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Mathematically Talented Women in Hollywood: Fred in *Angel*

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Abstract: Given the increase in the number of fictional women mathematicians and scientists on television and in the movies, educators who wish to incorporate pop culture into their classrooms need tools with which to evaluate these portrayals. In this article we summarize studies related to the impact of Hollywood representations on girls and then we provide a case study example of the character Fred Burkle from the television series *Angel*. In addition we provide a theoretical foundation and popular culture role model checklist that can be used to analyze other representations.

Keywords: Fennema-Sherman, gender schema, pop culture, representations of mathematicians, role models, women in math, women scientists on TV and in movies.

INTRODUCTION

Individual faculty such as those represented in this volume have used popular culture in the classroom to alleviate math anxiety and to help students connect to significant mathematics. Recent educational initiatives such as *We All Use Math Every Day* [12], co-sponsored by CBS, Texas Instruments, and the National Council of Teachers of Mathematics, and *MathMovesU* [31], sponsored by Raytheon, strive to change attitudes and attract students to mathematics by capitalizing on student enjoyment of celebrities and popular culture. At the same time, Hollywood has increased its use of mathematics and mathematicians, but some of those representations may not be all that positive for attracting students to mathematics. Others have examined the stereotype of the mentally ill mathematician (e.g., [25]), which may make it harder for students to identify with mathematicians. In this article we discuss the representation of mathematically talented women in Hollywood

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and provide a framework for examining the messages they may convey to the public and our students as we examine the example of physicist Fred Burkle in the television show *Angel* [1]. Unlike more recent representations of women mathematicians, such as Amita in *NUMB3RS*, which are aimed at a more mature audience, *Angel* aired on the WB network from October 1999 to May 2004 as part of a lineup of programs specifically targeted at teens and young adults. It is for this reason, and also because Fred's experiences provide a rich context to discuss a variety of issues related to women in mathematics, that we chose Fred as a case study.

IMPACT OF HOLLYWOOD PRESENTATION ON GIRLS

Where do people get their impressions of what mathematicians are like? Students, especially girls and young women, often have limited opportunities to meet real women mathematicians and scientists [33], yet they clearly must form their personal images of mathematicians from somewhere. A recent press release appearing in the newsletter of the Association for Women in Mathematics (AWM) notes, "We as a culture do a very bad job of telling our children what scientists do [37]." Numerous women mathematicians, including one of the co-authors, have been told they don't look or sound like a mathematician, and from research "We know that many students perceive mathematics as a discipline that is done by others rather than people like themselves. The 'others' may be the smartest students (Oakes, 1990), boys (Meyer and Koehler 1990), or specific ethnic groups (Moody 1997) [38]." While the importance of role models is well documented, examples of exceptional women mathematicians such as Emmy Noether can be detrimental [27]. Many students view all mathematicians as mathematical geniuses. If we only expose students to exceptional individuals who on the surface seem to be positive role models, like Emmy Noether, this can have the unintended effect of reinforcing the stereotype that one must be naturally gifted to be a mathematician. Many of our students who do not see themselves in this way may feel excluded. A number of studies show that television commercials that are gender-stereotypic caused some women to underperform on a mathematics test, avoid more mathematics questions in favor of verbal questions on an aptitude test, and indicate less interest in quantitative career fields than those who had not been exposed to the commercials [13]. Another small study showed that "Math majors like the negative portrayals of themselves, but, at the same time, some people did not major in math because of these portrayals [26]." Others have looked at the impact of biased media reports [9, 24, 29], and an upcoming publication will reflect on the representations of intelligent women [23].

Researcher Jocelyn Steinke asserts that in the absence of real-life role models, children will construct mental models of women in science from the

images they see in the popular media [32]. Other media studies support this view. "Research on cultivation theory suggests children (Swan, Meskill & Demario, 1988) and adolescents (Signorelli, 1990, 1993; Huston & Alvarez, 1990; Wroblewski & Huston, 1987) learn about the workplace from the unrealistic and stereotyped images they view on television" [36]. Psychologist Sandra Bem's gender schema theory posits that the degree to which children strongly associate stereotypically masculine (e.g., "ambitious") and feminine (e.g., "warm") traits with themselves influences how much they will use gender as a lens through which to interpret the world, and that media images of women scientists shape these self-perceptions [5, 6, 8]. The effect can become stronger over time as children more fully absorb and internalize these cultural stereotypes [7]. Steinke analyzed various portrayals of women scientists in television and film [32, 33, 34]. In [33] she used a framework of five themes derived from gender schema theory and previous literature on the experiences of women scientists in the United States: early encouragement in science, professional status, professional reputation, professional relationships and the impact of personal relationships on professional goals.

Some of Steinke's themes are similar to concepts included in the Fennema-Sherman mathematics attitudes scales [17], which assess eight components deemed by mathematics educators as critical for success in math: attitude towards success in mathematics, mathematics as a male domain, mother/father support, teacher support, confidence in learning mathematics, mathematics anxiety, motivation for challenge in mathematics, and mathematics usefulness. In a more recent presentation, Fennema discussed perspectives from many different fields regarding gender equity in mathematics and science, emphasizing the importance of using multiple approaches to further our understanding, including feminist and gender-based studies of the kind similar to Bem's work, to address the questions about girls' study of and participation in mathematics [16]. With this in mind, the authors will use both Steinke's themes and the Fennema-Sherman dimensions in analyzing our example of Fred in *Angel*.

There is one other issue that the authors feel should be addressed when discussing the representation of mathematically talented women in Hollywood. While the case for media images negatively shaping students' beliefs about women in mathematics is well-established, it does not necessarily imply that simply decreasing stereotypical representations and increasing the quantity of positive, realistic representations of women scientists on television and in the movies will in fact result in a corresponding increase in the number of girls who choose to pursue mathematics as a career. In its annual review of literature on women in engineering, the Society of Women Engineers (SWE) notes [18], "Simple one-shot exposure is probably not enough to get more girls involved in engineering programs. If that were true, then we would expect to see young female fans of *Star Trek Voyager*, with its strong female engineering characters, flocking to the field."

SWE follows this by emphasizing the role of home environment and parents, which is also addressed by both Steinke and Fennema-Sherman. The authors would go a step further and assert that for representations of women in the media to have an impact similar to that of live role models, girls need to be able to personally identify with the characters as professional role models in the same way they might identify with a real woman mathematician. Of course the issue of identification is complex and Steinke touches upon this in [34], where she analyzes appearance and the characterization of women scientists into the following categories: professional and realistic; mad and maniacal; clumsy and absentminded; and nerdy and antisocial. Here we phrase the issue of identification a bit differently. Students need to see people who are "like them" doing mathematics in the same ways they do. Therefore, the analysis of Fred will also include a discussion of whether or not she is someone with whom girls might identify both in the way she solves mathematical problems and on a personal level (see Appendix).

THE TELEVISION SHOW *ANGEL*

The television series *Angel* is a spin-off of Joss Whedon's popular cult series *Buffy the Vampire Slayer*. Both of these shows take place in the modern world, with a slight twist: vampires, werewolves, witches, and demons exist and walk among us. Magic is also real and potentially devastating on an apocalyptic scale. Angel, a vampire cursed with a soul (and therefore a conscience) lives in Los Angeles and fights against the forces of evil, usually mystical, with a mixed band of humans and supernatural allies. Among them is human woman Winifred "Fred" Burkle, a physicist introduced in the episode *Belonging* [1, 2ADH19]. When we first meet Fred she is traumatized and apparently mentally unstable from her ordeal of spending years in an alternate dimension. After coming back to Los Angeles with Angel she rather quickly recovers and becomes an asset to the *Angel* crew, revealing knowledge of not only physics but mathematics and engineering, plus a general skill for invention. She also fights physically at times alongside her male companions, demonstrating reasonable proficiency, a hallmark of Whedon's women characters. Many times Whedon has been praised for including these strong women characters in his work and inspiring others to do the same [35].

Are Whedon's women as progressive at doing science and mathematics as they are at fighting? Clearly the characters of any television show are dependent on the creators and writers who produce them, so it makes sense to examine the knowledge and experiences of these people when considering their women characters. A scientific degree is not a requirement for realistic representations in Hollywood, but familiarity certainly helps to create accurate and realistic portrayals, and fans of the show are often interested in the writer's perspectives, and so it is natural to include them in popular culture discussions.

We have found exactly one writer in *Angel* with a background in science. Jane Espenson has a father who was a chemistry professor. She double majored in computer science and linguistics as an undergraduate student and was a graduate student at Berkeley in linguistics. In terms of who she identified with, she said,

> And if we're talking *[The] Breakfast Club*, … Anthony Michael Hall–that's it! I was really quite a lot like him, only a girl. A little young for my age, kinda nerdy, not always conscious of how I looked while I was thinking. And I almost wound up a linguist because words are coool, man. [2]

The only episode of the series that contained significant mathematical content and might have needed mathematical expertise is *Supersymmetry* [1, Episode 4ADH05], but Jane Espenson did not seem to be working on *Angel* at the time, nor during any of the episodes containing Fred, and even if she had been, she probably wouldn't have had the mathematical physics background *a priori*:

> **Fred**: There are several competing dimensional theories. And, while each provide insights, physicists have long searched for a unifying theory–one that can account for both the behavior of the smallest sub-atomic particles and the largest forces of nature. If space-time can undergo massive rearrangement of its structure, which I believe it can, tearing and reconnecting according to a pre-determined disposition, then T-duality would allow for the compactification of extra space dimensions. Consider the non-perturbative properties of superstring theory. In D-branes, especially as applied to Dirichlet boundary conditions with dual open strings that are T-transformed. This, in turn, leads to the conclusion that strings can only end in P-dimensional dynamical … [1, Episode 4ADH05]

The wording of Fred's explanations indicates some level of expertise. Perhaps the writers adapted Brian Greene's book *The Elegant Universe* [19]. On the other hand, if there was a physics consultant or a writer with a scientific background working on the show at the time, he or she probably was not involved in all aspects of the show. While the episode title is correctly one word, the title of Fred's article is "Super Symmetry and P-Dimensional Subspace" which is awkward on a number of levels. Before Fred begins her talk, she is nervous because her presentation is between two prominent and well known physicists while she herself is a relative newcomer to the professional arena. The first two names on the symposium list, Laura F. Jenkins, and Anatole Popov, seem to be made up, while Ed "Whitten" and Brian Greene are indeed famous physicists, but Witten's name is misspelled.

Tim Minear, another writer for the show, was asked about problems reconciling the timeline of the main character in *Angel*, and he replied [28], "You think that's simpler? Hey, I was graduated from the Joss Whedon College of Advanced Mathematics. Hellifiknow." Joss Whedon, who created the show, explains that [22] "In A levels … you choose your three subjects. It's very odd, but it's also great because I didn't have to take math or science … Well that's why my wife does the bills … When the bills come and I go, 'What's a decimal?'"

Fennema-Sherman Analysis

Regardless of the feelings of the writers about mathematics and physics, Fred does come across in many ways that could be considered positive. What are Fred's attitudes toward her abilities in mathematics within the framework of the Fennema-Sherman mathematics attitudes scales? The *Angel* universe often makes little real distinction between the magical and the scientific. Many apparently magical effects are often revealed to be mathematical or scientific in nature. For example, the portal that conveys both Fred and the other *Angel* characters into the alternate dimension where we first meet her is later discovered by Fred to be created by "consonant representations of a mathematical transfiguration formula" [1, Episode 2ADH22]. In other words, the mathematical formulas that explain the physics of creating inter-dimensional portals had been turned into a spoken code that resembled a magic spell.

After returning to Los Angeles and recovering from her long exile, Fred and her mathematical abilities are readily embraced by the other characters. In the episode *Offspring* [1, Episode 3ADH07], the character of Wesley—heretofore the acknowledged "brain" of the group—asks Fred for help, "Gunn and I were hoping you could give us a hand with the Nyazian Prophecies. We need someone who can do the math." This is one of many examples in which mathematical thinking is portrayed as valuable in the *Angel* universe, and it is clear that the entire Angel crew, including Fred, understands its usefulness.

The evident zeal with which Fred uses her skills in tackling the variety of unique problems faced by the Angel crew points to her very positive attitudes about her own success in mathematics, as well as her confidence, motivation for challenge and general lack of anxiety about doing mathematics. (There are a few notable exceptions that will be addressed below in the context of Steinke's themes.) For example, by the end of the episode *Conviction* [1, Episode 5ADH01], Fred ably and authoritatively leads a team that includes other scientists in the search for a cure to a mystical virus that could wipe out millions. Finally, with regard to the perception of mathematics as a male domain, Fred never explicitly gives her views on the subject, but the way she interacts with the male characters (including male scientist subordinates in the fifth season) in the realm of problem-solving suggests that Fred does not

believe men have an advantage. Indeed, most of the central male characters readily admit that Fred's skills in the areas of mathematics and science far surpass their own and they support her in her mathematical and scientific endeavors.

If Fred is a generally confident, competent, and motivated woman who believes that women can succeed in mathematics and science, how did she get to be that way? We know little about Fred's life before the group encountered her, though we do get to meet her parents in *Fredless* [1, Episode 3ADH05]. What we see of Mr. and Mrs. Burkle implies that they are supportive of their daughter and her choices. We also see Fred's graduate advisor, Professor Seidel, in *Supersymmetry*. She credits the first course she took with him for inspiring her to change majors from history to physics, and he highly praises her skills to several members of the Angel crew. In addition, Fred readily accepts the presence of another woman graduate student in Seidel's lab, reinforcing that she does not regard physics as a male domain. Later we (and Fred) find out that Seidel was so intimidated by Fred's abilities that he sent her to the alternate dimension to remove her as a competitor—the ultimate in backhanded compliments, perhaps. Nonetheless, based on the way she talks about him to others, one might presume that he was supportive of her learning up until that point.

Steinke Analysis

Based on the Fennema-Sherman measures, Fred would seem primed for remarkable success in mathematics and science. Taking into account the somewhat non-traditional universe in which she lives and works, Fred is professionally successful for much of the series. So, just what is Fred's professional life like? Steinke's first theme—early encouragement—has already been discussed. The remaining four of Steinke's five themes specifically relate to professional issues. The second and third themes in Steinke's framework are professional status and professional reputation. Most ordinary people in the *Angel* universe are unaware of the magical aspects of the world in which they live, so much of the Angel crew's work goes unnoticed by anyone other than themselves and the underground magical community. Fred initially has no status other than "rescued girl," but in the space of a handful of episodes she becomes a fully integrated and collaborating member of the team.

By the beginning of the fourth season, in *Supersymmetry*, Fred has also achieved major recognition in the physics community. At the end of the fourth season, the Angel crew is offered control of a large supernatural organization as a reward for defeating a major villain [1, Episode 4ADH22]. As a result, Fred assumes a position as head of a research lab for most of the remainder of the series. It is during these latter two events—presumably two pinnacles of her professional career—that Fred overtly displays an unaccustomed lack of

confidence in her abilities. When Wesley tells her that he's sure she'll have no trouble running the lab, Fred replies, "I don't even understand half of what they're doing." [1, Episode 5ADH01]. Later, her assistant Knox insists that he wants Fred to feel "100% secure running this lab" and her response is "Yeah, that'll never happen in this lifetime." Of course, this is the same episode cited above in which she rallies the lab to find a cure for a deadly virus. Perhaps it would be overly critical to expect Fred never to have doubts. She is, after all, human, and it is these types of human reactions that students more readily identify with. However, her behavior at these two important junctures seem very stereotypical when compared to her confidence during other dangerous and challenging situations that occur during the series.

Steinke's last two themes relate to professional relationships and the impact of personal relationships on professional goals. Fred's colleagues in the Angel crew certainly collaborate with her as an equal and even defer to her on a number of occasions when it comes to intellectual matters. Yet, at the same time, they are frequently overprotective of her where potential physical danger is concerned, even though she managed to survive for five years on her own in a dangerous alternate dimension and has demonstrated suitable skills and resourcefulness in that area since joining the group. Fred gets injured in the fifth season episode *Lineage*, prompting Angel to chastise the male members of the group for allowing Fred to be put in danger, something he would not do for any of the male members of the group. However, when the character Wesley actually apologizes for not protecting her, Fred is offended and responds, "Do you realize how patronizing that sounds? Protecting me?" [1, Episode 5ADH07]. She reasserts the point that she understands the risk of her chosen profession and that engaging in dangerous activities is her decision to make as an adult woman. Of course, the situation is complicated by the fact that the man apologizing is not simply a colleague.

As is fairly typical on television, many of Fred's professional relationships cross over into romantic relationships. She first develops a crush on Angel during her escape from the alternate dimension, at one point literally visualizing him as a white knight on horseback. However, the crush fades and next she is involved in a love triangle with Gunn and Wesley, two male members of the Angel crew, which contributes to a rift between the two men [1, Episode 4AHD06]. Fred chooses Gunn over Wesley and carries on a nearly year-long relationship with him that appears to be affectionate and mutually supportive, both personally and professionally. Both during their relationship and after they break up, Fred and Gunn also continue to work together successfully as part of the unit and are eventually rejoined by Wesley. This leads to another brief love triangle involving Fred, Wesley and Fred's subordinate Knox. This time Fred chooses Wesley, who is very supportive about her career. The highly infatuated Knox is ultimately responsible for Fred's death at the end of the fifth season. Because he viewed

her as "the most beautiful, perfect woman," and on an emotional level he said she had a "warmth that took you in and held you until everything cold and distant melted away" [1, Episode 5ADH16], he exploits her scientific curiosity so that he can sacrifice her to bring a powerful supernatural being he worships back to life.

Being taken over by supernatural beings is not a danger real women mathematicians and scientists have to face, but Fred's ultimate fate could be read as a metaphor for a variety of real life pitfalls professional women may encounter when trying to balance complex personal and professional relationships. Knox's words about Fred also unfortunately reflect a type of spin often used in biographies or stories on women in mathematics and science, focusing on their sacrifices and non-scientific abilities rather than their professional achievements [33]. Mathematicians should be discussed in the context of their mathematics, not just as famous names. It is also important to balance discussion of the mathematical concepts with information about the way in which these individuals do mathematics and their lives outside of mathematics. Not only does this help students view mathematicians as real people like themselves, but it also helps students relate to the mathematics [20].

Our Popular Culture Indicators

Despite her multiple romantic entanglements and periodic stereotypical bouts of insecurity, in many other ways Fred seems to be a strong, positive woman character of the kind advocates would likely applaud having on television. However, would young women actually identify with Fred? Perhaps as a person, but probably not with regard to the way she does the mathematics and science. Whether it is due to the practical constraints of episodic television programming or other factors, the highly intelligent Fred is repeatedly shown as being naturally gifted; we very rarely see her struggling to solve a problem. Further, she ascends both academic and professional ladders very rapidly. Like real woman mathematician Emmy Noether, Fred is not merely talented, she is exceptional. In that respect, Fred would probably be placed firmly into the category of "others" who do mathematics by those viewing the show. (See Appendix for a checklist summary of all measures that can be applied to other popular culture representations.)

CONCLUSION

Of course television portrayals of most professionals are to some degree inaccurate glorifications and stereotypes; why should a portrayal of a mathematician be any different? But if we are to follow President Bush's remarks that we need to encourage children to take more mathematics and science, then

we must identify and correct inaccurate portrayals of our profession, especially stereotypes that could keep students out of mathematics classes. Numerous authors recommend exposing students to mathematicians whose style of doing math is identifiable as being similar to the way they do mathematics and to mathematicians who have well rounded lives [4, 11, 30, 32]. We as mathematicians know that women can be rational and feminine at the same time and successfully balance a career and family with interesting lives and scientific work, but the general public is not always informed about these facts, and some, including scholars, see the scientific method as "masculine science" (e.g., [10]). There have been calls to increase the number of talented women scientists on television in order to recruit more majors [3, 14], and in other non-scientific contexts television shows grounded in social learning theory have been shown to lead to lifestyle changes [15]. While it is wonderful to see an increase of strong talented women in mathematics and science portrayed in Hollywood, these portrayals may have negative effects, as we still don't see well balanced role models with whom girls are likely to identify [21, 34]. There is hope for the future as scientists and popular culture scholars increasingly strive to convey the importance of exposing students to numerous role models with diverse styles and lives who collectively earn high marks.

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APPENDIX: POPULAR CULTURE ROLE MODEL CHECKLIST FOR FRED

Here we use $\surd+=$ Good/Excellent, $\surd=$ Average, and $\surd--=$ Poor.

Steinke Framework

1) early encouragement in science $\surd+$
2) professional status $\surd+$
3) professional reputation $\surd+$
4) professional relationships $\surd$
5) the impact of personal relationships on professional goals $\surd+$

Fennema-Sherman Framework

1) attitude towards success in mathematics $\surd+$
2) mathematics as a gender-neutral domain $\surd+$
3) mother/father support $\surd+$
4) teacher support $\surd$
5) confidence in learning mathematics $\surd+$
6) mathematics anxiety $\surd$
7) motivation for challenge in mathematics $\surd+$
8) mathematics usefulness $\surd+$

Our Additional Popular Culture Indicators

1) students personally identify with the character $\surd$
2) students personally identify with way the character does mathematics $\surd-$

BIOGRAPHICAL SKETCHES

Sarah J. Greenwald is Associate Professor of Mathematics and a Women's Studies core faculty member at Appalachian State University. She has a long history of involvement with projects on women in mathematics in addition

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Jill E. Thomley is an Associate Professor of Statistics at Appalachian State University. She has a BA in Psychology from Harvard University and a PhD in Decision Sciences (Statistics) from Rensselaer Polytechnic Institute. An active professional statistician, she consults with scientists in various disciplines and has served as an evaluator for a number of large grants for the National Science Foundation. In the classroom she strives to include current data and cultural examples as well as historical background, especially at the introductory statistics level with non-majors. Her theoretical interests include the analysis of rank order data and circular statistics.