http://luna.ku.edu:8180/luna/servlet/detail/kuvclua~1~1~3609588~326041:1895-Class-Picture?sort=Creator_Name%2CTitle%2CDisplay_Date&qvq=w4s:/when/1895;sort:Creator_Name%2CTitle%2CDisplay_Date;lc:kuvclua~1~1&mi=0&trs=7;1897%20Class%20Picture,1897,University%20Archives,Spencer%20Research%20Library,University%20of%20Kansas,http://luna.ku.edu:8180/luna/servlet/detail/kuvclua~1~1~3609615~326044:1897-Class-Picture?sort=Creator_Name%2CTitle%2CDisplay_Date&qvq=w4s:/when/1897;sort:Creator_Name%2CTitle%2CDisplay_Date;lc:kuvclua~1~1&mi=0&trs=5.

families that wanted them educated enough so that they could support themselves until marriage. All of these women were in their late teens to early twenties when they started their undergraduate degrees. Female students outnumbered male students at KU in the university's first semester in 1867 to 1871. There is not research on why 1871 is the turning point for more male students but there are a number of reasons for more men later in the period. One reason, outside the Civil War's impact on men, could have been that as KU built a name for itself, a growing number of college-aged men travelled from greater distances to attend the undergraduate school and fill the ranks of the newly established professional programs. By the time MacKinnon, Grove and Rice went to KU, women were the minority of the student body. Women were still a large part of the undergraduate and graduate programs at the College of the Arts and Sciences at KU, yet enrolled in much small numbers in the professional schools.

Although, MacKinnon and Grove would have been among many other female students, they did not study the same disciplines as most. A majority of female students at KU focused on the liberal or fine arts, not the sciences. This made MacKinnon and Grove outliers among their female peers. Rice was even more unique because she was in the pharmacy school, which was considered a professional school. These three women succeeded as scholars in fields that were not seen as feminine. They were exceptions to the rule; while most women went into the arts and humanities, they went into the sciences.

Object 1

Bessie Growe's yearbook photograph and the biography included in the yearbook will be displayed on this panel.¹³

Caption Text for Object 1

This image and text was included in the KU *Jayhawker Yearbook* for 1897.

Bessie Growe's biography shows that she was well known for being a bright mathematics student who was very passionate about her field. The language of the biography also indicates that this was not usual for women, even calling mathematics a topic of "evil intentions that she had not outgrown to this day." Whether in jest or not, this description shows that women in the sciences was not see as normal or even a good thing. With her love of mathematics, Growe would have been a stand out student at KU, as science and math were not fields with a high number of female students.

Object 2

I will include a list from the KU Catalogue that enumerates how many students attended KU from 1866 to 1890. This list separates all of the information into groups based on the school or program of the students and counts how many men and women were enrolled in each school.¹⁴

¹³ University of Kansas, "Senior Annual Jayhawker Yearbook," (Lawrence, KS: Journal Publishing Company, 1897,) Marilyn Stokstad Reading Room, University Archives, 27.

¹⁴ "Growth of the University of Kansas, 1866-1890," *24th Annual Catalogue of the Officers and Students for the Year 1889-90* (Topeka, KS: Kansas Publishing House, 1889), 110.

Caption Text for Object 2

This list comes from the 1890 KU Catalogue and enumerates the students attending KU from 1867 to 1890. This list separates the students by gender, program and school. One might have expected that men were the majority in these years. However, from 1867 to 1872, women were the majority of students enrolled at KU. As time progressed, the number of male students increased until they were the majority of students. One reason for this growth could merely be that there were not enough men in the area ready to go to college until the 1870s. The Civil War took many men out of school for a long period of time, and by the school's opening in 1866, there were fewer men qualified to enroll.

Panel 7: To be a Woman at KU

MacKinnon, Grove and Rice dealt with more than just grades and degrees during their time at the university. They were held to different standards than men and expected to behave differently. These expectations had to do with society's ideas about proper gender roles and how respectable upper and middle class white men and women should behave. These expectations affected what women studied in school and what they did after earning their degrees. Because women were expected to marry and have children, many women chose this traditional path after their undergraduate studies.

Most women picked degrees that were connected to caring for people or were considered feminine, such as the arts, English, education, social work or nursing. Fewer women went into the fields of science or professional studies. Unlike the men in these fields, women were not expected to pursue careers or be hindered from marrying because

of their jobs. Some women studied these fields in spite of the biases against them. Mary Rice who may have just wanted an education or Bessie Growe who was passionate enough about the field to try to work in it are examples of this trend.

Object 1

The first object will be Annie MacKinnon's undergraduate senior survey, which will provide an example of formulaic language used by women to fit into female stereotypes.¹⁵ The image has a red outline around MacKinnon's answers and a blue outline around similar answers. I will also make note of this in the caption.

Caption Text for Object 1

In Annie MacKinnon's class survey in the 1889 KU yearbook, she does not stand out from other female students. This is because they all answered most of the questions in a similar manner (similar answers in the photograph above are outlined in blue). In fact, MacKinnon's answers (outlined in red in the photograph) are standard feminine answers, using the traditional idea of women as maternal and selfless. Woman understood and, in this case, even embraced the stereotypical images of womanhood that worked against them during this period. MacKinnon's only unique answer is her reply to the question about her greatest weakness, which she admitted, was her "quick, haughty temper."

¹⁵ "The Negatives from Which the Composite Photographs can be taken," University of Kansas, *The Helianthus Yearbook* (Lawrence, KS: P.T Foley, 1889) Marilyn Stokstad Reading Room, University Archives, 16.

Object 2

The other objects will be the three illustrations from the KU yearbook article that discusses stereotypes of university women.¹⁶

Caption text for Object 2

These illustrations were used to describe stereotypes of female university students in an 1899 KU yearbook article on the subject. The author believed that the perfect woman was smart but not too smart, social but not too outgoing. These ideas might seem familiar because they are similar principles used to judge women's actions today. Society has and still does police women's expressions and actions, leading many women to perform a femininity that follows these impossible standards. MacKinnon, Grove and Rice knew of these standards and would have been subject to them.

Panel 8: A Professional Woman

Mary Rice is a great example of a unique student during this time. She was one of the few women who enrolled in professional programs in the 1890s. During her time in the program, Rice was one of 8 women out of the 66 students. Compared to the 167 women who attended the KU liberal arts programs, this number is not high. This number is higher, however, than the other professional programs that year— there was only one female law student and no female engineering students. Professions were considered male pursuits because men were supposed to be the breadwinners and financially care for their families. Many women refrained from pursuing degrees in professional programs

¹⁶ Lucy Riggs, "Kansas University Daughters," *Oread Jayhawkers Yearbook*, (Lawrence, KS: University of Kansas, 1899), 143-45.

either because they simply were not allowed to enroll or because they were following gender social codes.

The model of professional education also made it difficult for women to study in these fields. In the field of pharmacy, an apprenticeship (learning a trade by following and training on site) with a pharmacist was the best way to pass a pharmacy-licensing exam before 1920. Women struggled to get pharmacists to choose them as an apprentice over male applicants. Pharmacy schools were closely tied with the former apprentice model. These programs, however, were in mostly co-educational schools, which allowed women to gain pharmaceutical experience outside an apprenticeship if they could not obtain one. Even though these schools could open doors for women, pharmacy was still a degree connected to an apprenticeship model and a male-dominated career, so not many women entered these programs.

Object 1

The first object will be a list of the students enrolled in the various schools at KU during 1893.¹⁷

Caption Text for Object 1

This 1893 list of KU students looks at the numbers of men and women in each school at the university. It breaks down into the pharmacy, engineering, law, fine arts, and “arts” (liberal arts and sciences including mathematics) schools with the number of men and women students in each school. From the list, you can see that men are the

¹⁷ “Summary of Enrollment,” *The Twenty-Eighth Annual Catalogue of the University of Kansas for the Year 1893-94*, (Topeka, KS: Kansas Publishing House, 1893), 102.

majority in the professional schools: pharmacy, law, and engineering. However, the fine arts school has few men compared to the female students. There were no rules, however, against studying in a field not gendered for you and some women (and men if you look at the fine arts section) at KU choose to study in fields typically not considered appropriate for them.

Object 2 and Object 3

The other objects I will display in this panel will be photographs to show female professionals¹⁸ and male professionals.¹⁹

Caption Text for Objects 2 and 3

Though women were not expected to have careers or be breadwinners, many still needed jobs. The standard female profession during this period was a teacher. The image on the left is of a 1890s female teacher teaching a co-ed class of younger children. It was easy for women to justify their pursuit of a teaching career because they could argue that the same feminine traits that society believed made them good mothers would also make them good teachers of young children.

As men did not have limits on the professions they could pursue based on gender, they had many more options. Scientific jobs, like engineer or chemist, at the end of the

¹⁸ *Early Schools (Circa 1890s)*, photograph, “Answering the Call: The History of NEA, Part 1,” NEA, <http://www.nea.org/home/11608.htm>

¹⁹ *Pharmacy demonstration. The hatless man on the far left is Prof. Sayre, dean of the School of Pharmacy*, 1891, University Archives, Spencer Research Library, University of Kansas, http://luna.ku.edu:8180/luna/servlet/detail/kuvclua~1~1~614652~151037:Pharmacy-demonstration--The-hatless?sort=Creator_Name%2CTitle%2CDisplay_Date&qvq=q:1891%2Bpharmacy;sort:Creator_Name%2CTitle%2CDisplay_Date;lc:kuvclua~1~1&mi=0&trs=1.

nineteenth century were becoming a huge enterprise. As an example, the photograph on the right is of a 1901 KU pharmacy class giving a demonstration on toxicology. The class at the pharmacy school included some women, but the demonstration pictured only includes men. This image represents how the public believed science and scientists looked — white and male.

Panel 9: Is it Dr. or Miss?

For women in the sciences, the fact that science was a male world made it difficult for women to succeed as scholars and professionals. However, Annie MacKinnon is one such success story. She was the only woman of the three profiled in this exhibit to earn her doctorate. After MacKinnon received her undergraduate degree in 1889, she continued her education at KU to receive her Master's degree in 1891. Afterward, she went straight to Cornell University and received her doctorate in 1894. This is a feat that not many women accomplished. One study claims that there were only 9 women with mathematics doctorates before 1900. In all fields, 228 women received doctorates before 1900 out of the over 3,000 doctorates awarded in those years. But, the numbers in the sciences were the lowest, including 8 women with Botany doctorates and 3 women in Physics.²⁰

But MacKinnon did not stop with her doctorate. She also studied two years at Gottingen University in Germany. This is impressive because European universities were much stricter on allowing women to study with men and co-education took much longer to take hold there than in America. MacKinnon's intelligence and education got her into a

²⁰ Table 2.1, Rossiter, *Women Scientists in America*, 36; Table 28, Thomas Synder, ed., *120 Years of American Education, A Statistical Report* (U.S Department of Education, 1993), <http://nces.ed.gov/pubs93/93442.pdf>, 82.

school that did not allow many women to enter its halls. The fields of science had excluded women for some time because of society's assumptions about women and their intelligence. Especially by the turn of the twentieth century, society saw science as a field of prestige and high intellect. In this period, most people believed these attributes described men, not women. For women working toward degrees, it was hard work to battle stereotypes about their intelligence and the worth of their scholarship.

Object 1

To show the audience what a woman working in the sciences would look like, I picked a photograph from the KU archives that shows an anatomy class with one woman in the class.²¹

Caption text for Object 1

This is a photograph of a 1890s KU anatomy class, humorously being taught by the model skeleton. As you can see, the class itself is small, but it still only has one woman among the few men in class. Yet, she is not removed from her classmates. It was sometimes the case in universities to completely separate men from women in classrooms. This image reflects the reality for women like MacKinnon, Grove and Rice. In some of their mathematics classes, they would have been the only women in the room.

²¹ *Professor Dyche and anotomy class*, 1890s, University Archives, Spencer Research Library, University of Kansas, http://luna.ku.edu:8180/luna/servlet/detail/kuvc1ua~1~1~614681~151040:Professor-Dyche-and-anotomy-class?sort=Creator_Name%2CTitle%2CDisplay_Date&qvq=q:Dyche;sort:Creator_Name%2CTitle%2CDisplay_Date;lc:kuvc1ua~1~1&mi=19&trs=25.

Object 2

The second photograph is the KU Graduate Club from the 1899 Jayhawker Yearbook.²²

Caption text for Object 2

This photograph of KU's Graduate Club from 1899 is a good look at what it was like for women studying in higher degree programs. The two women in the club represented the minority of women in graduate programs because while women were not rare in undergraduate programs, the numbers declined as the degrees advanced.

Panel 10: Research and Bias

A study of Bessie Growe's and Mary Rice's research reveals that women often faced different treatment because of their gender. Bessie Growe's experience at KU is one example of how women researchers were treated differently than male researchers. Growe wrote and published two papers while at KU, the first in 1897 and the second in 1901. The first article, "On New Canonical Forms of the Binary Quintic and Sextic" begins with a note by her professor Henry Bryson Newson. Instead of introducing Growe's work, Newson's introductory note gives himself credit for Growe's research by saying he discovered a theorem before it was published elsewhere and he gave it to Growe to prove. Newson never wrote introductory notes for any of his male students. This commentary was unique and seems to indicate that Newson wrote it simply because Growe was a woman. Growe was a talented mathematician in her own right. Her 1901

²² *The Graduate Club*, 1899, University Archives, Spencer Research Library, University of Kansas *Oread Jayhawkers Yearbook*, (Lawrence, KS: University of Kansas, 1899), 13.

article was published in the *American Journal of Mathematics*, a well-known mathematics journal – a feat her male peers did not accomplish.

Mary Rice did not deal with the same discrimination as Bessie Growe. For Rice, scientific writing styles did not make it clear what work she did in her research. Rice’s research was for her double MA degree in both chemistry and mathematics. Because of the way that academic scientists research and write collaboratively it is hard to tell how much work Rice contributed and how much credit she should receive for the project. The article describes a student obtaining a water sample, checking its composition and also computing the data. But as the paper is written in the first person, we can only assume that Rice is the student retrieving the samples and computing data under the supervision of her professor.

Object 1

The first object will be the first page of Bessie Growe’s article “On New Canonical Forms of the Binary Quintic and Sextic” with Professor Newson’s introductory note.²³ This will be placed alongside the first page of an article that Growe wrote called, “Removal of Any Two Terms from a Binary Quintic by Linear Transformation,” which contains no such note but was featured in the *American Journal of Mathematics*, the main American academic journal for mathematics.²⁴

²³ Bessie Growe, “On New Canonical Forms of the Binary Quintic and Sextic,” *Kansas University Quarterly* 6, no. 4 (October 1897): 201.

²⁴ Bessie Growe Morrison, “Removal of Any Two Terms from a Binary Quintic by Linear Transformation,” *American Journal of Mathematics* 23, no.3 (July 1901): 287-296.

Caption Text for Object 1

On the first page of Bessie Growe's article for the *Kansas University Quarterly* (left), her professor wrote an introductory note. In the first half of the note, Dr. Newson provided background on the topic. Later in the note, Newson explained that the idea for Growe's research was his idea and that he gave her the equation that she used in her research. Even if Newson did help her pick this topic, by writing this, Newson turned Growe into a computer, or someone merely computing equations, instead of supporting her as an independent researcher. In the article (right) published for the *American Mathematics Journal*, Growe had no introductory note. There is no mention of Newson or his influence on her work but the topic is very similar to the first article.

Object 2

This panel also will include the article Mary Rice wrote with her professor.²⁵

Caption Text for Object 2

This short article is an example of Mary Rice's research for her double MA in both chemistry and mathematics. Usually, women in the sciences worked under the supervision of their male professors. The only way for women to study under the guidance of female scientists was at women's colleges, which actively hired more women. In co-educational schools, men were always hired in science professorships over women. For the deans of these universities, they preferred the male students to be taught by men, even if a woman was qualified for the job.

²⁵ E.H.S. Baley and Mary A. Rice, "On the Composition of the Water from a Mineral Spring in Vicinity of "The Great Spirit Spring" Mitchell County, Kansas", *Transaction of the Annual Meeting of the Kansas Academy of Science* 14 (1893-1894): 40.

Panel 11: A Thing of the Past?

Annie MacKinnon, Bessie Growe and Mary Rice were exceptional scholars in a field that many women did not even enter. They had limited options for the course of their lives: low paying work or marriage. Women like Annie MacKinnon, who got to work as professors in their field at women's colleges, were lucky to get hired in their fields. They were treated differently in research and scholarship. They lived in a society that gave women fewer options, expecting women to marry and have children. MacKinnon, Growe and Rice walked the tight rope of appropriateness to obtain the education they wanted but in the end their limited options forced them to choose between their academic passions or acceptability and security in marriage. In the end, they, like most others, chose marriage.

Unfortunately, women's education, especially in STEM fields, is still a global issue today. In many places across the world, women find it difficult to receive an equal education or any education at all because of discrimination and social ideals about women. In the Western world, this is a more subtle bias because women are expected to be educated. Scientific and mathematics ability is still assumed to be a male skill, with women being under represented in fields like robotics, mathematics, physics, and other areas. One study showed that women accounted for only 12% of PhD faculty positions in mathematics in 2007, yet 29% of the mathematics PhDs were granted to women between 1996 and 2005. Rules and policies have helped women get into institutions and jobs but there are still limitations because of gender roles. An article written by the American Association of University Women argues that many of the problem for women in STEM

fields have to do with the social ideas that affect women's performances, like the social assumption that men are more competent or seen as better leaders than women.

Panel 12: Take a Walk in Their Shoes

The women profiled in this exhibit spent years of their lives becoming accomplished scholars in the fields of mathematics and science. Annie MacKinnon and Bessie Growe were highly educated in the fields of linear algebra and geometry with successful publications and degrees. Mary Rice also was skilled in the fields of mathematics and chemistry with a focus on pharmacology. To understand the kind of work these women engaged in at KU in the 1890s, here are samples of mathematics problems for you to solve. While these problems are much simpler than the complex equations that these women were computing, you can experience for yourself what their research was like.

Object 1 and 2

The panel will include examples of mathematics equations from Annie MacKinnon's dissertation and Bessie Growe's articles.²⁶ I will provide excerpts from these works that show both women computing and solving equations. I would like to provide a few pages for each but have each selection placed in their own stack, prepared like a book. In this way, one can flip through the pages to see what these women's work looked like and the difficulty of their research.

²⁶ Annie L. MacKinnon, "Concomitant Binary Forms in Terms of the Roots," *Annals of Mathematics* 9, no. 1/6 (1894): 95-157; Bessie Growe Morrison, "Removal of Any Two Terms from a Binary Quantic by Linear Transformations," *American Journal of Mathematics* 23, No. 3 (Jul., 1901): 287-296.

Caption text for Object 1 and 2

This scholarship produced by Annie MacKinnon and Bessie Growe shows exactly the kinds of problems the women were researching at KU. Featured here are MacKinnon's doctorate dissertation and one of Growe's published articles. Both women worked in the fields of linear algebra and geometry but you can see that their topics look dramatically different. Since mathematics research is independent, these women would have written and computed all of these equations independently. The topic and the computing would have been decided and completed solely by these scholars.

Example problem and solution

Find all solutions to the linear system: $x + y = 5$, $2x - y = 3$

Solution: Solving each equation for y , we have the equivalent system $y = 5 - x$, $y = 2x - 3$.

Setting these expressions for y equal, we have the equation $5 - x = 2x - 3$, which quickly leads to $x = 8/3$.

Substituting for x in the first equation, we have $y = 5 - x = 5 - 8/3 = 7/3$. Thus, the solution is $x = 8/3$, $y = 7/3$.²⁷

²⁷ Robert A Beezer, *Exercise and Solution Manual for A First Course in Linear Algebra* (Gig Harbor, WA: Congruent Press, 2012), 1-2.

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VITA

Savannah Nicole Lore was born in Chesterfield, Missouri on March 27, 1992. She was educated at her local public schools near Sullivan, Missouri and graduated from Sullivan High School fourth in her class in 2010. She went on to graduate from Missouri University of Science and Technology in Rolla, Missouri magna cum laude in 2013 with a Bachelor of Arts in History.

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Ms. Lore works at the Wornall-Majors House Museums as the Alexander Majors' House Weekend Manager and Camp Director. Upon completion of her degree, Ms. Lore plans to pursue further work in the field of public history.

Choosing the Best Course

Cultural and Social Influences on the Female Mathematics Graduate Students at University of Kansas in the 1890s

The equations on this panel and the following panels are excerpts from Annie MacKinnon's 1894 dissertation "Concomitant Binary Forms in Terms of the Roots" and Bessie Grove's 1901 article "Removal of Any Two Terms from a Binary Quantic by Linear Transformations."

$$\frac{1}{2} \left(\frac{d}{da} \right) T_3 = (bc)^2 (a^2 + by)^2 (ca + cy)^2 = (bc)^2 b^2 c^2 = H \text{ of quartic.}$$

Introduction

This exhibit examines the lives of three women who studied in the University of Kansas's graduate mathematics program during the 1890s: Annie MacKinnon, Bessie Growe and Mary Rice. Their experiences show the influence of society's ideas of womanhood on women's academic pursuits. These women were exceptional students and successful scholars. They spent their academic careers redefining the idea that women should only marry and have children, but with the limited choices offered to women in this period, they all ultimately decided to end their careers to marry.

The stories of these women will explain, in part, the history of women's education during the nineteenth century. Because these women were also in the field of mathematics, this exhibit looks into how women in the sciences had struggles that women in other fields of study did not.

These women are examples of some of the challenges faced by white women in higher education in late nineteenth century America but this exhibit also highlights their success as scholars. These issues are still faced by women in education and STEM today, as many of the ideas about women's roles have not changed. Therefore, this exhibit will use these women's stories to look at the past but also the present of women's experiences in education and STEM fields.

$$\Sigma (a\beta) (\gamma\alpha) \beta\gamma. \quad + 4(a\beta)(\gamma\alpha) \left\{ \frac{d^2\varphi}{dad\gamma} \frac{d^2\varphi}{dad\beta} - \frac{d^2\varphi}{d\beta d\gamma} \frac{d^2\varphi}{da^2} \right\}$$

The Two Choices for Women

Annie MacKinnon, Bessie Grove and Mary Rice knew their options were limited. In the scope of their lives, women could either marry or remain single but each option had problems. MacKinnon, Grove and Rice all chose to marry instead of remaining single. As talented scholars, they could have worked in academia. Annie MacKinnon worked at the women's college, Wells College, after she received a PhD at Cornell University in 1894. During this time, if a woman decided to marry in most cases that meant that she could not work. Women were expected to quit work or school once they married in order to care for their husbands and their homes. Some workplaces barred married women from employment, or fired women once they married. Bessie Grove left KU in 1901 without finishing her degree to follow her husband to his job as a professor at the University of Washington.



While this illustration is from 1903, it perfectly captures what society saw as the only paths for women during the nineteenth century: amoral spinster or happily married. It shows a girl and the two paths to her life. One path starts with reading the wrong books, growing up to flirt and seduce men, and ultimately becoming a social pariah. The other path paints the image that marriage and children is the perfect life for a woman. In their academic studies, MacKinnon, Grove and Rice were reading and learning a wide array of topics, like the girl in the illustration on the wrong path. The illustration notes that the right kinds of readings were those focused on manners, "Study and Obedience."

If a woman decided to remain single, she faced the problem of not being able to support herself. Many female job opportunities did not pay a living wage, or pay enough for a woman to survive alone. One way that woman worked around this problem was a "Boston marriage." In this situation, two women lived together to help pay for rent and other expenses. This was also how many women in romantic relationships with other women lived together. Though, in other situations, these arrangements were about two women living together to beat a system that made it hard for women to live without a man.

$$\Sigma \left[\frac{d}{da_2} \frac{d}{d\beta_2} \frac{d}{d\gamma_1} \dots \right] \equiv \frac{n(n-1)}{2} \left[\frac{d}{da_1} \right]^{n-2} \left[\frac{d}{da_2} \right]^2$$

Education, The Female

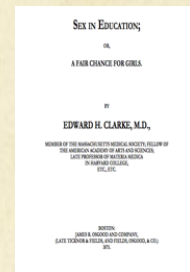
Tightrope

"The woman should have ample educational advantages; but save in exceptional cases the man must be, and she need not be, and generally ought not to be, trained for a lifelong career as the family breadwinner; and, therefore, after a certain point, the training of the two must normally be different because the duties of the two are normally different." – Theodore Roosevelt

By the late nineteenth century, most Americans believed in educating women. They reasoned an educated woman would be a better mother because she could teach her children. Society only considered it a problem when women had too much education. It was feared that women who did not follow the traditional path could be independent, though it was almost impossible for women to obtain jobs to make them financially independent. It was also believed that women would waste a degree if she decided to marry later on. This logic rejected the notion of education merely for education, but it also discouraged many women from pursuing higher degrees for fear of wasting the degree if they married.

All three of the KU graduate students worked for higher degrees; MacKinnon even went on to complete her doctorate in the field. These women would have felt the pressure to choose marriage while working for graduate and doctorate degrees. Each of them chose to marry after most of their schooling was complete; Bessie Grove even left KU before she finished her degree because she married. This pressure from society could be one reason these women felt that marriage was a good choice for them, but the reality was that it was one of their only choices.

Many Americans shared the belief that women's education should be unequal to men's because they believed women should be educated to make them good mothers or wives. Teddy Roosevelt shared this belief in a 1905 speech in which he states that the only purpose women have is to be mothers and "helpmates" to men. Roosevelt references the same belief that took away women's choices and limited how they could participate in the academic or professional world.

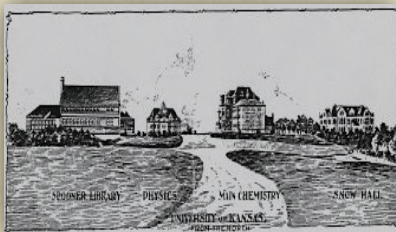


In the nineteenth century, scientists researched women's reactions to higher education. This is a chapter from a famous study by Edward Clarke in 1875 entitled Sex in Education or A Fair Chance for Girls. Here, Clarke argues that for women to have a "fair chance" in education they cannot have the same education as men. He stated that women could not physically or mentally handle the same type of education as men. It was feared that a woman who learned too much (or on the same level as a man) would be in danger of turning into a man. It was assumed that if women did not save their energy to be used for reproduction, though it was unclear how to do this, then their reproductive organs would waste away. MacKinnon, Grove and Rice would have been very aware of these assumptions about learned women and these ideas could have been a factor in why all of them married.

$$\{\varphi\psi\}^k = \frac{\sum (\rho_1\sigma_1) \dots (\rho_k\sigma_k) \varphi\psi}{\rho_1 \dots \rho_k \cdot \sigma_1 \dots \sigma_k}$$

The World of KU

MacKinnon, Grove and Rice went to a school where female students were not rare. When the University of Kansas opened its doors for its first academic semester in 1867, the only two students enrolled during that year were women. Women never were barred from an education at KU. In fact, KU was a leader in co-education since its creation. Co-education was a standard in the Midwest and KU followed the pattern of co-education previously set by the public secondary schools and private academies in the region. Kansans supported co-education when the area was still a territory with the Wyandotte Constitution of 1859 that made co-education mandatory in all Kansas schools.



This print shows the University of Kansas campus during the 1890s, where MacKinnon, Grove and Rice worked on their degrees.



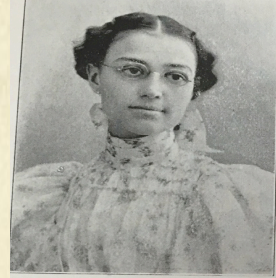
These images are of KU's classes of 1890 (top), 1895 (bottom right), and 1897 (bottom left). As you can see, women appeared as students. KU was the right place for MacKinnon, Grove and Rice to excel, as they did not have to fight to be included into programs.



The East Coast kept their tradition of male-only universities. Instead of changing these older universities into co-educational institutions, women's colleges were created when it became more acceptable for women to be educated at a college level. However, co-education did not always look like it does today. KU's creators conceived co-education differently. Their idea, when the school was being constructed, was to create two different branches of KU -- a female and a male branch. Fortunately for the female students, however, the university's lack of funds made it difficult to implement this separation of students.

The Midwest University Student

The typical Midwestern university female student looked a lot like MacKinnon, Growe or Rice. These three women were white and middle class. They came from families that wanted them educated enough so that they could support themselves until marriage. All of these women were in their late teens to early twenties when they started their undergraduate degrees. Female students outnumbered male students at KU in the university's first semester in 1867 to 1871. There is not research on why 1871 is the turning point for more male students but there are a number of reasons for more men later in the period. One reason, outside the Civil War's impact on men, could have been that as KU built a name for itself, a growing number of college-aged men travelled from greater distances to attend the undergraduate school and fill the ranks of the newly established professional programs. By the time MacKinnon, Growe and Rice went to KU, women were the minority of the student body. Women were still a large part of the undergraduate and graduate programs at the College of the Arts and Sciences at KU, yet enrolled in much small numbers in the professional schools.



Bessie Growe—Away down in the Blue Grass country of old Kentucky, on September 14, 1875—this is the date handed us by the owner of the biography and we respectfully refrain from comment—a new mathematical light dawned upon the world in the person of Miss Bessie Growe. From her earliest babyhood she had a passion for cubes, parabolas, logarithms and other like evil inventions, which she has not outgrown to this day. Coming to Kansas, she first fell into the toils of Fisher University and spent two years there, but afterward repented of her folly and came to K. U. to become a member of the class of '97. She has made mathematics her specialty throughout her college course, and has mounted to such dizzy heights of higher plane curves and Jacobi theories as the biographer dares not attempt to describe.

This image and text was included in the KU Jayhawker Yearbook for 1897. Bessie Growe's biography shows that she was well known for being a bright mathematics student who was very passionate about her field. The language of the biography also indicates that this was not usual for women, even calling mathematics a topic of "evil intentions that she had not outgrown to this day." Whether in jest or not, this description shows that women in the sciences was not seen as normal or even a good thing. With her love of mathematics, Growe would have been a stand out student at KU, as science and math were not fields with a high number of female students.

Although, MacKinnon and Growe would have been among many other female students, they did not study the same disciplines as most. A majority of female students at KU focused on the liberal or fine arts, not the sciences. This made MacKinnon and Growe outliers among their female peers. Rice was even more unique because she was in the pharmacy school, which was considered a professional school. These three women succeeded as scholars in fields that were not seen as feminine. They were exceptions to the rule; while most women went into the arts and humanities, they went into the sciences.

YEAR	TOTAL		MALE		FEMALE		TOTAL	PERCENTAGE
	ENROLLMENT	DIPLOMAS	ENROLLMENT	DIPLOMAS	ENROLLMENT	DIPLOMAS		
1866	100	10	80	5	20	5	100	10%
1867	150	15	100	10	50	5	150	10%
1868	200	20	150	15	50	5	200	10%
1869	250	25	200	20	50	5	250	10%
1870	300	30	250	25	50	5	300	10%
1871	350	35	300	30	50	5	350	10%
1872	400	40	350	35	50	5	400	10%
1873	450	45	400	40	50	5	450	10%
1874	500	50	450	45	50	5	500	10%
1875	550	55	500	50	50	5	550	10%
1876	600	60	550	55	50	5	600	10%
1877	650	65	600	60	50	5	650	10%
1878	700	70	650	65	50	5	700	10%
1879	750	75	700	70	50	5	750	10%
1880	800	80	750	75	50	5	800	10%

This list comes from the 1890 KU Catalogue and enumerates the students attending KU from 1867 to 1890. This list separates the students by gender, program and school. One might have expected that men were the majority in these years. However, from 1867 to 1872, women were the majority of students enrolled at KU. As time progressed, the number of male students increased until they were the majority of students. One reason for this growth could merely be that there were not enough men in the area ready to go to college until the 1870s. The Civil War took many men out of school for a long period of time, and by the school's opening in 1866, there were fewer men qualified to enroll.

$$\left[y^n \frac{d}{da_0} - y^{n-1} x \frac{d}{da_1} + y^{n-2} x^2 \frac{d}{da_2} - y^{n-3} x^3 \frac{d}{da_3} + \dots \right]$$

To be a Woman at RU

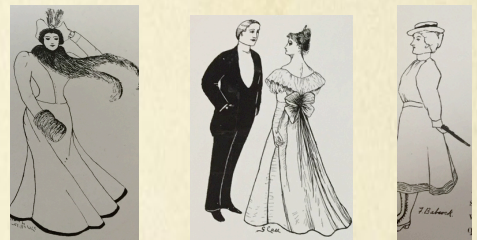
MacKinnon, Grove and Rice dealt with more than just grades and degrees during their time at the university. They were held to different standards than men and expected to behave differently. These expectations had to do with society's ideas about proper gender roles and how respectable upper and middle class white men and women should behave. These expectations affected what women studied in school and what they did after earning their degrees. Because women were expected to marry and have children, many women chose this traditional path after their undergraduate studies.

Most women picked degrees that were connected to caring for people or were considered feminine, such as the arts, English, education, social work or nursing. Fewer women went into the fields of science or professional studies. Unlike the men in these fields, women were not expected to pursue careers or be hindered from marrying because of their jobs. Some women studied these fields in spite of the biases against them. Mary Rice who may have just wanted an education or Bessie Grove who was passionate enough about the field to try to work in it are examples of this trend.

THE NEGATIVES FROM WHICH THE COMPOSITE PHOTOGRAPHS CAN BE TAKEN

Student Name	Work Name	Favorite Repose	Political Workings	Favorite Study	Class of Faculty	Profession
Harry Dickinson	Henry	"The book says"	Democracy	J. H. Confield	Little County	Underwriter
Wm. Talbot Oatwood	Hill	"I'm in it"	Blackstone	Boyle on Clinton	Under the	Practitioner
Gertrude Anna Christy	Gertrude	"A member of the	Give us something	Natural History	The Capital	Modelling
Geo. Loring Dink	George	"My own way"	Oratory	Boyle on Clinton	Under the	Practitioner
Wm. Francis Eddy	Francis	"It is important to"	Her hair	Physiology	Under the	Practitioner
Sherron A. Hestrop	Her	"Don't you believe"	Love of study	All of them	Under the	Practitioner
Gertrude G. Hestrop	Gertrude	"A little change of"	How to read	Practical Botany	Under the	Practitioner
Joseph Jacob	Joe	"What's the life?"	Is adapted to them	It's a man of	Under the	Practitioner
Charles E. Kellough	Chas. E.	"I can never give"	Has done them	The life of	Under the	Practitioner
Ann Helen Kennedy	Ann Helen	"Anger is love"	Will write and	How to please	Under the	Practitioner
Mary Alice Massey	Mary Alice	"I don't know"	Her hair	How to please	Under the	Practitioner
Paula V. McKeown	Paula	"I don't know"	Her hair	How to please	Under the	Practitioner
Delia M. Merrill	Delia	"I don't know"	Her hair	How to please	Under the	Practitioner
Wm. Allen Kewen	Wm. Allen	"I don't know"	Her hair	How to please	Under the	Practitioner
Stacy Phillips	Stacy	"I don't know"	Her hair	How to please	Under the	Practitioner
Frank Moorehead	Frank	"I don't know"	Her hair	How to please	Under the	Practitioner
Alta Lillian Stone	Alta	"I don't know"	Her hair	How to please	Under the	Practitioner
Louise T. Stone	Louise	"I don't know"	Her hair	How to please	Under the	Practitioner
Maria K. Taggart	Maria	"I don't know"	Her hair	How to please	Under the	Practitioner

In *Annie MacKinnon's class survey in the 1889 RU yearbook, she does not stand out from other female students. This is because they all answered most of the questions in a similar manner (similar answers in the photograph above are outlined in blue). In fact, MacKinnon's answers (outlined in red in the photograph) are standard feminine answers, using the traditional idea of women as maternal and selfless. Woman understood and, in this case, even embraced the stereotypical images of womanhood that worked against them during this period. MacKinnon's only unique answer is her reply to the question about her greatest weakness, which she admitted, was her "quick, haughty temper."*



These illustrations were used to describe stereotypes of female university students in an 1889 RU yearbook article on the subject. The author believed that the perfect woman was smart but not too smart, social but not too outgoing. These ideas might seem familiar because they are similar principles used to judge women's actions today. Society has and still does police women's expressions and actions, leading many women to perform a femininity that follows these impossible standards. MacKinnon, Grove and Rice knew of these standards and would have been subject to them...

A Professional Woman

Mary Rice is a great example of a unique student during this time. She was one of the few women who enrolled in professional programs in the 1890s. During her time in the program, Rice was one of 8 women out of the 66 students. Compared to the 167 women who attended the KU liberal arts programs, this number is not high. This number is higher, however, than the other professional programs that year— there was only one female law student and no female engineering students. Professions were considered male pursuits because men were supposed to be the breadwinners and financially care for their families. Many women refrained from pursuing degrees in professional programs either because they simply were not allowed to enroll or because they were following gender social codes.



Though women were not expected to have careers or be breadwinners, many still needed jobs. The standard female profession during this period was a teacher. The image on the left is of a 1890s female teacher teaching a co-ed class of younger children. It was easy for women to justify their pursuit of a teaching career because they could argue that the same feminine traits that society believed made them good mothers would also make them good teachers of young children.



As men did not have limits on the professions they could pursue based on gender, they had many more options. Scientific jobs, like engineer or chemist, at the end of the nineteenth century were becoming a huge enterprise. As an example, the photograph on the right is of a 1901 KU pharmacy class giving a demonstration on toxicology. The class at the pharmacy school included some women, but the demonstration pictured only includes men. This image represents how the public believed science and scientists looked — white and male.

School	Men	Women	Total
SCHOOL OF ARTS			
Liberal Arts	167	167	334
Education	1	1	2
Business	1	1	2
Journalism	1	1	2
Speech	1	1	2
Sum of all students	171	171	342
SCHOOL OF LAW			
Law	1	1	2
Sum of all students	1	1	2
SCHOOL OF PHARMACY			
Pharmacy	1	1	2
Sum of all students	1	1	2
SCHOOL OF ENGINEERING			
Engineering	1	1	2
Sum of all students	1	1	2
SCHOOL OF FINE ARTS			
Music	2	2	4
Drama	1	1	2
Art	1	1	2
Sum of all students	4	4	8
Sum of all students in all schools			
Men	176	176	352
Women	176	176	352
Total	352	352	704

This 1893 list of KU students looks at the numbers of men and women in each school at the university. It breaks down into the pharmacy, engineering, law, fine arts, and "arts" (liberal arts and sciences including mathematics) schools with the number of men and women students in each school. From the list, you can see that men are the majority in the professional schools: pharmacy, law, and engineering. However, the fine arts school has few men compared to the female students. There were no males, however, against studying in a field not gendered for you and some women (and men if you look at the fine arts section) at KU choose to study in fields typically not considered appropriate for them.

The model of professional education also made it difficult for women to study in these fields. In the field of pharmacy, an apprenticeship (learning a trade by following and training on site) with a pharmacist was the best way to pass a pharmacy-licensing exam before 1920. Women struggled to get pharmacists to choose them as an apprentice over male applicants. Pharmacy schools were closely tied with the former apprentice model. These programs, however, were in mostly co-educational schools, which allowed women to gain pharmaceutical experience outside an apprenticeship if they could not obtain one. Even though these schools could open doors for women, pharmacy was still a degree connected to an apprenticeship model and a male-dominated career, so not many women entered these programs.

Is it Dr. or Miss?

For women in the sciences, the fact that science was a male world made it difficult for women to succeed as scholars and professionals. However, Annie MacKinnon is one such success story. She was the only woman of the three profiled in this exhibit to earn her doctorate. After MacKinnon received her undergraduate degree in 1889, she continued her education at KU to receive her Master's degree in 1891. Afterward, she went straight to Cornell University and received her doctorate in 1894. This is a feat that not many women accomplished. One study claims that there were only 9 women with mathematics doctorates before 1900. In all fields, 228 women received doctorates before 1900 out of the over 3,000 doctorates awarded in those years. But, the numbers in the sciences were the lowest, including 8 women with Botany doctorates and 3 women in Physics.



This is a photograph of a 1890s KU anatomy class, humorously being taught by the model skeleton. As you can see, the class itself is small, but it still only has one woman among the few men in class. Yet, she is not removed from her classmates. It was sometimes the case in universities to completely separate men from women in classrooms. This image reflects the reality for women like MacKinnon, Grove and Rice. In some of their mathematics classes, they would have been the only women in the room.

This photograph of KU's Graduate Club from 1899 is a good look at what it was like for women studying in higher degree programs. The two women in the club represented the minority of women in graduate programs because while women were not rare in undergraduate programs, the numbers declined as the degrees advanced.

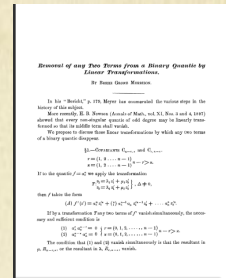
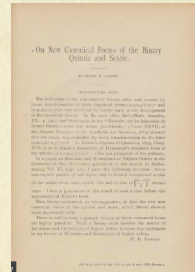
But MacKinnon did not stop with her doctorate. She also studied two years at Gottingen University in Germany. This is impressive because European universities were much stricter on allowing women to study with men and co-education took much longer to take hold there than in America. MacKinnon's intelligence and education got her into a school that did not allow many women to enter its halls. The fields of science had excluded women for some time because of society's assumptions about women and their intelligence. Especially by the turn of the twentieth century, society saw science as a field of prestige and high intellect. In this period, most people believed these attributes described men, not women. For women working toward degrees, it was hard work to battle stereotypes about their intelligence and the worth of their scholarship.

$$a = a_1x + a_2y, \quad \beta = \beta_1x + \beta_2y, \quad \gamma = \gamma_1x + \gamma_2y, \quad \delta = \delta_1x + \delta_2y,$$

Research and Bias

A study of Bessie Grove's and Mary Rice's research reveals that women often faced different treatment because of their gender. Bessie Grove's experience at KU is one example of how women researchers were treated differently than male researchers. Grove wrote and published two papers while at KU, the first in 1897 and the second in 1901. The first article, "On New Canonical Forms of the Binary Quintic and Sextic" begins with a note by her professor Henry Bryson Newson. Instead of introducing Grove's work, Newson's introductory note gives himself credit for Grove's research by saying he discovered a theorem before it was published elsewhere and he gave it to Grove to prove. Newson never wrote introductory notes for any of his male students. This commentary was unique and seems to indicate that Newson wrote it simply because Grove was a woman. Grove was a talented mathematician in her own right. Her 1901 article was published in the *American Journal of Mathematics*, a well-known mathematics journal – a feat her male peers did not accomplish.

Mary Rice did not deal with the same discrimination as Bessie Grove. For Rice, scientific writing styles did not make it clear what work she did in her research. Rice's research was for her double MA degree in both chemistry and mathematics. Because of the way that academic scientists research and write collaboratively it is hard to tell how much work Rice contributed and how much credit she should receive for the project. The article describes a student obtaining a water sample, checking its composition and also computing the data. But as the paper is written in the first person, we can only assume that Rice is the student retrieving the samples and computing data under the supervision of her professor.



On the first page of Bessie Grove's article for the Kansas University Quarterly (left), her professor wrote an introductory note. In the first half of the note, Dr. Newson provided background on the topic. Later in the note, Newson explained that the idea for Grove's research was his idea and that he gave her the equation that she used in her research. Even if Newson did help her pick this topic, by writing this, Newson turned Grove into a computer, or someone merely computing equations, instead of supporting her as an independent researcher. In the article (right) published for the American Mathematics Journal, Grove had no introductory note. There is no mention of Newson or his influence on her work but the topic is very similar to the first article.



This short article is an example of Mary Rice's research for her double M.A. in both chemistry and mathematics. Usually, women in the sciences worked under the supervision of their male professors. The only way for women to study under the guidance of female scientists was at women's colleges, which actively hired more women. In co-educational schools, men were always hired in science professorships over women. For the deans of these universities, they preferred the male students to be taught by men, even if a woman was qualified for the job.

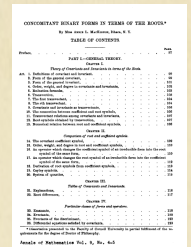
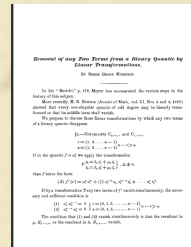
A Thing of the Past?

Annie MacKinnon, Bessie Grove and Mary Rice were exceptional scholars in a field that many women did not even enter. They had limited options for the course of their lives: low paying work or marriage. Women like Annie MacKinnon, who got to work as professors in their field at women's colleges, were lucky to get hired in their fields. They were treated differently in research and scholarship. They lived in a society that gave women fewer options, expecting women to marry and have children. MacKinnon, Grove and Rice walked the tight rope of appropriateness to obtain the education they wanted but in the end their limited options forced them to choose between their academic passions or acceptability and security in marriage. In the end, they, like most others, chose marriage.

Unfortunately, women's education, especially in STEM fields, is still a global issue today. In many places across the world, women find it difficult to receive an equal education or any education at all because of discrimination and social ideals about women. In the Western world, this is a more subtle bias because women are expected to be educated. Scientific and mathematics ability is still assumed to be a male skill, with women being under represented in fields like robotics, mathematics, physics, and other areas. One study showed that women accounted for only 12% of PhD faculty positions in mathematics in 2007, yet 29% of the mathematics PhDs were granted to women between 1996 and 2005. Rules and policies have helped women get into institutions and jobs but there are still limitations because of gender roles. An article written by the American Association of University Women argues that many of the problem for women in STEM fields have to do with the social ideas that affect women's performances, like the social assumption that men are more competent or seen as better leaders than women.

Take a Walk in Their Shoes

The women profiled in this exhibit spent years of their lives becoming accomplished scholars in the fields of mathematics and science. Annie MacKinnon and Bessie Grove were highly educated in the fields of linear algebra and geometry with successful publications and degrees. Mary Rice also was skilled in the fields of mathematics and chemistry with a focus on pharmacology. To understand the kind of work these women engaged in at KU in the 1890s, here are samples of mathematics problems for you to solve. While these problems are much simpler than the complex equations that these women were computing, you can experience for yourself what their research was like. .



This scholarship produced by Annie MacKinnon and Bessie Grove shows exactly the kinds of problems the women were researching at KU. Featured here are MacKinnon's doctorate dissertation and one of Grove's published articles. Both women worked in the fields of linear algebra and geometry but you can see that their topics look dramatically different. Since mathematics research is independent, these women would have written and computed all of these equations independently. The topic and the computing would have been decided and completed solely by these scholars. .

Problem:

Solve for x and y in this linear system: $x + y = 5$, $2x - y = 3$

Solution: Solving each equation for y, we have the equivalent system $y = 5 - x$, $y = 2x - 3$.

Setting these expressions for y equal, we have the equation $5 - x = 2x - 3$, which quickly leads to $x = 8/3$.

Substituting for x in the first equation, we have $y = 5 - x =$

$$5 - 8/3 =$$

$$7/3.$$

Thus, the solution is $x = 8/3$, $y = 7/3$.