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ABSTRACT

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Identity Reconstruction of Women in Physics: Interventionist Discourse Matters

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Abstract

This research draws a group of women physicists' experience in organizing a local network to investigate how individuals' career decisions are affected by their identity transformation. Poststructuralist feminist theories of identity and discourse are used to compare three women physicists' cases with data collected from in-depth interviews and participatory observation. My research argues that the availability of various discourses and the existence of interventionist discourses are essential to individuals' identity reconstruction: The more diverse the discourses, the more durable the subject's original identity. I demonstrate that gender issues in science education are not only about equity but also about identity, that gender is an informative window through which to probe minority groups' participation in the general communities, and that an understanding of identity transformation from school level to faculty level is necessary.

Introduction

If resources and access are available, will individuals, especially minorities, necessarily choose the routes they are encouraged to take? With numerous female-friendly and gender-inclusive science curricula, is the female participation rate in science at various levels vastly increased? Small increases at the secondary and postsecondary levels, the long-standing small percentage at the university faculty level, and the percentage decrease from high school to faculty level all report disappointing answers to this question. If resources and opportunities are enhanced and inequity diminished, why are the targeted group members remaining outside of the door? What factors remain under-examined?

Over the past three decades, researchers have identified gender bias in the norms, beliefs, presentations and practices of science and science education. Corresponding remedies such as alternative curricula and interventionist projects have been implemented in order to reduce such bias and increase females' and minorities' participation in science. Such efforts to

foster structural equity have achieved some success but are not always appreciated by their targeted groups—girls and women. Sometimes, this kind of feminist efforts generated anti-feminist resistance from girls (Kenway & Willis with Blackmore & Rennie, 1998). For example, researchers found that attempts to persuade girls to pursue particular subject and career choices often adopted a rather authoritarian model of pedagogy—preaching rather than teaching. Such a model failed to adequately attend to the complex issues of reception and identity (Kenway & Gough, 1998). A mere focus on structural equity is not enough to push the goal of equity forward to a larger success. This difficulty indicates that gender issues in science education are not only about *equity* but also about *identity*.

This research investigates the identity reconstruction of women physicists in their experience of organizing a local supporting network. It focuses on how they position themselves within the available discourses and how they construct the meanings of "women in physics" in the male-dominated community. Such positioning and identity reconstruction shapes their decision-making and informs an understanding of their choices regarding science careers. My focus on the faculty level is an attempt to invite conversations between findings at various stages, such as school level and faculty level, and contribute to a continuum of understanding about how identity issues matter from school to work. Such a continuum will enable a more informed and comprehensive reform of science curricula.

Before illustrating the identity reconstruction of some of the selected cases, I briefly review the literature concerning gender and science and the identity studies in science education; then I will review my research context and its methodology.

Gender and Science

Sandra Harding (1986) has pointed out that gender and science research has extended its focus on "the woman question in science" to a focus on "the science question in feminism." The former highlights the concerns regarding why so few women are retained in sciences and how we can identify the factors that disadvantage women and girls. The latter places women in the centre and instead problematizes science, asking what is wrong with science in that it does not meet girls' and women's needs and interests. These two focuses are both important and contributive to our understanding of why there is still a gap between women and science, and particularly between women and physics.

For the woman question in science, researchers have located some factors that affect girls' science learning and career choices. For example, girls' choices are influenced by issues of social or sexual attractiveness (Head, 1987; Priest, 2000). Gender stereotypes are enforced when both female and male students consider science more important for boys than for girls (Spear, 1987), and students' impressions of the scientific characteristics are more often associated with masculinity than with femininity (Kahle & Meece, 1994). Even teachers bear such stereotypes and interact with students in ways that favour boys (She, 1998). In high schools, boys were reported to dominate lab activities and control the use of equipment while girls are left to watch and assist in mixed-sex groups, or are left without adequate equipment in all-girl groups (Tobin, 1996). Women choosing scientific careers are encountering unfriendly environments and stereotyped expectations (NFB, 1996; Pattatucci, 1998).

While girls' science learning environments are problematic, the nature and naming of science is problematic too. Various projects related to the science question in feminism have scrutinized the masculinity and masculinist values inherent in the ideology, nature, text and language of "western" science (Kelly, 1985; Keller, 1985, 1992). Fundamentally, science is masculine because its epistemology and methodology are dominated by de-contextualized

abstraction, objectivity, and a nature/mind dichotomy. Modern science discourse denies other knowledge systems—such as that generated by midwives (Ginzberg, 1989) and Chinese medicine theories—the label of "science," ascribing them as irrational. The so-called "science" is narrow and only presents western middle-class white males' interests due to its historical development (Harding, 1986,1991). A few feminist educators are dedicated to searching for alternative forms or practices of "science," or reclaiming the phrase "women's science" (Eisenhart, & Finkel, 1998).

As research and findings around Harding's two questions accumulate, less attention, however, has been paid to the understanding of how women cope with their disciplines and environments. The reasons why women's participation in science decreases as their academic and professional level increases are still unclear, and our knowledge of what issues matter to women in their participation in science communities is still limited. Therefore, research on women's participation at higher levels is necessary and it provides a vision of an imaginable future for girls in school science. In turn, current identity studies at the school level can aid the construction of theoretical frameworks for identity studies at the faculty level.

Identity Studies in Gender and Science Education

The focus on identity formation and transformation is a relatively new research topic in the area of gender and science education. Drawing on the perspectives from situated cognition which suggests that learning ought to be thought of as a process of identity formation (Lave & Wenger, 1991), US scholar Nancy Brickhouse argues that the study of identity formation is important in understanding the ways in which gender plays a role in science learning (2001). In examining urban schoolgirls' scientific identity formation, Brickhouse and her colleagues found that school science does not provide learners with a wide range of identities (Brickhouse, Lowery, & Schultz, 2000). Choosing to engage or not engage in school science is a matter of identity formation in interaction with prevailing and dominant discursive structures of power. As Brickhouse (2001) puts: "the decision to disengage, resist, and ignore is the important other side of engagement and learning" (p. 287). Understanding issues of identity, marginalization, and engagement in school science becomes essential for teachers to prepare student scientists of diverse identities (Brickhouse & Potter, 2001).

Angela Barton, a US feminist science educator, has also developed a scholarship to inquire how inclusive the science education community is in its efforts to understand the meanings of "science for all" (Barton, 1998a, 1998b, 2001). Barton adopts theories in critical pedagogy and feminist pedagogy (Giroux, 1991; Gore, 1993) to examine the questions of representation and identity in doing science. For Barton, pedagogy in science classrooms is about the struggle for identities and representation, and it asks us to think about much more than scientific concepts when we consider helping all children to become scientifically literate (Barton, 1998b). Barton pays particular attention to urban homeless children's socially, politically, and historically situated identities in acquiring access to science. She illustrates the significance of different life experiences in intimately shaping the ways in which children engage each other and think about science.

In the UK, Gwyneth Hughes (2001) examined how students produced their scientist identities within various competing discourses. She argues that students' scientist identities cannot be adequately portrayed within rigid, isolated categories of gender or ethnicity. Instead, a multidimensional approach is necessary for a more comprehensive picture. According to Hughes, students' decisions to take or not take science courses were better understood by how their scientist identities transformed through the interaction of various available discourses.

Some students were able to reconfigure discourses available to them to produce a "new scientist" identity that was different from what was portrayed by science curriculum. Hughes concludes that the availability of competing discourses is important in facilitating new scientist identities.

Such scholarship of identity studies in science education provides valuable theoretical and analytical frameworks to pose broader questions such as how identity, representation, and discourse interact when individuals make choices, and how their choices may in turn affect the discursive structures in which their identities were formed. I intend to draw on such frameworks and the feminist critiques of science to understand women scientists' positioning of themselves and reconstruction of their identities within the available competing discourses. I also intend to draw the findings from women scientists' experiences to seek connections to and implications for the school level.

The Study

Jing, Hong, and Kim are women physicists based in an Asian country. Their cases are part of a larger research that monitored women scientists' identity transformation through the organization of a local support group for women in physics. The organization of such a local support group, though, was not a task that originated out of the internal needs among women scientists in this country. Instead, it was a mission brought back by two male colleagues—the president and secretary general—of the national physical society, attending the 1999 annual assembly of the International Union of Pure and Applied Physics (IUPAP), an influential international organization with member countries around the world. The IUPAP ordered the physical society in each member country to investigate the current status of the local women in physics and form a "Working Group on Women in Physics" (WGWIP) in their own country.

Jing, Hong, and Kim's country was chosen for the purpose of my research because it was in a period of seeking to increase its visibility and recognition among international communities. Such a mission from an influential international organization became a good opportunity for it to act as a "standard" member by carrying out the mission assigned. This country was chosen also because it had adopted the North American science curriculum and followed its development since World War II. The science curriculum discourse in this country is thus very similar to that in North America, yet the kind of feminist discourse of women and science was not found before the imported mission arrived. The significance of such a situation will be discussed later.

The study of the WGWIP in this country was conducted from December 2001 to June 2002, before the first IUPAP international conference on women in physics took place in Paris and after a local symposium for women in science concluded. During this period of time, in-depth interview and participatory observation were used as research methods. I worked as the executive secretary in forming the working group, acted as the liaison among group members, participated in the Paris conference presentation, and organized the local symposium. Several women and men scientists outside of this working group were also interviewed for their strong opinions against the group. In total, twenty-seven women and four men scientists were interviewed. Data consists of interview tapes of one hundred hours in total length, written interview notes of two hundred hours, statistics obtained from universities and governmental offices, three hundred and twenty email communications, documents for a conference and a symposium, and the meeting minutes of the working group.

Jing's, Hong's and Kim's stories are highlighted for the purposes of this paper to discuss a range of identity reconstruction through the reconfiguration of available competing

discourses. The discussion of identity reconstruction will focus on two identities: women and/or physicists. Being the only female faculty member in her department, Jing strongly dis-identified herself as a "women in physics". With exposures to limited competing discourses, her several decisions showed a conflict between her identity as a woman and her identity as a physicist. Hong also spent many years as the only female faculty member in her department, but her identity as a woman and her identity as a physicist were first confluent, and later conflicted as competing discourses appeared. Confluence between these two identities emerged again after she participated in the organizing of the working group. Kim was another key member of the working group and was exposed to discourses regarding gender and feminism. Coherence between her identity as a woman and her identity as a physicist was shown in her active role in the working group.

Four Competing Discourses

There are four discourses involved in the identity reconstruction processes of the three women physicists. Through the reconfiguration of such discourses, Jing, Hong, and Kim demonstrated different levels of identity conflict, confluence, and reconstruction. These discourses are "the physics discourse," "the woman discourse," "the international discourse of women in physics," and "the local feminist discourse."

As mentioned before, the Asian country selected has been following the science curriculum used in North America since the end of World War II. Masculine language and images, as well as the gendered biases involved in such curriculum, especially the older versions, can be commonly found in the science curriculum of this country. Although used in a different cultural context, the masculinity in such curriculum was not criticized but extolled because such curriculum was imported as "the science" taught in the "advanced," stronger countries. The masculinist values embedded in such curriculum were reproduced outside of North America through a colonialist route. In Jing, Hong, and Kim's country, science, especially physics, presents itself in an image unfriendly to women. Physics is perceived as an uncommon choice for women; and women who choose physics are said to be excellent, outstanding, exceptional, and extraordinary. This is what I term the physics discourse in this country.

The woman discourse is constructed mainly around the stereotypical feminine roles women should play, and partly around the contrary masculine images presented in the physics discourse. The women discourse involves sayings and beliefs such as: women should have children in marriage; women are responsible for childcare, care of the elderly, and other domestic activities; successful women can balance well career and family. The women discourse, in contrast to the physics discourse, involves conceptions such as women bearing inferior cognitive ability in science. Thus scientific excellence is hardly compatible with femininity within such discourse.

In the past three decades, feminist scholars and educators in the US, the UK, Australia, New Zealand, and Canada have been aiming to locate the masculinity of western science, and corresponding remedies have been implemented to reduce or correct the gender biases in science practices and science curricula. Such feminist efforts have paralleled the development of the feminist movement, and science is one of the many social registers to which feminist critiques apply. Thus the resolution of the 1999 annual assembly of IUPAP to form a working group on women in physics can be seen as a political and practical measure to make gender visible in physics communities, and as a home grown feminist call for action in North America. However, when such action was ordered to happen outside of a North American context—

such as in some third world countries where gender issues in science may take different routes and the local physics communities could have different attitudes towards feminism—it became an imposing imported item foreign to the local physics communities. In Jing, Hong, and Kim's country, there was very little research about the feminist critiques of science and it was not visible among members in their physical society. In fact, many members still hold suspicious or hostile attitudes towards the feminist movement. The formation of a supporting group for women in physics and the improvement of women's participation in science became a novel, intriguing mission brought to these local women physicists by an "international discourse of women in physics", but they did not necessarily consider it as feminist.

In other social, economical, and political arenas of this country, the feminist movement did take place and achieved some successes. Feminism was brought in by many scholars in social sciences and humanities, most of whom completed their PhD degrees in the US. There are feminist awakening groups, workshops, and organizations mainly focusing on eliminating gender inequity in social, economical, and political aspects. The recently established government also offered a big push for feminist policy making because it owes a great deal to local feminist groups who ran a successful campaign for its election. Thus for women currently or recently working in physics, the local feminist discourse is available but outside of their departments, their disciplines, their laboratories, and their textbooks. For these physicists, feminism is nothing new, but something most of them have not connected to their work.

Identity Reconstruction and Transformation

In a feminist poststructuralist framework, the working group on women in physics and their departments can be seen as the discursive fields where the interaction and competition of these four discourses took place. In this section, I use three women physicists' cases to demonstrate how their identities as women and as physicists conflict or coincide with each other through the reconfiguration of these available discourses. These interactions lead to identity reconstruction and transform what it means to be a woman in physics. While the physics discourse, the women discourse, and the local feminist discourse were locally available, the international discourse of women in physics was brought into being and functioned to anchor and sew the three other discourses together. It has a crucial impact on making the identity reconstruction process possible and functions as what I call "interventionist discourse."

Jing: Don't Single Me Out as A Woman in Physics!

Jing was recruited into her department in the mid-90s as the successor to the only female faculty member. After World War II, her country had begun its close ties with the US and established her department as its first in physics. With its historical heritage, it is among the most prestigious in the country and has an international reputation. In the twenty-five years before Jing was hired, there was only one female faculty member in the department. When it came time for this senior female to retire, she insisted that her position be filled by another female in order to establish a tradition and maintain their department as the model for other physics departments in the country, wherein every physics department should have at least one female faculty member. In a selection committee meeting, she told other members that she would reconsider retirement if the department failed to recruit an excellent female.

Jing was hired. She was the only female among the other strong candidates. Many senior committee members knew her well because she achieved the first place award every

year when she completed her undergraduate and master's degrees in this department. With outstanding distinction and strong references, she was admitted to a well-known, prestigious Ivy-League American university to complete her PhD degree in physics. When she applied for this job, she just finished her degree with outstanding academic records, excellent publications, and cutting-edge research proposals. The committee's internal reason for hiring her remained unknown, but later she learned that there was a "hire a woman" conversation during the competition process. She was very upset when she connected the conversation and the fact that she was hired.

Soon after Jing was hired, the retired female professor approached her and asked her to take special care of the few female students in the department because they may see Jing as their role model, a position the former professor had held before her retirement. Jing rejected her suggestion and told her that she did not see any reason to separate female students from male students, nor did she think female students needed special care. In the first few years of her employment, Jing was asked several times to sit in various departmental committees because she was the only female faculty member. She was expected to speak for female students and herself in ways her male colleagues might not. She rejected these invitations and told them: "If you want me to sit in just because I am a woman, I will not do it." When the mission to form a working group on women in physics was presented to her, she rejected it again and stressed that she had no interest in participating in such a groups if it was merely focusing on women. Her colleagues were surprised by her rejection and later learned not to mention the word "woman" if they wanted to include her in any collaborative work. When I was wrapping up my fieldwork, Jing was considering leaving this department.

Jing's several rejections of the label of a "woman in physics" and refusal to act as a woman representative clearly shows her discomfort with the fact that she was both a woman and a physicist. However, her reaction is quite common among many women physicists and is a typical stance minority members usually take when pressed to represent their entire communities in the public sphere. Minority members tend not, unless for political purposes, to feel comfortable being addressed by their difference from the majority members. Many of them follow the expectations, rules, or discourses even more strictly than the majority members because they want to show they are qualified members of the community. In order to justify their existence, many minority members choose to silence their difference or offer hostile responses towards any conversation about it because difference means, to them, some intrinsic inferiority they have tried hard to get rid of. This is exactly how a community or an institution as discursive structures function to regulate individuals' perceptions and behaviours to perpetuate the existing structure of power. In such instances, there runs the risk that a role model for minorities may become an excellent substitute member of the majority; i.e., a black role model becomes a substitute white, or a role model woman becomes a substitute man.

Jing was troubled by the conflict between the "women discourse" and the "physics discourse." These two discourses function to produce a common stereotype that ordinary women cannot do physics, or that ordinary women do not have adequate ability to do physics. Within such discourses, the idea of "woman" is associated with inferiority. As an "exceptional" woman who can do physics, Jin tried hard to prove that "some women" could be "as good as" men in physics and that she was a qualified member on the superior side. However, when it came to the moment of recruitment as recognition, it struck her that the "woman" in her was brought out by others and was, she suspected, attached as part of the recognition. The deemed inferiority came back to haunt her. Jing was overtaken by the physics discourse against women. She failed to acknowledge that her own academic excellence could possibly be confluent with her sex and gender. The incompatibility between the woman

discourse and the physics discourse continued to bother her to such an extent that she did not feel comfortable addressed as a woman in physics, or to join any kind of group associated with such an idea. Her identity as a woman and her identity as a physicist continued to conflict with each other and prevented her from exposure to or acceptance of other discourses related to women, such as the local feminist discourse and the international discourse of women in physics.

Hong: Maybe I'll Stay For Future Women in Physics

Hong was the only female faculty member in her department for 10 years and there was no one before her. She used to brag that she was the only female physicist between the two quarter-ends of the country for one decade until two other female physicists were recently recruited into other universities in the same region. She usually appears in a feminine look with long, black hair and skirts. Given her compliance with such coded femininity, she stressed that she could be very assertive and rigorous to her male students. Sometime, however, she was easier on her female students "because they tended to have more emotional troubles", according to her. Hong has encountered sexual harassment by a male faculty member from another department but has no one in her department or in her network to talk with. She also complained about feeling isolated because her male colleagues usually formed groups for activities she considered not suitable for women.

Hong worked hard in the 10 years with the department and was promoted to the full professor level. She got married three years ago and, due to her age, was having difficulties getting pregnant. Because her husband worked overseas, it was difficult to arrange time for them to get together. Hong was considering quitting her job, if necessary, to be a full time mother-to-be because she was feeling tired of and not satisfied by the work she did. She questioned whether choosing a demanding and hard working physics career is a good decision for women who also want family lives.

When she first received the invitation to form a working group on women in physics, Hong was not particularly interested until another invitation arrived. Her closest female friend in the university, who happened to be a feminist sociologist, invited her to speak to some outstanding female high school students in order to encourage their interest in science and technology. This second invitation inspired her interest to form a working group to support and mentor future women in physics. Drawing from her experience, she thought that it was important to talk with girls about whether they are suitable for physics and the possible challenges that lie ahead.

She then actively responded to the first invitation and took the initiative to form the working group. She organized several meetings and recruited several other women physicists to join her. However, in as many instances as possible, she wanted to make sure that some male colleagues were also included in this working group. She was afraid that excluding males also meant excluding resources. Hong believed that forming a women-only group, or a considered-to-be feminist group, inside a physics community, would not gain support but would offend male colleagues who usually have more resources and are in a better power network. She took a very careful, possibly anti-feminist, stance in organizing this group. In a 10-page document, she mentioned five times that this working group should not be mistaken as any kind of "feminist" group. In a preparatory meeting in which some male colleagues and students were present, she urged them to take it easy the establishment of this group and not to think of it as a "feminist" attempt.

I asked Hong what and how she thought about feminism. She told me about her feminist sociologist friend. This friend "revealed" to her some of the fierce internal conflicts

inside the feminist scholars' association in the country. Sometimes good friends became enemies. Feminism, to her, was not working even inside the feminist community. Therefore Hong did not believe that it would be a good strategy for this working group to adopt any feminist stance. Hong's sociologist friend also gave her some negative feelings when she tried to "sell" feminism to Hong. This friend, who was interested in women in science, kept telling Hong that because she was a minority in physics, she must have been oppressed or discriminated against, and that she should identify how her male colleagues oppressed her and fight for her equal rights. Hong did not feel so and was not in the position to receive this kind of advice. For Hong, this friend's feminism was not emancipative, but rather oppressive.

After 2 years of service, Hong stepped down from the chair position of the working group but remained very active. She worked with other women physicists in the group to maintain a support network among women like her and to help their female graduate and undergraduate students to survive in physics. This task became the most meaningful to her and she would remain in her physics professor position to carry out this task.

Unlike Jing, Hong's understanding of her recruitment to the department was not involved with "hiring a woman" discourse. Her bragging and feminine appearance showed that she was quite happy to be an exceptional woman who could handle physics. Her identity as a woman and her identity as a physicist was confluent until she was married. In her marriage, she started to draw on other aspects of the women discourse and felt the pressure to give birth. Her repeated failed attempts drew her to question the physics discourse she had formerly embraced. Her identity as a woman in physics became unstable until the international discourse of women in physics intervened. The international discourse of women in physics provided her with an internationally legitimate ground to see herself as a "woman in physics" and gave her new and meaningful understanding of her position. It helped to stabilize her identity and encouraged her to remain in the position of a woman in physics. This international discourse, however, has not influenced her negative opinions about feminism. The kind of local feminist discourse she was exposed to was not understanding and inviting but rather imposing and dogmatic. It would be interesting to see how her identity as a woman in physics may change or transform in the future when she is exposed to more diverse kinds of feminist discourse.

Kim: We Are Responsible For the Word "Feminism"

In contrast to Hong, Kim as the successor chair of the working group was keen on addressing gender issues and was friendly to feminism. She responded enthusiastically to my request to interview her about women in physics and told me that improving women's situations in physics was always an important issue to her. Her different attitude towards feminism was shown in a preparatory meeting for the local symposium when she had a dispute with Hong. As usual, Hong was stressing how important men's inclusion to the working group was. Therefore, she argued, they must include several important men from the physics society into this symposium, although designed only for local women in physics. For Kim, however, the purpose of organizing such a symposium was to provide a safe, private, space for women physicists to gather and meet each other, which would be different from other kind of public conferences or symposiums. As Hong's opinion that men be included gained favour amongst the other participants, Kim anxiously interrupted: "Why do we always have to hold on to men's legs?"

Kim's belief in a "women's safe space" is a product of her participation in a women's awakening group. Troubled by family problems, Kim was introduced to an awakening workshop reflecting on the ideas of women and of women's bodies. Through the course of the

reflection, Kim experienced tremendous personal growth and re-identified herself as a strong woman who emerged out of a vulnerable, insecure, and hurt one. She believed that women's growth and strength could be evoked in a women-only space and she was ready to share this positive experience of hers with other members in the working group. The kind of support she received from this experience remade her into a strong woman able to continue her career in physics, and empowered to encourage other women to stay in physics.

Eight years ago, before returning to her own country, she served as a senior fellow in the Research and Development sector of a famous US company for energy and technology applications. Certain family-friendly facilities were provided, and policies were implemented to assure equal opportunities for women and minorities in the company. Although Kim was not particularly active in pursuing women's equal rights at that time, she was certainly exposed to the kind of feminist discourses available in the US. Therefore when the international discourse of women in physics arrived at her office, she was no stranger to it and promised to participate as an active member. The easy connection between local and international feminist discourses enabled her to see the task of a working group from a feminist perspective. One day she shared with me the conversation she had with Hong about their different attitudes towards women's equal rights and feminism. She told Hong: "I don't see the point of distancing ourselves from feminism. What we are doing is to pursuing equal treatments that men already have. Maybe we are responsible for the word 'feminism' too."

For Kim, her identity as a woman was challenged because of family issues, but her identity as both a woman and a physicist appeared to be confluent and coherent. She did not question the values of being a woman in physics but further ensured these values. Her exposure to local feminist discourse prepared her for a personal and powerful commitment to a feminist endeavour. The international discourse of women in physics provided her an opportunity to carry out such commitment. It is reasonable to expect that her identity as a woman in physics is stable and will enable her to transform her problematic surroundings.

Interventionist Discourse and the Availability of Various Discourses

The stories of Jing, Hong, and Kim present a range of identity reconstruction via the reconfiguration of four identifiable competing discourses. Their identities as women and identities as physicists have been discussed. Jing did not have exposure to either local feminist discourse or international discourse of women in physics. The conflict between the woman discourse and the physics discourse troubled her identity stability so much that she strongly dis-identified herself as a "woman in physics". Hong's identity as a woman was at first confluent, but came into conflict when the competition between the "women discourse" and the "physics discourse" appeared. Her exposure to the local feminist discourse was rather negative and caused a barrier that prevented her from utilizing such discourse. The international discourse of women in physics functioned as an interventionist discourse to Hong and helped to stabilize her identity and keep her in her position for a while. Kim was exposed to all four discourses and was able to reconfigure them to support her identity and her ideas about what the working group should do. Kim was also capable of dealing with the intrinsic conflict between the woman discourse and the physics discourse, and was able to transform the conflict into an emancipative task by utilizing the other two discourses. Coherence was shown between her identity as a woman and her identity as a physicist. The relations between the three woman physicists and the four discourses are displayed in the following table:

Table 1
Three woman physicists' identities within four competing discourses

	Physics discourse	Women discourse	International discourse of women in physics	Local feminist discourse	Women identity and physicist identity
Jing	E. A.	E. ~A.	~E.	~E.	Conflicting
Hong	E. A.	E. A/~A.	E. A.	E. ~A.	Confluent
Kim	E. A.	E. A.	E. A.	E. A.	Coherent

Note. E means with exposures; ~E means without exposures. A means approval of such discourse; ~A means disapproval of such discourse.

Their experiences show that the availability of various discourses and the existence of interventionist discourses are important to the identity reconstruction process. When individuals are only exposed to a limited number of discourses, they have limited room to position themselves, especially when the available discourses are competing against each other, as in the case of the woman discourse and the physics discourse.

The stability of individuals' identities is determined by the stable positions they find within the available discourses. If the current discourses are not providing stable positions, the availability of other discourses becomes critical. When alternative discourses intervene, they offer individuals more dimensions of reconstruction and possibilities of transformation. In the three cases outlined, the international discourse of women in physics and the local feminist discourse functioned as interventionist discourses in identity reconstruction. These interventionist discourses interacted with the other two existing discourses, and different levels of stability in their identities as women in physics were observed after the interaction. Hong was exposed to more interventionist discourses and had a more stable woman physicist identity than Jing; Kim had an integrated understanding of both interventionist discourses, and showed more coherence in her woman physicist identity than in the confluence of Hong's.

The availability of various discourses and the existence of interventionist discourses are important to the identity reconstruction process. They provide more possibilities for identity reconstruction and affect levels of identity stability. A stable identity affects individuals' choices regarding whether they stay in their own positions, in their own departments, or do progressive work based on their positions.

Conclusion

The three women physicists' stories enable us to rethink the gender issues in science and science education as not only a matter of equity but also a matter of identity. The local feminist discourse and the international discourse of women in physics both arrived as resources for gender equity. They provoked critical reflections on gender and science, and provided the possibilities for equal access and equal opportunities. While equal access and opportunities may be available to individuals, women may not necessarily take them up until they can reposition themselves and reconstruct their identities comfortably within the discourses. If participation is a matter of access and choice, these women scientists' cases ask us to refine choice as contingent upon a stable and supported identity, and to consider the availability of various discourses a condition of identity transformation.

These stories also shed new light on our understanding of identity studies in science education. The call for a "gender-inclusive" science launched a wide and deep discussion and reflection among feminist scholars about what counts as inclusiveness. Issues of inclusiveness

demand that researchers investigate participants' identities not only of gender, but also of class, ethnicity, region, religion, and sexuality. In this vein, research focusing on gender tends to be seen as "merely" focusing on one factor and overlooking others. The findings from these three cases, however, turn this kind of argument around and show how a focus on gender can generate informative arguments for foci on other factors. A focus on gender in science is not "merely one factor," but a window on how minorities participate in their communities and how their decisions are made. Questions about women and science are particularly suitable for this purpose because women were minorities in science more than thirty years ago, and they are still minorities in science now. The literature on gender and science produced in the past three decades provides a basis upon which to reenergize future studies on issues regarding minority participation, choice, and identity in science.

My research at the faculty level serves as an invitation for conversations with current identity studies at the classroom level. Current identity studies in classroom levels believe that how students form their scientist identities and how teachers transform their identities in the teaching and learning of science in classrooms are important to educators' understanding of their participation patterns and choices, hence important to a further reformation of science curricula. Less attention, however, has been paid to the understanding of what kind of challenges could appear after students' choices in science and how their identities as scientists may change beyond classroom level. My study at the faculty level serves an informative purpose on such inquires and a provocative purpose for asking questions such as how far science reform at school level can go. An organic integration of findings from both levels is crucial for efforts aimed at a comprehensive reform of science curricula. How researchers can transform scientists' experiences into interventionist discourses that educators can use in science classrooms and how such interventionist discourses could help prepare future scientist identities are challenging and necessary foci for future identity studies in science education.

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