Equal Opportunities International

Women withdrawers in engineering studies: Identity formation and learning culture as gendered barriers for persistence?

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Abstract

Purpose – Scholarship on women in engineering education mainly focuses on the question of how to attract more women to this subject. The topic concerning women in engineering education is here guided by the question of why women leave engineering studies. The paper aims to examine the main conflicts women encounter in engineering education and to derive implications for interventions suited for strengthening institutional bonding forces.

Design/methodology/approach – The question is approached through case analyses of 40 interviews with women and men (as the control group) who have left their studies. In addition, repertory grids were carried out with all interviewees and analysed. On the basis of these analyses, five types of dropout could be defined. Two case studies with women are presented in detail in this article. These cases are especially representative of two types of dropout that are characterised by high quotas of women.

Findings – The central conflicts of women in engineering education are often either suffering from poor grades or that women being afflicted by a subjective feeling of not gaining a deep understanding of technical phenomena. These two conflicts represent the two pillars of identity formation in engineering education that are necessary to bind students to their studies: passing the exams with good grades and feeling self-efficacious in the handling of technology.

Originality/value – Up-to-date subject-specific studies on dropout in engineering education – especially with a focus on women – are marginal in Europe, and particularly so in Germany.

Keywords Educational sociology, Learning, Gender, Germany

Paper type Research paper

Introduction

In Germany, dropout rates in engineering are very high. More than every second student leaves his or her university-level engineering degree without a qualification. Individual statistics at some universities indicate higher dropout rates of women in comparison to men. Against this background, the analysis of two case studies with women who have switched to more application-orientated institutions will be presented. They reveal insights into both the process of dropout decisions and the main cornerstones of an alienating learning culture that fosters this process. We will identify two fundamental reasons why women drop out:

(1) the subjective feeling of not understanding the subject matter in sufficient depth; and

(2) the feeling of scraping through the exams (for which there is no hard evidence).

Equal Opportunities International
Vol. 28 No. 1, 2009
pp. 36-49

0261-0159
DOI 10.1108/02610150910933622

As we found in our interviews, these reasons are related to the two pillars of academic and professional identity formation. We conclude that broadening the performance and learning culture is necessary to enhance the persistence of women students in engineering.

Background and problems

At German universities in 2004, approximately every second student withdrew from his or her engineering degree (Heublein *et al.*, 2005, p. 30). In some subjects the rate is higher than in others. Presumably, the rate of women students is thereby higher than the rate of men (Meinefeld, 1999, p. 89). But there are no differentiated statistics in this field. The study of dropouts in engineering education as a whole is an under-investigated research field. There are many studies about dropouts at universities but most of them do not consider the situation of engineering degrees – especially not through a gender lens. However, the proportion of women students in engineering subjects in particular is historically very low. While a diverse range of efforts to achieve equity for women in science, technology, and engineering has been directed to gaining women for engineering studies, the reasons why at least half of the women leave their studies after a few semesters has not yet been researched in detail. The dramatically high attrition rate of women students in engineering shows that the question of how women can be attracted to engineering studies is shortsighted. Interventions aimed at motivating women towards technical occupations seem questionable at the very least if young women who have decided in favour of an engineering subject are disappointed and switch to a more application-oriented institution or to a non-technical subject right away. Apparently, most technical subjects at universities are still unattractive and exclusive. Thus, an equally important question is why so many women students leave their engineering degrees without a qualification and how they can be retained in their degree programs. The objective of our study is therefore to investigate why women withdraw from engineering degrees. Against the background of stagnating or falling enrolments of women up to 1995[1], it seems to be even essential to enhance the persistence of women in engineering studies.

Literature review

Investigations concerning dropout rates in engineering studies in Germany normally do not focus on gender-specific reasons for student attrition. A gender analysis is carried out rather peripherally, if at all. Of the German dropout studies in the field of engineering, there is only one small survey focusing on women dropouts in engineering studies, which is part of a larger European study carried out in seven European countries (cf. Womeng, 2005). This study identifies a number of barriers for women to persist in engineering and science. According to this study, the most important reasons for leaving engineering degrees are loss of academic self-confidence in a competitive environment and disappointment about the science and engineering curriculum. The latter barrier is also an important one for men. For women, it is often not a lack of academic ability that diverts them from continuing their studies. The lack of self-confidence developed independently from academic performance seems to be the critical factor. Further barriers identified were loss of interest, discouragement by low grades, poor teaching, an unapproachable faculty, feelings of isolation and intimidation, and financial problems. Finally, women have a high desire for all

kinds of practical work. They want to link theoretical knowledge with practical applications. Freshmen and freshwomen in engineering are surprised at the high level of mathematical content and they find math courses especially very difficult (Faulkner, 2005, p. 17f). But a striking finding in this context is that women students in particular often assume that everybody is better than they are, and that they are not good enough, even though their achievements are at least average (Faulkner, 2005). Their self-conception of their own professional abilities influences the tendency to drop out much more than their professional interests (Fellenberg, 2005). The loss of academic self-confidence in a competitive environment was also one of the main reasons for women dropping out or switching in two US studies (Seymour and Hewitt, 1997; Brainard and Carlin, 2001). Seymour and Hewitt (1997) found that there were no significant differences in the factors of high school preparation, ability, or effort expended in the coursework between students who remain and those who switch. However, Brainard and Carlin (2001, p. 35) found that females with high competence often suffered a decline in confidence in their academic abilities in math and science.

These studies prompt the following questions:

- If the differences in the academic requirements and experiences between students who stay and those who go are either minor or do not exist at all, what is behind the reasons for dropping out?
- What causes the loss of academic self-confidence even though the withdrawers have managed their exams?

Research questions, theoretical and methodological approach

In 2005, supported by a grant from the Federal Ministry of Education and Research, we began a study about undergraduate women at prestigious technological universities in Germany. The study has three primary goals. The first is to obtain a more accurate view of the reasons why these women dropped out. The second goal is to determine what factors influence the persistence and the withdrawal of women in engineering degrees. The third goal of the study is to design starting points for reforming the engineering curriculum and the teaching itself in ways that will enhance the persistence of women students in engineering.

Research questions

To explore the factors that cause student attrition, we first focus on those factors that are relevant from the point of view of withdrawers in general. However, from the perspective of the withdrawers we also get information about the contextual conditions of the university and the match between individual and institutional structures of interaction. To reproduce the process-related character of attrition, we attempt to identify the decision-making process between experiences in the degree program that have integrating or alienating effects. And finally, differentiating between types of withdrawers with a subsequent analysis of the gender distribution within the types counteracts the risk of reproducing gender stereotypes (Koch and Winker, 2003).

In summary, in order to gain a better picture of dropouts in engineering and to gather possible explanations for women's higher attrition rate, the questions of our qualitative study are the following:

- What are the fundamental points of conflict, central experiences, and main problems in engineering that could be identified as cornerstones in the process of attrition?
- Are there different types of withdrawers, and can we find a specific gender distribution within these types?
- Can we draw conclusions from specific types of withdrawers for the higher rates of women dropouts in comparison to men?

Theoretical background

Only a few empirical dropout studies are based on a theoretical approach, and we are unaware of any studies in the field of engineering working within this area. Nevertheless, there are several important approaches to explaining student dropouts, such as the student integration model of Tinto (1975) and the student attrition model of Bean (1980, 1982), designed according to attrition in organisations. In Germany, Ströhlein (1983) also developed a dropout model. This model is based on a conflict-related theoretical approach. He particularly stresses alternative scope for action as an important factor for dropout decisions.

Tinto's (1975) model proved the most adequate approach for the conception of our study, because he differentiates between academic and social integration, which students have to achieve to complete their studies successfully. He sees the main reason for student attrition in the difficulties students have with integration into university and their major. He stresses that students have to provide integration achievements in both academic and social respects. While social integration is marked by existing friendships and other relationships within the faculty (institutional commitment), academic integration is characterized by the students' grade performance and the self-evaluation of their own intellectual development (goal commitment). In accordance with this twofold process of integration into university life, we distinguish between more academic-related aspects of dropout reasons and more social-related aspects.

According to both our research questions and our theoretical connection to Tinto's dropout model, the analysis of women dropouts in engineering education was guided by the hypothesis that female attrition is caused by mismatches with regard to their academic and social integration.

Research method

The study employs several instruments to gather information:

- a qualitative, episodic interview concerning attrition that is supplemented by a grid interview;
- a questionnaire concerning technical attitudes, technical interests, and achievement in exams; and
- an online questionnaire designed on the basis of the qualitative instruments.

The research project is currently in the process of finishing the qualitative part, where 30 interviews with women withdrawers and ten with male withdrawers were analysed. In this article, we will detail selected results from these interviews, and therefore only describe the design of the qualitative instruments we have developed for this purpose.

We have decided in favour of episodic interviews because narrated episodes are a suitable basis for the complex reconstruction of individual reasons and experiences gained. In this way, we expect to gain knowledge about the withdrawers' central experiences and fundamental points of conflict, which were relevant for the decision to leave their engineering degrees. We have designed a structured interview form to ensure that the same academic and social situations, which are specific to engineering studies, are addressed and the same information is gathered on each student. These situations can be divided, following Tinto's dropout model, into academic and social situations of studying. All these situations have to be narrated by the student, bearing in mind whether they integrated her or him into the engineering degree or whether they fostered the attrition decision. Subsequent to the episodic interview, we employ a grid interview (cf. Kelly, 1991) to receive the personal assessments of the students' experiences told in the episodes. We assume that these assessments are actually the relevant factors in the decision-making process and explain why one student leaves the university and another student with the same experiences stays. At the end of the interview, the students have to fill out a questionnaire, which provides us with information about their technical attitudes and interests, and about their achievement in the final three years of school and in the exams they have already sat.

The analyses of the interviews start with single case analyses of all interviews (see below). These single case analyses begin with a synopsis of the respective interview that summarises the narrated episodes of a student along a timeline marked beginning, progress, and end of study. Thereafter the characteristics of the student that are relevant for engineering study, such as technical attitudes, school and course achievements at university, and so on, are noted. That is followed by the identification of the individual conflict and attachment experiences that are gained by the key sentence approach (cf. Leithäuser and Volmerg, 1988) in combination with the repertory grid approach (cf. Kelly, 1991). Finally, on the basis of these conflict and attachment experiences, and its evaluation by means of the central reasons of withdrawal that the student has given, the categorisation is carried out by determining the specific elements of a type (individual characteristics, specific conflict and attachment experiences, central withdrawal reason) and by finding a meaningful name for this type. At the end, all single case analyses are compared with each other and the cases for the types are given a closing placement.

Analyses and results

Overview of the results

Before presenting two particularly meaningful case studies we will give a short overview of the five types of withdrawers we have found in our interviews.

In the first type we find a mismatch in the study logic. The university has certain study demands but the students only have their learning experiences from school. They have great problems learning the self-organisation of learning. We find this problem mainly among students who have passed their school exams without any major effort. A key sentence of this type could be: "I don't know how to study, I passed my school exams without much effort". This type seems to be gender-neutral.

In the second type there is a mismatch in the contents of the curriculum. The university teaches basics and the students want to learn occupation-related content. In this type we often find students who have a lot of technical experience and a concrete

image of their future jobs. In this type we probably find more men than women. The key sentence of this type could be: "I had a clear occupational goal. I knew exactly what I wanted to learn at the university".

In the third type there is a mismatch in the assessment logic. "I always suffer from my average performance" is the key sentence of this type and at same time the main dropout reason. He or she doesn't know how to put his or her grades into relation with his or her achievement at school. Persons of this type have certain characteristics. They used to be the best at school, so they aren't used to getting poor grades. Their levels of previous knowledge of technology were not the same but all in all they are not the typical "techies" and "computer geeks". They derive their confidence for studying successfully in a technical field from their very good performance at school. Their intention to study engineering or computer science is often to get a good and safe job. At university, they get only average grades in their exams, going by their own assessment logic – that is, the logic of school. At school, if you know the subject matter and can apply it you get a good grade. In technical degrees at university, assessment is focused on selection. At university only a very few students get good grades in the first semesters. The majority of the students only scrape through their exams. But students of this type cannot adapt their logic of assessment from school. They drop out because they cannot bear having poor grades. Accordingly, they cannot develop job-related self-confidence. In his type we find more women than men.

The fourth type we have found comes into conflict with the subject matter. "You only hear the background to things you don't even know", is their key sentence. This dropout type shares a lot of characteristics with the third type. They also have high grades in school and are also more likely to have low levels of technical experience, but they have a high interest in technology. Moreover, they are also confident about studying a technical degree successfully, due to their school performance. However, the main difference between these two types is in the intention. Central for this type is that they want to get a deep understanding of technical phenomena and artifacts. But at university they are mainly trained in mathematical skills. Lecturers at university do not provide students with a great deal of overviews and conceptual knowledge. Instead, they teach a lot of isolated facts and mathematical procedures. This type of student cannot develop the necessary images about the modes of operation of technological phenomena and artifacts, and this is the reason why they suffer, even if they get good grades in their exams. In spite of good grades they cannot develop job-related self-confidence because they always have the feeling they do not understand anything. In this type we also find more women.

The main conflict of the last type is the conflict between students' own gender identity and the mainstream gender identities of the field. Here, too, we find more women than men. It is noticeable that these women often are not German nationals. They have their cultural roots in Southeastern European countries. They have very positive impressions about engineering degrees from female friends who have studied engineering abroad. Their friends have told them they have really nice fellow students and really enjoy university life. Such was their expectation and, at the same time, their intention in starting their technical degrees. In contrast to the women from the other types, they had only average grades at school, very limited technical experience, and a less specific interest in technology. One remarkable factor is that these women have a

high general confidence in their performance abilities at university. However, right from the start, they experience that they look different to the other women and the other women also let them know that they are different. The key sentence of these women is: "I looked totally different to the other women; they all looked a bit like the guys". It follows that they are socially excluded. That is very dramatic in technical degrees, because the students need mutual academic support to get through their exams. And thus, social exclusion causes academic exclusion at the same time.

Case studies

The selected case studies describe two types of withdrawers (types three and four) that have high quotas of women in comparison to the other types[2]. Further, these two cases represent two central conflicts of women that hinder the academic identity formation in engineering education that is necessary to be successful and to achieve a diploma. The case studies are structured in the following way. Firstly, we give an overview of the beginning, the process, and the end of the students' studies. The guiding questions were the following:

- What was the intention behind choosing the study and what were the important impressions and experiences in the course of the study?
- Also, what were the central reasons for dropping out?

Secondly, we work out the main lines of conflict that were relevant to the decision to drop out as a result of the conducted repertory grids. Thirdly, we compare both attrition processes, and finally we draw some conclusions and point out their implications for interventions suited for strengthening institutional bonding forces.

Karin[3]: "I couldn't meet my own demands on myself. But I'm still homesick"

The beginning. Karin starts a general engineering degree at a technical university because she is not yet quite sure which subject direction she wants to take. Karin took physics and mathematics as her main courses at school and got good exam results. She has gained an insight into the sciences through her father, a physicist. Before starting her degree, Karin had already heard how difficult "math and so on" is supposed to be at university. Karin manages to deal with these concerns by means of thoughts like, "Well, you're not bad at math, it'll work out OK". She is "really motivated" and wants to enjoy her degree and make progress. She has found out in advance how her university of choice compares to other universities. Its good reputation leads her to expect to receive good degree training.

The process. Karin always enjoys studying at the technical university. She has a lot of friends and enjoys spending time with other students. The only thing she dislikes is the labs, in which "you suddenly sit there, have no idea about anything and just kind of get through the torture". Overall, Karin always feels the lack of "some kind of reference to applications". Other than that, Karin judges courses as a question of people rather than subjects. She experiences faculty members, tutors, and study groups as very different – some as beneficial, some as a hindrance. Karin has problems with the slow, soporific voices of professors, which present a tough challenge for her powers of concentration. After the third semester, Karin switches to electrical engineering. On this course, she enjoys programming methodology, the only subject in which she feels close to what she originally wanted. She likes the fact that she can directly apply the

material she learns in lectures, i.e. she does not just "learn for the sake of it", but experiences the success of entering "the right thing on the keyboard".

The end. Karin passes the *Vordiplom* (intermediate diploma) in electrical engineering with a grade of 3.3[4]. Karin is unable to integrate this grade into her self-image: she has the feeling that she studied as hard as she could, but always only scraped through her exams and would not be able work any harder in the future. The thought of what she regards as a worthless degree with a grade of around 3.0 makes it clear to her that the whole course is not what she originally wanted. Before Karin leaves the university, she has a guidance meeting with the students' advice center. She finds the meeting "not all that good: I came out the same as I went in". Karin starts a degree in geology but then breaks it off after one semester, because she dislikes the pure rote learning and misses the mathematical side. She then starts a course in electrical engineering at a university of applied sciences, where she picks up from the fourth semester and has now been studying for one semester. Via her boyfriend, who is still a student at the technical university, Karin still hears a lot about her former place of study. She sometimes thinks that she should have stayed on at the university after all, and refers to feelings that "one might describe as homesickness".

Karin's conflicting experiences. In the repertory grid, it is clear that Karin orders the situations she experienced during her degree using the dichotomous construct "successful/not successful". Three situations stand out as particularly negative in her individual assessment:

(1) *Vordiplom* grade;

(2) torque; and

(3) lab.

On the basis of the interview material, these situations can be examined more closely. For all three situations, we can match up basic convictions and experienced learning environments with each other and filter out the following contradictions:

Students' own expectations of their performance must be able to be fulfilled within the degree program

Conviction: I wanted to end up with a good degree
"I had found out in advance how this technical university compares to other universities and I'd found out that it's actually very good, has a very good reputation, and so I had quite positive expectations. I wanted to end up with a good degree when I was finished".

Learning environment encountered: I always just about scraped through
"I could have just carried on studying then, but I got a grade of 3.3 for my *Vordiplom* and I kind of had the feeling I was already working as hard as I could. The studying I was doing was all I could do, I couldn't do any better and then I still always just about scraped through with a 4.0 or 3.7 or whatever. And I kind of had the feeling, this isn't what I want, what's the point if I get a degree with a 3.0 or so, then no one will take me anyway".

Successful application of the course material is the main thing

Conviction: the positive exception: experiences of success through prompt application
"Programming methodology was fun. We always had to do the exercises, we had to hand in a program at a certain time and present it, and I have to say I found it really good fun because I

could do something at home, I could apply what I'd learned in the lecture directly and if I didn't understand something I either looked it up or I asked someone. I had the link to the application and then I knew where I wanted to go. We programmed this game and worked out figures and programmed a calculator. So you experienced success when you managed it".

Learning environment encountered: taught content with no relation to applications
"I always kind of studied, learned, and then I kind of had the feeling I didn't even know what I was doing it all for exactly. The relation to applications, it was always somehow missing. That was in mechanics for example, when we talked about torque for the first time. I didn't know what a torque is, I had no idea and I couldn't picture it either. I mean torque – it took a long time for me to understand it and I wasn't the only one".

Common understanding only works if everyone has a similar pace

Conviction: a similar pace is key
"It probably only works if you have a similar pace. I mean, if there's someone who always understands everything straight away and you maybe don't get it quite so quickly, then you get left behind later, if the other person's always ten steps ahead of you. Then you always have the feeling you're lagging behind".

Learning environment encountered: the others were much too fast
"I always found labs awful. [...] And you suddenly sit there, have no idea about anything and just kind of more or less get through the torture somehow. I was usually the one who wrote everything down, but I hadn't done a related apprenticeship. They always put it all together really quickly and I thought, well why's he doing it like that, I mean, one guy always made an effort to explain it but for me it was just always a kind of torture".

Anne[5]: "I thought this was a place of learning. But you only hear the background to things you don't even know."

The beginning. Anne wants to be an engineer and starts a general engineering degree course at a technical university. Whereas her desire to become an engineer is emphasized several times, her motive for choosing this particular degree course is not detailed in the interview. Starting an engineering degree is strongly influenced by Anne's great curiosity for technical matters. Anne looks forward to "learning something [she] always wanted to know": how technology works and how to make it. Anne feels a great need for explanations of (everyday) technology and assumes "that's exactly what you learn here, because it's a place of learning". She has always been interested in books that explain technology ("How does a stereo system work?") but has never found a really good one. Anne assumes that the university will provide her with "pre-sorted" information to enable her to understand technology.

The process. Anne's prevailing memories of the technical university are of the large amount of material for her degree and the lack of contact between the teaching staff and the students. Anne spontaneously lists "a continually punishing pace" and the accompanying concentration problems, no time for her own thoughts and the resulting feeling of inner vacuum, and the lack of connections between faculty and students, manifested in the complete lack of "well-thought-out, exciting narratives" as lasting impressions. Her memories repeatedly refer to the taught material's lack of reference to the real world. Anne is "totally disappointed" that she only learns the background to

things that she does not yet even know, and does not get to know the things themselves first. Having enjoyed the preparatory mathematics course, Anne encounters an abstract world in the subjects of mathematics and machine elements in particular, in which one learns "to push numbers back and forth without knowing why". Anne tries to demand the explanations she needs by asking the lecturers explicitly for pictures and explanations of the way components work. However, the responses to her questions are once again abstract formulae. Her despondency becomes permanent because there is no bridge between the material the lecturers want to teach and the content that Anne is capable of understanding. Anne finds it almost impossible to study on her own, as "information was always missing" to solve tasks. Anne therefore always studies with a female friend. However, even studying with a friend is very demanding for Anne, as the material from the lectures is never sufficient for solving the tasks, and she rarely finds the necessary information for processing the tasks in books or handouts. For this reason, Anne prefers to study in the library, because "there are always students there you can ask".

The end. Although Anne passes all her interim exams, she drops out of the degree course after the third semester and starts a degree in mechanical engineering at a university of applied sciences. She is in her third semester there at the time of the interview. Anne would have dropped out of the degree course at the technical university earlier if she had had an alternative. Asked about the main reason for dropping out, Anne replies that she had "just felt really unhappy". She talks about her desperation to become an engineer on the one hand but being unable to stand it in that form on the other.

Anne's conflicting experiences. In Anne's repertory grid, one can gather that she orders the situations she experienced during her degree according to the dichotomous construct "make me feel strong and good/make me depressed". As with Karin, three situations stand out as particularly negative in her individual assessment:

(1) learning background to unknown things;

(2) pushing numbers back and forth in mathematics; and

(3) "stiff" faculty.

With the aid of these three situations, we can also describe three basic convictions that conflict with the learning environment Anne encountered:

The taught material must contain answers to the student's own questions

Conviction: relation to the real world – I wanted answers to my questions
"I'd been looking forward to learning what I'd always wanted to know. Because our world is just made up of so many technical things, I thought that would be exactly what you learn here. And for me, engineering actually does mean thinking up practical things and just using technology to achieve something good".

Learning environment encountered: the lost picture and the absence of the learning object
"But it was actually more like you learned the background to things you didn't even know yet. I actually thought you'd learn about the things all around you, how they come about and what's behind them. But it was just the background behind these backgrounds, which you couldn't understand yet because you didn't know the things themselves yet".

There always has to be a bridge to the new world that links up to the things one does know.

Conviction: it doesn't work without a bridge to the new world
"I find you always learn by comparing things that are new with familiar things and making a connection at that point in your mind, and if there's no bridge, you can swim as much as you like, it doesn't work. Then you can try as hard as you like, but it can't possibly work".

Learning environment encountered: abstractness – the impossibility of appropriation
"It was so fully abstract in math that at some point I could push numbers back and forth but I didn't know at all what I was doing. And it would have helped so much if someone had just said, for example you use this to add and subtract points in a computer. You couldn't make any connections in your mind, they were just numbers".

Faculty members have to think on the same level as their students and take on the students' perspectives

Conviction: thinking things out together
"Then there was another one (professor at the university of applied sciences). He talked about machine tools and what ways there are of working with metal. And the atmosphere there was always almost cozy. It reminded me of when my grandmother used to iron and I sat next to her as a child. Because he just chatted away calmly and then occasionally asked: 'And what else can you do here?' Really calm and friendly. And, yes, it was more like thinking things out together or story time.

"The fact that he [the professor] stands next to you, so to speak, as if he were looking quite closely with you and developing it clearly for the first time himself. Like, what else can you do here, what else is there? The fact that he stands with you on the same side".

Learning environment encountered: the vicious cycle of discomfort
"And often they were unsure themselves as well. Especially the mechanical engineering people, they stood there in their gray suits, seemed unsure themselves, but in any case they seemed really stiff and more and more uncertain, the more boring it got and people naturally started chatting. Because they just didn't make it exciting or think along with us, but were completely locked away in their screwy world. They couldn't make a connection to us".

Comparative interpretation of the interviews

One can recognise the dropouts presented here as actors taking actions due to a discrepancy between their individual convictions and the learning environments they encounter. Their attrition is preceded by the confrontation of convictions and actual circumstances and a mismatch between the two. The interviews thus support the approach of Tinto (1975), interpreting withdrawal from university as failed academic and/or social integration. However, it also becomes clear that every failed integration entails concealed conflicts. A behaviour- and conflict-theoretical approach to the phenomenon of attrition – as formulated by Ströhlein (1983) – appears appropriate to make Tinto's (1975) integration metaphor more precise: student attrition presents itself as more or less painful actions of students who are unable to live out their own ideal of worthwhile learning in the learning environment they encounter. This general reflection that applies to all dropout types we have found in our study can be made more concrete with regard to the gender dimensions of attrition in engineering studies. The two case studies highlight two significant lines of conflict, which encourage female students in particular to leave who are fully capable of meeting the demands:

(1) the feeling of always only scraping through; and

(2) the feeling of never understanding anything in sufficient depth.

For Karin, the *Vordiplom* grade of 3.3 and her related feelings of never being able to get a good degree form the main reason for leaving. We must point out the subjectivity of Karin's evaluations. From a statistical point of view, Karin's *Vordiplom* grade is average. Additionally, the *Vordiplom* grade does not entail a clear prognosis for the final grade, as a rule. Many students gain a significantly better final grade than their *Vordiplom* grades would suggest. Unfortunately, Karin was only able to relativise the significance of her *Vordiplom* grade after leaving the university:

> We also talked about why I switched to the university of applied sciences. And then my former fellow student said: grade 3.3 for your *Vordiplom*, we all had that, I only got 2.7 as well and now I have a grade 1 for my *Diplom*. And then I thought, well, maybe I might have managed it here after all.

Anne, in contrast, leaves the university because she has a permanent feeling of not understanding things sufficiently. Before leaving, Anne makes intensive attempts to demand explanations. Only when her initiatives fail does she switch to the university of applied sciences after the third semester, worn out:

> I couldn't imagine how a certain component, an amplifier, works, why power comes in on one side and out again on the other side. And so I'd asked him [the lecturer] if he could give me a picture or an image of how it works. Just wanted him to tell me an idea so that I could imagine what the component's like, and he started explaining me the whole thing, these lines and formulae all over again, but that wasn't what I wanted to know. So I asked him again, and then he got really angry and said I should listen properly. And then I didn't dare to say anything again, so I listened to what I didn't want to know for another half hour.

Conclusions: factors for strengthening the integrating forces within the university

The findings indicate that there are two factors that hinder the academic and professional identity formation of withdrawers who reached all institutional goals successfully but did not start with profound practical knowledge:

(1) the subjective feeling of average or bad grades; and

(2) the subjective feeling of insufficient comprehension.

An important characteristic of the technical universities that causes these conflicts is the fact that the first four semesters of a technical degree are a stage of selection. Normally, technical universities in Germany have no access restrictions. Instead these universities select very drastically. This means that most of the students scrape through their exams in the first four semesters and do not have good grades. The type who "doesn't know how to put his or her grades into relation" is particularly affected by this characteristic. Secondly, quite a lot of previous mathematical and technical knowledge and skills are implicitly demanded for a technical degree, but this previous knowledge is generally not stated explicitly in the information material. This aspect is a specific characteristic in this field because other degrees do not normally demand special previous knowledge (such as medicine or law). Or they do demand special previous knowledge, but then they state these demands explicitly and have acceptance

tests (such as music and art). The third conflicting characteristic is the fact that technical degrees are separated into two phases. In the first four semesters, the students learn only basics, which are focused on mathematical formulae. Students of the type who "don't know how to understand technology" have no chance to open up the technical field for themselves because they cannot see the technical phenomena behind the mathematical formulae. From Karin and Anne's conflicting experiences we can derive approaches for action in the fields of academic integration formulated by Tinto. The integrating force and inherent attractiveness of engineering degree courses can be enhanced for these dropout types by means of the following factors:

- In the area of "grade performance", the introduction of an assessment system aimed at strengthening students' academic self-confidence in the subjects in question and less at selecting students.
- In the area of "intellectual development", creating a specific relation to technical objects encountered in everyday life and linking to students' previous knowledge (a bridge to the new world), prompt application of curriculum material, teaching with empathic dialogs and exciting narrations, and constructively taking into account and using students' different levels of previous knowledge in group work.

Notes

1. Source: Statistikportal VDI: Berufsstatistiken-Hochschule; see http://194.245.72.99/index4.php?CHOICE = I_1FS&GESAMT = 1&FACHBEREICH = Ingenieurwissenschaften + insgesamt&SIZE = 600x400 (accessed September 2, 2007).
2. The gender identity conflict is also very important for female students – especially for foreign persons. We will debate this in a special article.
3. Name changed to ensure anonymity.
4. To place this grade in context, note that the examination board's statistics on all students state the average *Vordiplom* grade as slightly above 3 (1 = distinction, 5 = fail).
5. Name changed to ensure anonymity.

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