Doctoral Women's Learning and Identity in the Culture of Engineering: Stories as Situated Retellings

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Abstract

The participants' stories emerged as a 'reconstruction' of how they came to be doctoral engineers. The tensions experienced by the doctoral women engineers were very intertwined and linked to complex relationships that were regulated by cultural, institutional, and historical circumstances and influences. While Women in Science and Engineering [WISE] programs and scholarships have improved the presence of women in faculties of engineering, without structural changes this may not continue.

Introduction

Women face many obstacles in their academic careers but there is a gap in the research with regards to their perceptions of science and engineering education and how non/participation in the culture of engineering affects their identities. Moreover, little research has been conducted with female PhD students especially with regards to the reasons they have continued their studies, and their level of satisfaction with their career and lives.

The Canadian Council of Professional Engineers (2000) reports 15 per cent of doctoral students enrolled in engineering to be women. These results have improved in the last decade although the actual numbers are still small. “Programs at the graduate level merit special attention because graduate education is tied, directly and indirectly, to subsequent professional participation and performance in the field (Fox, 1996), and thus the graduate level is a critical stage for programmatic initiatives” (Fox, 1998, p. 201).

According to the CCPE (2000), the overall total number of doctoral degrees awarded is now at its’ lowest during this last four year period [1996-2000]. While the total number of doctoral degrees awarded to women in engineering has increased to 85 in 1999 and a lower number of 72 in 2000. Recruitment and retention programs for women, in Canada and abroad, have attempted to address these disparities at all program levels (Emerson, Williams, & Kieley, 2002; Fox, 2003; Frize, 2002; Gibney, 1998; Male, Lawrance, & Dias, 2002; Rinehart & Watson, 2002; Rosser, 2001; Wood, 2002).

The scope of this paper addresses the following questions: 1) What are the perceptions of doctoral women engineers related to participation and learning in faculties of engineering? 2) How do the female PhD students’ non/participation in engineering affect their identities? 3) What do female PhD students perceive as the ‘unofficial’ ways of continuing the history and traditions of the profession in faculties of engineering?

Conceptual Framework

The sociocultural approach examines how identity, as self-chosen description of a person, takes place within human action. This approach reminds us that "personal narratives and life stories are: socially situated actions; identity performances and; fusions of form and content" (Mishler, 1999, p.18). Narrative data is recognized "as modes 'secondary production', drawing on and redoing culturally available plots to construct their [the participants'] own distinctive stories" (Mishler, 1999, p.25). In addition, other culturally 'defined categories' that influence 'stories' such as gender, sex, power, and sexuality need to be uncovered (Britzman, 1998; Butler, 1999; Remlinger, 1995). The notion that these 'stories' are "situated retellings… responsive to the contexts of their production", co-produced and "developed within the on-going dialogue between interviewer and respondent" (Mishler, 1999, p.25) requires an emphasis on language when considering identity.

An extension of the sociocultural approach, situated learning, emphasizes the importance of context in learning.

> Legitimate peripheral participation provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artifacts, and communities of knowledge and practice. It concerns the process by which newcomers become part of a community of practice (Lave & Wenger, 1991, p. 29).

This also requires a shifting of the analytic focus from the individual as learner to learning as participation and performance in the social world. Performance in

relation to technology and science research has become increasingly important (Haraway, 1997; Latour, 1993; Mol, 1999). It is thought that to “tell techno-science stories is, in some measure or other, to perform techno-science realities…[that are] a particular and located enactment or performance of technological knowledge and practice” (Law & Singleton, 2000, p.767).

Lave and Wenger (1991) recognize the importance of social relations within a community of practice because students do not learn only from their instructors. As well, “it seems typical of apprenticeship that apprentices learn mostly in relation with other apprentices” (Lave & Wenger, 1991, p.93). More recently Wenger (1998) elaborates that “more experienced peers are not merely a source of information; … they also represent the history of the practice as a way of life. They are living testimonies to what is possible, expected, desirable” (p.156). This concurs with the research that affirms the importance of role models in developing ‘imaginable’ identities, especially in regards to women (Bandura, 1997; Fox-Keller, 2002; Franks, 1998; Frize, 2000). Theories of learning and identity with regards to science education are intricately inter-twined. The process of becoming a female engineer is studied in light of learning as social participation. Wenger (1998) contends that “participation here refers not just to local events of engagement in certain activities with certain people, but to a more encompassing process of being active participants in the practices of social communities and constructing identities in relation to these communities” (p.4).

Method

The purpose of this study is to understand how sociocultural influences affect women's choices to participate in science and engineering. It is also important to understand those influences on the choices related to enrolment and retention of women in science and engineering programs at multi-levels. On the basis of these statements, data collection employed a case-centered approach. In keeping with Mishler (1999), this study can be seen as a collective case study, that is, one story with multiple characters. More specifically, Mishler's (1999) case-centered research is an approach with distinctive features that requires individual trajectories of change to be retained through all stages of analysis. "Findings, therefore, do not refer to measures of variables aggregated across groups of individuals but to similarities and differences among intra-individual or intra-case patterns of change" (Mishler, 1999, p.11).

The collective voices of my participants exemplify both similarity and difference within this unique population. This is supported by Mishler (1999) who posits "rather than suppressing the variability among my respondents in how they achieved their adult identities, this approach retains and respects their differences and addresses them within a comparative framework" (p.11). This attention to studying diversity and change in lives and locating participants within the social and cultural matrix is a "step toward a relational conception of identity that contrasts with a view of identity as immanent or indwelling within a person, stable or consistent, carried into and expressed across situations" (Mishler, 1999, p.16).

Methodologically, the design adopted is a naturalistic qualitative inquiry using two open-ended interviews with participant verification after the first interview. The co-constructed narratives of seven doctoral women engineers, at various stages in their programs, were the primary source of data. The participants were enrolled in doctoral electrical or mechanical engineering programs at various Canadian universities. The life history narratives, from the participants' perspectives, help explain how they have come to be engineering students, what paths they have chosen, and how their relationships influenced these choices. Moreover, these stories detail how science and mathematics were best learned as well as the context of the experiences. In summary, my objective was to obtain thick descriptive data, stories composed by the women to tell me who they are and who they would like to become.

Findings

The participants' stories emerged as a 'reconstruction' of how they came to be doctoral engineers. From a sociocultural perspective, the tension of participating in social communities was an indicator of mediated action. "From this perspective, speaking, thinking, and other forms of human action are taken to involve an inherent, irreducible tension between agent and cultural tools such as language and narrative texts" (Werstch, 2002, p.6). The main tensions, or units of analysis, that emerged from the doctoral women's narratives are discussed.

Tension

The participants recounting their engineering experiences were fraught with tensions and contradictions. Many women started a particular 'theme' of their story by recalling the positive aspects of their experience but this description included contradictory statements that illustrated negative and differential treatment if not instances of exclusion. Fletcher's (1999) notion of women performing 'relational maintenance' was apparent, that is, their taking on the responsibility of keeping the peace within their work environments even when their remembrances comprised a parallel statement of this reality.

The main tensions which emerged from the doctoral women's stories were: 'Altruistic motives versus Elitism', that is, how the women's motivation for choosing and staying in engineering collided with the notion of superiority within the culture of engineering; 'Competence' as a measure of engineering ability; 'Exclusion' versus becoming one of the guys; and, 'Sameness versus difference'. These tensions inter-connected the context of their remembrances.

Altruistic Motive: Choice of Engineering/Elitism

In discovering the 'plot that links the elements of the stories' (Polkinghorne, 1995) in my narrative analysis, I was drawn to the recounting of altruistic motives of most of the women engineers. Although the ages and educational levels of my participants differed when their epiphany took place, the women remembered knowing that they 'wanted to help people' or they recognized their need to 'benefit society'. One engineer affirmed

> I had always been interested in science and then I realized that what I wanted to do was help people directly and get that immediate feedback and be able to see the impact that you could have on their lives-the beneficial impact. So, I realized that I wasn't going to get that from an undergraduate degree in engineering. So, I sort of thought of my master's as specialization in [sub-discipline] engineering.

While many studies reported females choosing science and future careers based on wanting to help people, most girls chose paths more in keeping with traditional sex-roles such as teaching and nursing (Subotnik & Arnold, 1997; Kerr, 1995) while some females were able to combine their outstanding abilities in science with stereotypical notions and sex-roles for women such as pediatric doctors, biologists, etc (Bandura, 1997; Wood, 1999). Doctoral women engineers' altruistic motives were novel in their 'vision' of engineering as a venue for helping society, and at the same time, reducing the influence of these stereotypical sex-roles or not allowing them to alter their career decisions. Interestingly, many women engineers made last minutes decisions to select engineering programs at the undergraduate level and were not knowledgeable of engineering as a program or a profession. One woman recalled her acting on this motive later in her career.

> I wanted to do something that I felt would contribute directly to society. Unfortunately for some of us it takes a little longer. It takes some of us like 8 years to figure that out. My thing was that I didn't find the [industry] work challenging, I didn't get any mental or emotional reward out of making a conveyor belt work better or a motor work better, or an elevator work faster or whatever.

Moreover, once the choice of engineering was made they were committed to their path. While deterrents in the learning environment and culture of engineering were reported, they maintained focus in their engineering studies. Unlike the women in Holland and Eisenhart's study (1990), the career interests of the doctoral women remained central and not marginal. The 'traditional culture of romance' and stereotypical sex-roles were reported to have some effect but more often romantic partners shared their interest in science, and were perceived as less 'problematic' to their completing their doctoral studies.

The altruistic motives of some of the doctoral women were frequently in tension with the notion of superiority often promoted within the culture of engineering. The doctoral women remembered first encountering this notion of superiority during frosh week with the songs and chants that cheered, "we are the best, of the best". When examining attrition rates, Anderson (2002) found that women engineers were uncomfortable with the male dominated culture, especially the attitude of superiority and elitism. Moreover, the very public and unique traditions of frosh week, coupled with the other traditions such as the engineering jacket, iron ring, and the oath of obligation, helped set engineering apart from other university faculties. No other faculties went to such elaborate lengths to demonstrate their uniqueness. This notion of uniqueness concurred with Drybrugh's (1999) notion of 'affiliation with the profession' thought to be a 'necessary' bonding process in the culture of engineering.

The dominant population in engineering was elitist for those whose performances best reflected the 'play hard, work hard' culture of engineering

(Dryburgh, 1999). They were the “kings”, according to one participant. Being most popular, they also were elected to positions of authority in such hierarchies as engineering societies. They determined which engineering peers got to participate fully in the social aspects of engineering. One woman affirmed

> Well, I don’t know if there is so much as a culture to engineering, but there is a culture to gadgets, there is a culture to technology; there is a culture to making things work. It is the last male domain. And it is very much in my opinion, it is very much like the garage built out back where the guys all hang out and they talk whatever they want to talk about. And they accept work and they tinker with the car or whatever. It is the same feeling, the same mentality. And I don’t know how that gets passed along except that because it is predominantly male and up until may be the last decade, they have had an incredible amount freedom to say and do whatever they liked. Right. Even the guys who didn’t necessarily like it, like I said they were my friends wouldn’t dare say anything against their buddies, you know. It is the silent acceptance of it.

For those males who did not live up to this elite reputation, the label ‘girl’ was bestowed upon them. Henwood (1998) and Hopkins (1998) also found that when masculine identities were threatened, gender differences were reasserted in order that the ‘natural order of things’ was restored. Therefore, those males who did not perform masculinity correctly were belittled. As well, a clear message was sent to the women. They did not belong to the ‘brotherhood’; they were peripheral participants in the masculine culture of engineering. Hopkins (1998) examined the use of “ ‘Girl’ as an allowable, non-profane substitute for ‘faggot’, ‘homo’, and ‘cock-sucker’, mirrors and thus reveals a common essence of these insults. It signified ‘not-male’, and as related to the male speaker, ‘not-me’”

(p.169). This and other insults suggested a failure of living up to a gendered standard of behavior and a gendered standard of identity.

Although doctoral women first remembered elitism with their peers, the classroom environment also incubated this notion of superiority. Professors not only told them that they were the smartest, but also demanded that they accomplish tasks independently. Asking for help or clarification in class was perceived as a weakness. In many instances, the person asking for help was reprimanded and humiliated. Questioning in class was appropriated as a 'performance of posturing', that is, asking a question where students could demonstrate their knowledge and competence. Most frequently, this performance was reserved for males. One engineer recalled

> There was one male grad student that I had a problem with … he would posture and he would act very superior during class even with the profs, especially with the female profs.

Only one participant reported "acting aggressive" in her research group in order "to be noticed", but not in the presence of a professor. In agreement with Dryburgh (1999), engineers, especially women, must learn to perform confidently and competently when unsure of themselves.

In addition, engineering professors were thought to affirm this notion of elitism in class when discussing salaries and levels of engineering as well as management positions. Based on data from the majority of males in the profession of engineering, entry-level salaries are high for a four-year program and promotions can be frequent (Industry Canada, 1999; CCPE, 2003). Starting salaries of women engineers to date are at par if not greater than the men, and

women are usually hired first (Kemper, 1990; McIlwee & Robinson, 1992), although this gender distinction was not reported to be made by professors.

This notion of elitism in the culture of engineering overflowed into the work place. The doctoral engineer with industry experience felt that elitism in the workplace inhibited communication within the team. She surmised

> They are finding that this is a problem in the sense that you go out into the real world and you have engineers on teams, and they are not talking to each other. There is the elitism problem. My experience with most male engineers is that most of them do not have very good personalities in the sense that their sales and social skills are lacking. But there are more and more employers that are like it doesn't matter if they can put together the formula they have to talk to the client.

Although not new, teamwork is now more valued in engineering schools since industry often informs change in programs of engineering. Kemper (1990) affirmed that more emphasis was placed on teamwork and communication in American engineering schools but he made no mention of addressing 'differences' in the group, or overcoming the notion of superiority that affected the behavior of some engineers.

In summary, both in the profession of engineering and in the public, what engineers actually 'do' appeared to be unclear. Elitism appeared to be a façade, an elaborate practice/reaction that may be related to engineers' non-specific job description (Dryburgh, 1999). Another rationale was the perception that the American public does not value their contribution to society (Kemper, 1990), yet according to the Canadian Council of Professional Engineers [CCPE] that was

not the case. The manager of communications of the CCPE asserted that the Canadian public generally had a positive image of engineers and they were reasonably well informed about what engineers do in certain disciplines of engineering (Kowalenko, 2000).

Competence

Competence can be seen as the ‘currency’ of engineering. It is highly valued and must be acquired at all costs. Doctoral women spoke of ‘competence’ when describing their work; competence was viewed as being able and confident to solve engineering problems, as well as gaining respect in their community. When describing some male members of work groups, the notion of ‘posturing’ emerged. In posturing, one asked questions in order to demonstrate one’s dominance in a subject area already mastered in order to deflect attention away from those areas where one’s knowledge was weak. This performance was necessary to ensure that one was thought of as being competent. Regardless of gender/sex, engineers were reported to be constantly evaluating others, as well as being evaluated related to their competence. One participant talked about a woman in her work group as being incompetent because she was not doing her share of the work and asked “dumb” questions. This same participant thought that she wanted to work with more peers so that she could work out some of the questions and issues in her research and not be afraid to “ask dumb questions”. The performance of one’s competence can be undermined by asking questions, but that was also viewed as important to learning and problem solving. This

tension between performance of competence and questioning during learning strikes at the heart of how engineers view themselves and measure others in the culture of engineering

Dryburgh (1999) also found that women engineers must learn to portray their competence to others. This portrayal of competence appeared to be quite unnatural for most women as it was not in keeping with societal gender/sex-roles. In fact, one international participant in this study who described herself as being physically small and viewed by others as 'subservient' due to cultural and gendered stereotypes, found it necessary to "act aggressive" in order to be recognized as leading the research in her group. She pondered that it was perhaps more a gender issue than a cultural stereotype. This performance of competence can be misconstrued as an attitude of elitism. While this was in keeping with Anderson's (2002) line of argument that women in engineering were uncomfortable with the culture of engineering which included an attitude of superiority, Dryburgh (1999) explicated this performance as part of 'solidarity with the profession', that is, being able to solve ill-defined problems with confidence—or at least appearing to be confident.

Exclusion vs. One of the Guys

Through the women's stories, it became apparent that many were in fact excluded from both learning and social situations. Of course, this exclusion was disguised in various ways and degrees. Classroom discourse and its related learning activities were thought to take place in phases such as authoritative

discourse, internally persuasive discourse (Bakhtin, 1981), and genuine dialogue (Sidorkin, 1999). In the engineering classroom, many professors were reported to teach using long-winded lectures that were poorly understood.

> And profs are only taught to teach in one or two ways. That horrible lecture where they get up and write everything on the board and you spend the whole class copying down these horrible notes, you are writing down math which is all Greek by the time you get to fourth year physics, alpha this and beta that. That is all you do is write down the notes. And you get home and you have to decipher this and understand. But that was what the lecture was supposed to do. Or the labs-that aren't really designed to teach, they show you a technique but they don't really explain the theory.

In this instance, the professor in authority was seldom challenged, as this would bring into question 'his' competence and 'his' power. This was in keeping with Bakhtin's (1981) 'authoritative discourse' where the knowledge 'taught' was accepted or believed on the basis of the performance of the authority figure.

When this new knowledge must be applied during group assignments, members reconstructed their understanding of this knowledge through dialogue and negotiated meaning and application. This reflected Bakhtin's (1981) second mode, or 'internally persuasive discourse' and was thought to be particularly useful in classroom settings where language and cultural differences impeded understanding lectures as the main approach to teaching. As captured in the women's statements, learning also appeared in social situations such as sporting events, drinking activities, or just over a 'bite to eat' all of which can excluded some women. If participants did not share the same interests or if the 'events'

were deemed inappropriate because of gender/sex stereotypes or cultural/ religious restrictions, they were not included.

A third discourse provided the opportunity for “genuine dialogue to happen” (Sidorkin, 1999, p.136) and referred to Bakhtin’s (1984) notion of carnival. Members of the group know each other informally and feel ‘free’ enough to openly make sense out of classroom ‘talk’. This third discourse has not been given enough weight when evaluating learning environments for women. One engineer explained

> I think it is fun to know you can go to the grad club at 4 o’clock on a Friday- you are going to run into all of your colleagues. I think that is a good thing. Because it means you are socializing with the people that you work with, you are not just merely saying hello to them in the halls. So having that social group that has the same restrictions, it is really comforting for a lot of graduate students. Yes, I have to drink cheap beer because that is all I can afford to drink.

It is in these situations of informal conversations that male members decided who was competent, who had demonstrated their affiliation with the ‘work hard/ play hard culture of engineering’ as proposed by Dryburgh (1999). As detailed by one doctoral woman, there was a relationship difference when working in groups, “when men decide they don’t like that person, they DON’T like that person”.

Courses or programs often relied on group assignments, but did not take the time to explain the learning strategies or expectations such as identifying what you already know, what you need to know, and how you are going to learn

it, as well as distributing the work responsibly. It was more often assumed that the members knew how to work it out amongst themselves.

> It was discouraging to work on projects when we were assigned projects, and assigned groups. A couple of times they were assigned alphabetically; there were some people in my group that were very difficult to work with in terms of their attitude, both towards work and me at the time--towards myself and what role I would be allowed to play in designing and contributing ideas. It was very frustrating because they were treating me--like my ideas were all ridiculous. But like at the end-- there was one part of that project that we had to do very thorough mathematical analysis and that was one of the most challenging parts of the project, and they [the group] gave the entire thing to me. I think at the same time they were saying, 'no we don't want you, you can't do this' and then they were too lazy to try the too difficult parts themselves. So, it was a very weird kind of attitude.

Participants experienced group work as a constraint, without an awareness of the inequitable societal structures comprised in their explanations. Who gets to decide who is marginal, peripheral, and dominant- or are there multiple influences at play within the complex culture of engineering?

In the classroom and in the engineering culture at large, women engineers experienced various degrees of exclusion even when judged as competent. Appropriate displays of competence, such as being awarded a doctoral scholarship often resulted in jealousy from their colleagues. Male peers questioned the scholarships obtained and this judgment sowed the 'seed of doubt' that still follows some of the women engineers. One engineer asserted

> When you get into graduate school it is a smaller field and people who are there genuinely want to be there doing research and they don't really care. As long as you really are

> confident, there is not so much resentment. I haven't encountered the same kind of resentment in graduate studies. But of course you kind of carry that little bit of questioning of one's worth from undergrad just wondering, "why did I get this scholarship"? "Why am I getting NSERC?" "Did they make a mistake?" "Are they going to find out?" But yeah it's, I think as a graduate student, I have probably asked myself those questions more than anybody else has. As an undergrad that is when that seed of doubt was sown though. And that was definitely external influences.

The study of Noble et al. (1999) posited that successful women still carry with them this internalized gender inferiority, questioning themselves and wondering if they are imposters; these feelings were reflected by the participants of this study. In a similar vein, women doing well threatened the 'masculinity' of some males. Some male colleagues made negative comments in order to reinstate male dominance or the 'natural order of things' (Henwood, 1998). One doctoral woman explained the sexist comments she received after comparing her higher marks with the 'guys', with the words, "he put me in my place".

Conversely, the participants were often labeled 'one of the guys'. Herein lies the tension. The males in the class often wished amongst themselves for more women to date. The doctoral women remembered having conflicted feelings towards this. On the one hand, the statement can be seen as a compliment- they are competent enough to be considered 'one of the guys'. On the other hand, they questioned why they are not seen as a 'woman', as a dating partner. 'Woman' and 'engineer' were seen as polar opposites. To be one was to deny the other (Dryburgh, 1999; Henwood, 1998).

According to Butler (1999) this denial of 'who they are', in which "persons only become intelligible through becoming gendered", has caused the women to question their gender performance and its relation to heterosexuality (p.22).

Interestingly, most doctoral women ended up dating other engineers, so obviously some men made the mental leap and disregarded this 'gendered dichotomy'. One participant recalled one of her male engineering friends thinking it was too difficult to date women engineers because they were too argumentative and competitive. Apparently, women need to maneuver through both their public and private 'selves' and through the societal expectations associated with each.

Sameness versus Difference

While 'sameness' and 'difference' appeared to be contradictory terms, they reflected the ongoing struggle for neophyte engineers becoming affiliates within the profession. It appeared that 'sameness' and 'affiliation' had similar meanings in the culture of engineering. 'Difference', on the other hand, was more fluid; less defined, predictable, or accepted. In the narratives of the doctoral women, 'differences' were expressed in relation to 'Sex-roles' and other related differences such as 'Ethnic/cultural differences' and 'Language', and lastly, 'Sexuality'. Each of these 'differences' are discussed in the context that they emerged in the women's talk of how they came to be doctoral engineers.

The notion of 'sameness' was reported in various contexts by most doctoral women. Common characteristics that seemed to be reinforced in the

university culture included perseverance, patience, self-confidence, and time management skills. Some doctoral women even felt that a dress or appearance ‘code’ characterized all engineers, male and female. The level of difficulty of the engineering workload left little time to be spent on appearance. Lab work required that comfortable, worn clothes be chosen. This notion of a ‘certain look’ in the ‘work hard’ culture of engineering was in keeping with Dryburgh (1999) who asserted that compliance with this dress code, if you will, also demonstrated ‘solidarity with the profession’. Interestingly, the importance of the choice of clothing was most strongly voiced by international students where this was perhaps, one of their only shared ‘symbols’ of belonging in engineering. One doctoral woman attended an undergraduate program where the “sameness of students” encouraged a strong bonding of their class because students were of a similar age, nationality, educational experiences, and most were living in residence. An affiliation with the ‘play hard’ and ‘work hard’ culture of engineering prevailed (Dryburgh, 1999).

In the culture of engineering, certain shared experiences bonded engineering students together, for example the learning environment, their treatment by professors, and the affiliation with the profession which was expressed in the symbols, history, and traditions of the practice. Many doctoral women spoke of poor teaching and negative treatment coming from their professors.

> Profs are lousy teachers for the most part. There should be better education on how to be an educator. There is no good program that I have encountered that teaches a prof about

> contemporary educational theory and how to teach. They give you great profs that first year because that is the only way they can keep you-if you have a shitty prof the first year you are going to drop out. So all the good profs teach introductory level courses and may be they teach some of the second year courses so you don't really get exposed to how horrible teachers profs are. Like my third and fourth year profs, they might as well not been there, they could have just given me the text book and I could have read it and probably done equally as well, if not better. Instead of being confused by the lectures and the way the material was taught.

This 'shared culture of hardship' both in relation to treatment received and the difficult workload strengthened their relationships (Dryburgh, 1999). Other shared experiences for Canadian engineers were the engineering jacket as a symbol of affiliation with the 'work hard' culture. Only after completing the first year of the program was the leather jacket allowed to be worn. This was particularly important at one university where the beating of the engineering jackets on the ground, to intimidate new frosh, was essential to belonging, to passing on the traditions.

> I had the opportunity to be around [frosh] week when engineering students paint themselves purple and spike their hair and wear kilts, and their coats and wear the- GPA what they call their "golden party armor" and they dye them purple and go around and beat them [jackets] on the ground. And you would think that there was some big pneumatic pile driver going on at one end of [a street on campus] while you were walking out. But it is a couple of hundred undergraduate engineering students beating their coats in synchronicity at the top of the street. That is the culture. They get in trouble for harassing freshmen when freshmen arrive on campus because they are so intimidating. And then the greased

> pole. But engineers have the reputation for drinking hard and partying hard and that was their thing.

Another symbol of 'solidarity with the profession', the iron ring, transmitted the traditions and history and was perhaps, the last rite of passage for the engineering student. The ring was a constant reminder of the engineers' obligation to perform well, that is, with competence, diligence, and confidence (Dryburgh, 1999). Moreover, the 'common oath of obligation', commissioned by Engineering Institute of Canada in 1922, along with its formal [secret] ceremony was crafted by none other than Rudyard Kipling (Corporation of the Seven Wardens, 1991). As part of the ceremony, 'the newly qualified engineer' recited the common oath to a more experienced engineer- a type of apprenticeship into the 'brotherhood' of engineering as participants called it.

> And I found it almost disturbing when I got my iron ring. And there are a number of professional engineers roaming around the floor and put the ring on your finger and shake your hand and welcome you to the profession. And that-it was like a secret society. And it was just disturbing. Yeah, there is this whole ritual that you have to go through that seems utterly ridiculous. And then you are welcomed to the profession-it is like the godfather coming up. I don't know; it was just weird.

All of these symbols of traditions acted as a bond, a sameness of identification with the culture of engineering.

Although sameness was celebrated, differences abound in faculties of engineering and this created tension. Many doctoral women chose alternate paths before selecting engineering. With the exception of one, all the other

participants completed their undergraduate degrees at different universities perhaps giving them a diverse perspective of engineering education and preferred practices. A few of the women have completed consecutive degrees in faculties of engineering, while others reported leaving engineering during their Master's degree for more applied research in science. Furthermore, some of the women were new to faculties of engineering, having arrived with science degrees from other departments.

Thus, the notion of 'sameness' was important in engineering. Common characteristics, a similar dress code, and other symbols of 'sameness' identified those engineers who have affiliated with the profession. Even the 'shared culture of hardship' acted as a method of bonding engineering classes together. Unfortunately, sameness as an ideology failed and some 'differences' were more easily overlooked than others. The following sub-themes are beset with tension and emerged when considering 'differences': Sex-roles, Ethnic/cultural difference and language, and Sexuality in the culture of engineering.

Sex-roles and other differences.

Doctoral women reluctantly described their differential treatment with other colleagues. Some participants disclosed they were teased, and downplayed these behaviors, while others admitted being harassed or being consulted only when their contribution was essential. Some women were verbally harassed for doing well and not being a man.

> And some of the guys that I would go and have a smoke with, you know we would be talking about an assignment or a question or a test or whatever, and I would say what I got. And unfortunately there was more than one occasion where it was said that I got it [good mark] because I had spent time in the prof's office on my hands and knees. But there were people there that were my quote, unquote friends. Right. And I am sure if those friends had heard anyone say that to their sister, they would have killed them. But I was supposed to be able to look after myself because I chose this, it was my choice to go into this, it was all guys but I picked it. So you fend for yourself, girl. I just think it was that I was kicking his ass in one of these courses and he didn't like it. So he was trying to put me in my place.

What appeared to upset this participant the most was her friends' silence when listening to the sexist comments. The notion of choosing engineering, a male domain, was justification for the disparagement of women who threaten some students' beliefs of male superiority. It was 'par for the course'; the expected camaraderie was difficult to distinguish from harassment.

The gendered performances of students as well as their individual personalities affected the division of labor during group work. Some women were told what they could do, while others reported that males claimed the 'real' work for themselves and assigned to the women roles that required softer skills such as the presentation of their assignment. When the number of women in the groups increased, participants reported more sharing of the workload and enjoyed it. Not all males were prepared to handle the difference in interactional styles practiced in female dominated groups. The female groups tended to follow

a less linear plan and were more ‘relational’ in addressing the problem to be solved as well as the needs of the group members.

Professors of engineering reminded doctoral women who were new to engineering of their outsider status, that they were not really engineers. One participant recounted

> I am not an engineer so maybe I notice it more, because my area is physics and biology, so I don’t have an iron ring. When I first walked into the office of the head of grad students in mechanical, I was given a stiff lecture about how I wasn’t an engineer and I wasn’t allowed to call myself an engineer and how I would never be an engineer. And I was walking in with full NSERC funding; it was the most negative impression I have ever gotten at the department.

They had not partaken in rituals and symbols, or the competence testing of the undergraduate program. They were not part of the ‘brotherhood’. In fact, professors at some universities excluded doctoral women from their particular ‘language of bonding’ that is, swearing and cursing with their male graduate students. Other professors refused to hire women doctoral students just in case they needed heavy lifting of mechanical parts and couldn’t afford to hire an assistant. Professors acted as the ‘gatekeeper’ of the profession by determining who was included into the culture of engineering (Dryburgh, 1999). In my study, exclusion was based on difference rather than a lack of ability. Women spoke of not wanting to be sworn at but yet “felt” the difference- they wanted to be valued for the qualities and abilities they brought to engineering, but ‘difference’ here meant exclusion.

The tension of feeling different, along with the subsequent differential treatment, did not occur only in the culture of engineering. Participants described being treated 'differently' in social situations when acquaintances learned of their educational/occupational choices. One woman reported

> People's reactions are not always favorable. They expect you to turn around and all of the sudden have some big horn come out your back. It can be a little bit odd. Or the other end of it is if you end up a cocktail party with a bunch of professionals who are all like stroking their own feathers, their response to you isn't any better because it is a little intimidating- they are intimidated by what you do. You bring it down a notch I mean. There is that expectation …about of knowing- or being a general expert. Or worse yet, I am supposed to know everything there is to know about electricity and be able to fix your toaster. Sorry. If it is not working, throw it out.

Most doctoral engineers attempted not to reveal this information, or tried to make engineering sound less intimidating. Only one participant proudly exclaimed her choice, but noted importantly that she used non-technical, very plain language in her description. Although all of the participants' families supported their engineering choices, not all of them understood what their daughters 'did'. In some instances, this lack of understanding caused some parents to treat their daughters a little differently. Their advanced abilities in math and science left them a little confused and awestruck. It is thought that when women choose new ways of 'being and knowing' they often feel distanced from their family and culture (Gilligan, 1993; Subotnik & Arnold, 1996).

Ethnic/Cultural difference and language.

In this study, two of the doctoral women were international students new to North America. Both of the women had completed a B. Eng. and a master's degree in their countries of origin. Each of these international women chose a different discipline of engineering and in a different province of Canada. These different choices added to the already complex web of 'difference' for international women and their experiences. The participants explained that acceptance into a doctoral engineering program for international students required that they be 'funded' by their doctoral advisor. Some universities had unions who helped regulate the amount of money and the hours worked for students who were 'soft-funded' by professors' research grants. Neither of the doctoral women was protected by graduate student unions at their universities, with one woman confiding that working for her advisor was slowing her own research. The other participant worked for a professor who had fewer students, and reported a more positive experience.

'Permanent resident status' was thought to be important for both international women in order to apply for Canadian scholarships and to be able to work outside of the university. One participant in particular reported that she "kind of starved" herself until she could change her status. Both perceived their obligation to work for their advisors as a requirement that set them apart from Canadian engineering students. The extra burden of work also fed into stereotyping some ethnic minorities as 'hard workers'. In fact this stereotype reminds us of Dryburgh's (1999) 'work hard' culture of engineering and perhaps

explains why some ethnic minorities are viewed as fitting in better with the culture of engineering (Grandy, 1997; 1998; Jones, 1999). These international women can be considered as ‘voluntary immigrants’ in that they have moved to Canada in search of greater educational, and eventually, economic gain (Ogbu, 1987). The two participants spoke of many master’s Chinese students in their departments. One participant revealed not liking engineering and knew other international women who chose engineering for practical reasons related to immigration. She thought that many international students only obtained student visas if they chose disciplines of engineering that Canadian students did not want. Moreover, permanent resident status, with the possibility of citizenship, was usually achieved with a doctoral degree. For these reasons, international women who also pursued doctoral degrees in engineering can be viewed as having multiple differences and were at risk of marginalized treatment.

Language also exemplified ethnic difference in engineering. Doctoral women reported that international students worked and socialized between themselves because of the language barriers. They felt understood, that it was more comfortable to talk and learn in a ‘native’ language. It appeared that gender was ‘forgiven’ when working in groups of engineering students who were ethnically/culturally diverse. The sharing of a common language and similar experiences took priority, instead of enacting sex roles, and was beneficial in order to complete and understand the difficult subject matter of engineering. One international student added that she preferred talking to nonnative English speakers because they talked slower and were more patient in answering her

questions and providing help. While these engineers recalled minority students only socializing among themselves, others remembered colleagues purposely working with English speaking students because they wanted to learn the language and customs of their new environment. Thus, culture and language can be seen as barriers to be overcome in order to obtain their long-term goals for employment (Ogbu, 1992).

For our international participants, the tension of being ‘different’ in a culture that expects ‘sameness’ multiply marginalizes them. They were excluded but they were not aware of it. They felt that they were treated fairly but superficially so; they were included when their expertise was needed. Most of the Canadian doctoral engineering women described experiencing sexist remarks and harassment, being invited to ‘inappropriate’ events or activities involving alcohol, as well as other types of negative treatment. It appeared that the international women in this study were viewed as ‘very’ different and were therefore treated in a ‘special’ way. They were neither seen as ‘dating material’ nor ‘one of the guys’. And it was interesting that they did not even recognize this differential treatment, perhaps it was an attempt at self-preservation.

Some participants spoke of international students, both male and female as not participating in the “normal university social scene”, that is, they did not participate in what Dryburgh’s (1999) named the ‘party hard’ culture of engineering. Even when socializing with other women engineering students, differences in language and cultural background prevented full participation in the ‘party hard’ activities that usually included pubs, alcohol, and even the choice of

foods shared. Some participants spoke of trying to negotiate the difference by hosting multicultural potlucks, thus allowing for socializing but without the usual emphasis on alcohol. In sum, religious customs and [strict] gender roles expected of international women restricted their participation in the dominant culture of engineering.

Sexuality: Difference but how different?

Doctoral women who attended predominately white, higher SES universities also reported knowing GLBT engineering students and university professors. Engineering faculties in very traditional/conservative regions of Canada, along with universities known for the large multicultural populations, reported “never” considering anyone but heterosexuals attending engineering programs. This notion of ‘assumed heterosexuality’ in engineering was noted by Henwood (1998), Hopkins (1998), and Remlinger (1995) and reflects an ideology that is seldom questioned. Doctoral engineers who confided having friends who were GLBT also spoke of homophobia in their institutions. During her master’s program, one participant worked in a research group with a female colleague who “had a girlfriend”. Although this lab group was mostly all-female and very close, this relationship was not discussed openly. This colleague had not ‘come-out’ publicly and was very private; so much so, she was harassed by the only male in the lab group who had no idea of her sexual orientation, assuming she was heterosexual. This same doctoral engineer affirmed knowing bi-sexual women as well, exemplifying the ‘performed difference’ at this university and

adding, “women who are in engineering are not your average women anyways”. Another participant recalled her roommate’s ‘coming-out’ to the engineering society where it appeared this ‘difference’ was overlooked. Interestingly he was a male graduate student who, therefore, had already successfully demonstrated his affiliation with the ‘work hard and party hard’ culture of engineering (Dryburgh, 1999). It is not clear what response he would have received from the engineering society if he were ‘multiply-marginalized’, that is, belonging to another culture or being a woman.

In summary, the tensions experienced by the doctoral engineers were very intertwined and linked to complex relationships that were regulated by cultural, institutional, and historical circumstances and influences.

Transformations

Since the aim of engineering education is learning, recommendations for change will begin here. Faculties should examine epistemologically how science is constructed and taught, and how a change in this ‘view’ can assist professors to teach in ways to encourage learning and participation especially for engineering students of ‘difference’. Since professors’ teaching was viewed as a hindrance, offering workshops as part of their teaching workload to pedagogically improve content, delivery, and evaluation of courses would be a starting point on the continuum of change. Appointing a committed working group of professors to investigate a holistic student-centered program, such as mechanical engineering at University of Sherbrooke, is another salient recommendation. An important

consideration when designing courses and lessons for the classroom is not to use ‘binary logic’ or simply use a ‘taxonomy of difference’, that is, insert a cultural component into the current curriculum that isolates the ‘essences’ of various culture. This insertion could misrepresent foreign cultures and reinforce stereotypes, constructing students of difference as ‘Other’ (Guest, 2002).

More specifically for faculties of engineering, structural barriers and policy procedures need to be examined. The doctoral women perceived their advisors as a barrier to their timely and successful progression through the PhD program. A doctoral candidate’s positive relationship with their advisor is of paramount importance (Cooper & Stevens, 2002; Crude, 2001; Fox, 2000). Faculties of engineering need to develop explicit expectations as to what constitutes adequate PhD research, dissertations, and doctoral experiences. In other words, faculties need to mandate explicitly the preparation of doctoral candidates. This could minimally include listing basic criteria needed to complete the PhD, specific timelines for student-progression along the PhD continuum, and ways to encourage and assist with conference presentations and publication of articles. Moreover, advisors should receive training from the faculty/university on how to ‘become’ an advisor. Areas to be addressed are guidance strategies, examining and improving interactional styles, how to train RA and TAs, and examining the perceptions of the ‘role of advisors’, that is, challenging the new advisors’ previous beliefs and assumptions. Graduate exit surveys could be employed, similar to current teaching evaluations, to help shed some insight on what the advisors are doing well and what needs improvement. As Rosser (1998) has

suggested, multi-perspective approaches to increasing enrolment and retention of women in engineering are more effective and in keeping with addressing notions of ‘difference’ in engineering populations.

Understanding difference.

Understanding how the ‘other’ is constructed is an arduous process but sensitivity training could be undertaken and led by members of the engineering faculty so there would be an awareness of differential treatment, and subsequent appropriate strategies could be implemented and re-examined. Addressing the ways the masculine culture of engineering is maintained in faculties of engineering, where histories and practices of the ‘brotherhood’ are kept alive, needs to be made visible. These bonding practices need not be ‘outlawed’ but examined and modified so that ‘affiliating with the profession’ is more inclusive and representative of Canadian universities’ diverse populations.

As part of the engineering program, elective courses should be taken outside of the faculty to provide exposure to ‘difference’ in relation to students and curriculum as well as various teaching methods. Moreover, ethics courses or design-engineering courses could examine sexism, racism, and homophobia, along with its many shades and subtleties, in order to question the ‘androcentric’ focus in engineering. A priority for faculties of engineering should be the recruitment and retention of women professors and advisors. In order to attract women professors into academia, financial support and assistance with teaching and mentoring must be made available as well as allowing this to be reflected in

the tenure-process as outlined by the University of Waterloo (2002). The critical mass of women engineering students, along with other types of ‘difference’, must be mandated through policy change in faculties of engineering in order for Canadian society to be truly represented in the profession of engineering. The notion of ‘affiliating with the profession’ may provide bonding and strength for its ‘privileged’ members but its traditions are excluding for people of ‘difference’ and do not reflect a multicultural Canada.

In sum, structural changes need to be addressed inside faculties of engineering and in conjunction with industry and the bodies that govern the profession of engineering. While WISE programs and scholarships have improved the presence of women in faculties of engineering, without structural changes this may not continue. By adding a postmodern frame to research and solutions, the complex social, cultural, and political influences that affect the negotiations of race, class, gender/sex, and sexuality in engineering can be examined. The value of ‘difference’ in diverse engineering environments can, therefore, be made visible.

References

Anderson, I.J.T. (2002). *The social construction of female engineers: A qualitative case study of engineering education.* Unpublished doctoral dissertation, Dept. of Sociology, University of Saskatchewan, Canada.

Bakhtin, M. (1981). *The dialogic imagination: Four essays by M. M. Bakhtin*. Austin: University of Texas Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: W.H. Freeman and Company.

Britzman, D.P. (1998). *Lost subjects, contested objects: Toward a psychoanalytic inquiry of learning.* NY: SUNY.

Butler, J. (1999). *Gender trouble: Feminism and the subversion of identity.* (Rev.ed.). NY: Routledge.

Canadian Council of Professional Engineers. (2000). *Canadian engineers for tomorrow: Trends in engineering enrolment and degrees awarded 1996 to 2000.* Canadian Engineering Resources Board.

Cooper, J.E. & Stevens, D.D. (2002). *Tenure in the sacred grove: Issues and strategies for women and minority faculty.* Albany, NY: Statue University of New York Press.

Corporation of the Seven Wardens. (1991). The iron ring: The ritual of the calling of the engineer. Accessed 3/25/2003, Http://www.ironring.ca/

Crude, W. (2001). *The Ph.D. trap revisited.* Toronto, ON: The Dundurn Group.

Dryburgh, H. (1999). Work hard, play hard. Women and professionalization in engineering: Adapting to the culture. *Gender & Society, 13*(5) 664-682.

Emerson, C., Williams, F.M., & Kieley, J. (2002). *Advancing career success: Professional development initiatives that work for women in science and engineering.* Conference proceedings of the 12th International Conference of Women Engineers and Scientists (ICWES-12), July 27-31, 2002, Ottawa, Canada.

Fletcher, J.K. (1999). *Disappearing acts: Gender, power, and relational practice at work.* Cambridge, MA: MIT University Press.

Fox, M. F. (1996). Women, academic, and careers in science and engineering. In C. Davis, A. Ginorio, C. Hollenshead, B. Lazarus, & P. Rayman (Eds.), *The*

equity equation: Fostering the advancement of women in the sciences, mathematics, and engineering (pp. 265-89). San Francisco: Jossey Bass.

Fox, M. F. (1998). Women in science and engineering: Theory, practice, and policy in programs. *Signs: Journal of Women in Culture and Society, 24*(1) 201-223.

Fox, M.F. (2000). Organizational environments and doctoral degrees awarded to women in science and engineering departments. *Women's Studies Quarterly 2, 8*47-61.

Fox. M.F. (2003). Gender, faculty, and doctoral education in science and engineering. In *Equal rites, unequal outcomes: Women in American research universities* (pp. 91-109).

Fox-Keller, E. (2002). A world of difference. In J. Kourany (Ed). *The gender of science* (pp. 125-135). New Jersey: Upper Saddle River.

Franks, S.E. (1998). One woman's life in science. In A. M. Pattatucci (Ed.), *Women in science: Meeting career challenges* (pp.116-132). Thousand Oaks, CA: Sage Publications.

Frize M. (2000). Women role models do make a difference. *University Affairs,41*(4), 29.

Frize, M. (2002). *The bold and the brave: Women engineers striving for change.* Conference proceedings of the 12th International Conference of Women Engineers and Scientists (ICWES-12), July 27-31, 2002, Ottawa, Canada.

Gibney, K. (April, 1998). The gender game. *American Society for Engineering Education,* [ASSE Prism], 14.

Gilligan, C. (1993). (2nd ed.). *In a different voice: Psychological theory and women's development.* Cambridge, MA: Harvard University Press.

Grandy, J. (1997). Gender and ethnic differences in the experiences, achievements, and expectations of science and engineering majors. *Journal of Women and Minorities in Science and Engineering,3,* 119-143.

Grandy, J. (1998). Response bias in a survey of Asian-American and white science and engineering students. *Journal of Women and Minorities in Science and Engineering,4,* 1-13.

Guest, M. (2002). A critical 'checkbook' for culture teaching and learning. *ELT Journal, 56*(2) 154-160.

Haraway, D. (1997). *Modest_witness@second_millennium. FemaleMan©_meets_ oncomouse™. Feminism and technoscience.* NY: Routledge.

Henwood, F. (1998). Engineering difference: Discourses on gender, sexuality, and work in a college of technology. *Gender and Education 10*(1) 35-49.

Hopkins, P.D. (1998). Gender treachery: Homophobia, masculinity, and threatened identities. In N. Zack, L. Shrage, & C. Sartwell (Eds.) *Race, class, gender, and sexuality: The big questions (pp. 168-186).* Malden, MA: Blackwell Publishers.

Holland, D. & Eisenhart, M. (1990). *Educated in romance: Women, achievement, and college culture.* Chicago: University of Chicago Press.

Industry Canada (1999). *Report on the working group for women in science and technology.* Government of Canada.

Jones, L. (1997). *Race, gender, and marginalization in the context of the natural sciences.* Unpublished doctoral dissertation, Ohio State University, USA.

Kemper, J.D. (1990) (4th ed.). *Engineers and their profession.* Toronto, ON: Holt, Rinehart and Winston Publishing.

Kerr, B.A. (1994). *Smart girls two: A new psychology of girls, women, and giftedness.* Dayton, OH: Ohio Psychology Press.

Kowalenko, K. (2000). Canada has higher awareness of engineering. *IEEE: The institute, 24*(12) 1-7.

Latour, B. (1993). *We have never been modern.* Cambridge, MA: Harvard University Press.

Lave J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. NY: Cambridge University Press.

Law, J. & Singleton, V. (2000). Performing technology's stories: On social constructivism, performance, and performativity. *Technology and Culture, 41*,October, 765-775.

Male, S., Lawrance, W., & Dias, T. (2002). *Recruitment and retention of female students in engineering courses at Curtin University of Technology.* Conference proceedings of the 12th International Conference of Women Engineers and Scientists (ICWES-12), July 27-31, 2002, Ottawa, Canada.

McIlwee, J.S. & Robinson, J.G. (1992*). Women in engineering: Gender, power, and workplace culture.* NY: SUNY.

Mishler, E.G. (1999). *Storylines: Craft artists' narratives of identity.* MA: Harvard University Press.

Mol, A.M. (1999). Ontological politics: A word and some questions. In John Law and John Hasaard (Eds.), *Actor Network Theory and After* (pp. 329-350). England: Oxford and Keele.

Noble, K., Subotnik, R., & Arnold, K. (1999). To thine own self be true: A new model of female talent development. *Gifted Child Quarterly, 43 (*4), 140-149.

Ogbu, J.U. (1987). Variability in minority school performance: A problem in search of an explanation. *Anthropology of Education Quarterly, 16*(4) 312-334.

Ogbu, J.U. (1992). Understanding cultural diversity and learning. *Educational Researcher, 21*(8) 5-14.

Polkinghorne, D. (1995). Narrative configuration in qualitative analysis. In J.A. Hatch & R. Wisniewski (Eds.), *Life history and narrative* (pp. 5-23). London: Falmer Press.

Remlinger, K.A. (1995). *Production, resistance, and opposition: Students linguistically constituting ideologies of gender and sexuality.* Unpublished doctoral thesis, Michigan Technological University, Michigan, USA.

Rinehart, J., & Watson, K. (2002). *A systemic change model in engineering education and why it is relevant for women.* Conference proceedings of the 12th International Conference of Women Engineers and Scientists (ICWES-12), July 27-31, 2002, Ottawa, Canada.

Rosser, S. (2001). Will EC 2000 make engineering more female friendly? *Women's Studies Quarterly,3*, 164-186.

Rosser, S. (1998). Applying feminist theories to women in science programs. *Signs: Journal of Women in Culture and Society, 24*(1) 173-199.

Sidorkin, A.M. (1999). *Beyond discourse: Education, the self, and dialogue.* NY: State University of New York Press.

Subotnik, R. & Arnold, K. (1996). Success and sacrifice: The costs of talent fulfillment for women in science. In Karen Arnold, Kathleen Noble, and Rena Subotnik (Eds.), *Remarkable women: Perspectives on female talent development* (pp. 263-280). NJ: Hampton Press.

University of Waterloo. (June 2003). *Welcoming women faculty: The report of the provost's task force on female faculty recruitment.*

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* NY: Cambridge University Press.

Wertsch, J. (2002). *Voices of collective remembering*. NY: Cambridge University Press.

Wood, S. (1999). *The family, home, and school environment's influence on gifted girls' perceptions of choice to take extracurricular science classes.* Unpublished master's thesis, University of Ottawa, Ottawa, Ontario, Canada.

Wood, S. (2002). Perspectives of best practices for learning gender-inclusive science: Influences of extracurricular science for gifted girls and electrical engineering for women*. Journal of Women and Minorities in Science and Engineering, 8*(1), 36-51.