



From Fixing Women to Transforming Systems: A Power-Critical Application of Soft Systems Methodology in STEM

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Abstract

Women remain persistently underrepresented in STEM (Science, Technology, Engineering, Mathematics) fields, particularly in higher career levels and leadership positions. Despite numerous programs designed to support women individually – such as mentoring, coaching, and training – gender disparities endure, suggesting that these interventions fail to address the structural roots of inequality. This article presents a research design that adopts a systemic perspective informed by *Soft Systems Methodology* (SSM) and *Critical Systems Heuristics* (CSH) to shift the focus from changing women to transforming the behaviour of responsible, but largely unaffected, system participants – namely, men in positions of power. We conducted problem-centred interviews with women in STEM to build *purposeful activity* models of their career experiences and challenges. These served as a basis for discussion in workshops with responsible, but not affected system participants, e.g. professors and research associates. While the initial aim was to generate actionable recommendations, it became increasingly clear that the workshops' most significant impact lay in the processes of self-reflection and shifts in attitude among male participants, catalysed by the depth and openness of the group discussions. Changing these attitudes is particularly crucial because men in these positions shape and sustain institutional logics; thus, transforming their perspectives represents a key leverage point for systemic change. Despite methodological challenges and unresolved questions regarding its long-term impact, this study demonstrates a power-critical adaptation of SSM by integrating elements of CSH to address power asymmetries and epistemic injustice supporting transformative processes in power-unequal contexts.

Keywords Women in STEM · Soft systems methodology · Epistemic injustice · Critical systems heuristics · Organisational development · Power asymmetries

Introduction

The pursuit of gender equality in academia is an objective of many different funding programmes in research and organisational development. Especially in STEM (science, technology, engineering, mathematics) fields, women are highly underrepresented. In 2021,

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women made up only 35% of people employed in STEM occupations in the United States (National Science Foundation 2023). In the European Union, 32.8% of tertiary education graduates in STEM fields were women (Eurostat 2024). In Saxony, Germany, women represent only 17.2% of the workforce in STEM professions (Institut der deutschen Wirtschaft 2024). This especially low rate fostered the following research and its funding by the European Social Fund as part of a larger project involving four different universities in Saxony with the general aim of developing policy strategies improving the recruitment of women as executives in STEM fields.

Although, programmes to promote women and research exploring their underrepresentation are widespread (Brötzmann and Pöllmann-Heller 2018; Kanny et al. 2014; Palid et al. 2023; Wang and Degol 2017), those promotion programmes mainly focus on women as individuals and therefore suggest individual measures such as fostering professional enthusiasm in female pupils, mentoring young female researchers in STEM, or offering special trainings for applications or salary negotiations (Brötzmann and Pöllmann-Heller 2018; Palid et al. 2023; Wang and Degol 2017). Even though these programmes have been around for several years or even decades (Brötzmann and Pöllmann-Heller 2018; Palid et al. 2023), the gender proportions in STEM remain stagnant; the over-representation of men, especially in higher career levels and leadership positions, appears robust and lasting (Dubois-Shaik and Fusulier 2017; Speer 2023). From a systemics point of view, this comes with no surprise, since the individuals are elements of a self-stabilizing system and changes on an individual level are often counteracted through circular feedback (e.g. Cabrera et al. 2015). If we acknowledge that gender inequality is not just a tame problem of the individual woman, but a *wicked problem* (Rittel and Webber 1973) of our society with high complexity, inextricable interactions and no final ‘good’ solution, systems thinking becomes inevitable (O’Brien et al. 2017; Shapiro and Kato 2021).

In this article, we argue that for the problem of underrepresented and discriminated women in STEM, academic organisational development needs to steer away from individualised cause-and-measure cycles and surface-level interventions, towards a systemic perspective to tackle the structural roots of inequality. As an important starting point, the main objective of this study was to abandon the general approach of changing the behaviours and attitudes of the discriminated women in order to adapt them to a system designed in accordance with male needs. Instead, to enhance the attractiveness of the STEM field for women, we switched our focus towards the influential system participants upholding inequalities, i.e. the responsible men. Hence, our main goal was to identify recommendations leading to behavioural changes of those mainly unaffected system participants. To conduct reflective discussions about alternative behaviours with them, we used the Soft Systems Methodology (SSM) as an underlying framework for structuring our procedure.

The Soft Systems Methodology (SSM) was developed by Peter Checkland to analyse complex problem situations rooted in human activity, considering both the situation’s environment and the individual worldviews (Weltanschauungen) of all actors involved (Checkland and Poulter 2010). Therefore, this method enables us to widen our scope from the focus of the individual women to other systems participants like their peer men, their superiors throughout their career, and the institutions and organisations of which they are members of. However, as Jackson (2019) points out, SSM assumes a level playing field in which all participants can communicate and negotiate on equal footing – an assumption that ignores real-world asymmetries of power and knowledge which are fundamental to inequalities.

Against this background, Jackson (2019) refers to Habermas' (1974) concept of the *ideal speech situation* as a normative prerequisite for fair deliberation in SSM. A *genuine accommodation* can only emerge if discourse between participants occurs under conditions approaching this ideal: without coercion, with equal opportunities to speak, and free from ideological or power-based communication barriers. Yet, as Jackson stresses, organisations are typically marked by social inequalities, asymmetrical power structures, and uneven intellectual and epistemic resources. In such contexts, a balanced discourse is structurally impeded: powerful actors prevail – not necessarily out of strategic intent, but because their privileged position limits access to experiences that would allow them to appreciate other perspectives. The result is often “false accommodations” based not on equitable deliberation but on the reproduction of existing hierarchies and epistemic authority (Giddens 1993; Jackson 2019).

This dynamic becomes particularly problematic in highly hierarchical and androcentric fields like STEM – systems historically and structurally aligned with male experiences – especially when SSM is applied without critical reflection on power dynamics and the aim of the intervention is the promotion of women. Women bring contextual experience and expertise regarding structural disadvantage, while men often speak to a reality they have never lived. According to Checkland, SSM would treat these different perspectives as epistemically equivalent (Checkland 1981). Yet when men have an equal say in what gender equality should look like in a male-dominated STEM context, the result is not a balanced dialogue, but rather the reinforcement of structural power asymmetries under the guise of participatory methods.

Therefore, it becomes even more important to ask (Burell 1983): Whose interests does a proposed solution ultimately serve? Measures like mentoring or coaching the discriminated women may appear supportive at first glance, but they individualise structural problems while the system – its power dynamics, exclusions, and cultural norms – remains untouched. The seemingly “culturally feasible” (Checkland and Poulter 2010, p. 205) solution thus serves not women, but rather the continuation of the existing order by promoting adaptation instead of transformation, a dynamic often remaining invisible in SSM (Jackson 2019). Therefore, responsible professional practice requires critical reflection on which facts and values were considered, and which were not. The critical assessment of such boundary decisions - what is part of the system and its analysis and what not - is the key element of Critical Systems Heuristics (CSH) developed by Ulrich and Reynolds (2010). This method focuses on a deeper understanding of the perspective of the marginalised group. It claims an ethical-normative description of how things are and should be (Hutcheson et al. 2024), consistent with critical social theory (Habermas 1971). However, this normative notion stands in contrast to a constructivist point of view (Von Glasersfeld 1984) and more specifically to social constructionism (Gergen and Gergen 2003) questioning the objectivity of social norms and suggesting that they are created through social interactions and shared agreement. This major focus of SSM - on dialogue and mutual learning - is neglected in CSH due to its critical perspective on social interactions. Here, it is more important to advocate for the marginalized group, even when it comes at the cost of an impaired mutual understanding of the groups (Midgley and Rajagopalan 2021). To overcome this methodological dilemma, we decided to find new ways of using SSM procedure and terminology under the umbrella of methodological pluralism (Jackson 2019).

First, we acknowledged that the problem of gender inequality in STEM is complex, pluralistic, and pervaded by imbalanced power-structures. Therefore, we began our problem evaluation with the marginalised group of women in STEM, aiming to empower their perspective.

Second, we were sensitive to the fact that marginalised groups can be involved in reproducing the dominant social structures due to implicit cultural norms, thus involuntarily stabilising them (Bourdieu 1982). Hence, we critically examined the narratives of our interview partners regarding the activities of the men in power impacting their career decisions.

Third, we sought to find solutions based on behavioural changes among the men who are responsible for upholding the imbalanced power-structure rather than changes demanded of the affected women. This led us to adopt a solution focused approach (de Shazer and Berg 1992) in a workshop-format, discussing the identified actions with men in similar positions by asking them about the possible meanings of these actions and feasible alternative behaviours that would be less discriminating towards the affected women.

Fourth and finally, we missed our aim: the workshops resulted only in already known and very specific behavioural recommendations. However, to our surprise the workshops created an atmosphere, where the participating men started to see their own actions under the perspective of the affected women, questioning them and considering how they could change their behaviour. Though, instead of the targeted policy recommendations for behavioural change of the responsible system participants, we attained a change of attitude within this target group - a much more powerful leverage point for systems change (Meadows 1999).

In the following section, we outline how we translated this methodological stance into a tangible process, present the results we obtained, and conclude with a critical discussion of our unconventional approach.

Our Use of Soft Systems Methodology

As Checkland and Poulter (2010) point out, good uses of SSM are always situation-specific and open to new learning. We followed this principle by applying the methodology in a critically reflexive way, adapting it to the power structures of our context and challenging the tacit assumption that all perspectives are equal. This reinterpretation allowed us to use SSM as a framework for generating a structured, systemic understanding of the problem without reproducing the very hierarchies we sought to challenge.

Development of the Rich Picture and CATWOE Analysis

As suggested by SSM, our process began with the development of a *rich picture* to gain a structured understanding of the problematic situation. A rich picture is a collection of all components, conditions and participants as well as their connections that come to mind when considering the identified problematic situation (Checkland and Poulter 2010). This picture, created by us as researchers, enabled the identification of the CATWOE components. CATWOE is the acronym for the components that make up the concept of a *purposeful activity* (Checkland and Poulter 2010) which are described in the following sections. We identified them following the order proposed by Checkland and Poulter (2010).

First, we clarified the specific Transformation (T) we wanted to analyse. T is described as the transformation of an entity from one state into another (Checkland and Poulter 2010). The system we want to model is transforming female individuals into academically educated STEM-women with the prospect of taking leadership positions.

Second, we defined the worldview (W). In the original SSM, the W is different for each actor (A), resulting in different models that are formed from the individual perspective of each actor (A). But because of our power-critical discussion (see above), we have decided to base our models on a power-critical and feminist informed worldview (W). This does not mean that we do not want to respect the worldview (W) of the actors (A)/owners (O), but SSM is intended to inspire an energetic discussion, which is why we go into the models with a central worldview and only bring the worldview of the actors (A)/owners (O) into the workshops when they are included in the conversation.

Third and fourth, we identified a wide array of customers (C) which are affected by the system (e.g., women in STEM across different career stages, schoolgirls), and actors (A). Actors (A) are capable of acting within the system and have opportunities to shape it (Checkland and Poulter 2010). We identified parents, peers, partners, teachers, professors, colleagues and superiors and according to our premise of not changing the women, we focussed on male actors (A) in order to analyse their actions and their position in the system.

Fifth, we defined the state of Saxony or more specifically the Saxon ministry of science, culture and tourism as the system's owner because formally it holds the institutional power and funding authority for universities and therefore the women in academic STEM fields. It also is responsible for funding this research, which gives the impression that there is an awareness of the problem situation.

Sixth, we have defined the last CATWOE element, the environment (E). Since we acknowledge gender inequality as a *wicked problem* of high complexity, it is inherently difficult to determine where the system ends and where the Environment begins (Rittle and Webber 1973). To account for this ambiguity, we chose to define a relatively broad system boundary - following the rationale of Ulrich and Reynolds (2010). Accordingly, we considered media representations (e.g. women in STEM, gender equality issues) and the broader political climate as relevant environmental conditions.

Based on this CATWOE analysis, we developed the following root definition. It describes the current state of the system and served as the foundation for our model building and discussions: "It is a patriarchal social system that structures career choices and the pursuit of interests and application of skills based on gender stereotypes, making educational and career paths in STEM subjects more difficult for women than for men."

This root definition would enable us to form the models very close to the biographic narrations of the interviewees. We also generated an additional root definition to manifest our best-case Transformation to illustrate the contrast that we want to reduce in the process of this research. That best case root definition reads as follows: "It is a social system that ensures that women can choose STEM subjects/professions according to their abilities/interests in a self-determined and equal manner and can rise to leadership positions in these fields."

The outcome of this step led to the decision to diverge from the standard SSM procedure. Specifically, we chose not to involve the identified actors (A) and owners (O) directly in the early modelling phase. Instead, we focused exclusively on the experiences of those affected by the system – namely, women in STEM – in order to avoid reinforcing the very hierarchies that often remain unchallenged in conventional applications of SSM (Jackson 2019). This strategic deviation aligned with our intention to use SSM not just as a participatory tool, but as a critical framework responsive to structural inequality.

Data Acquisition and Processing

For model building, we conducted problem-centred interviews (Witzel 2000) with eight women from various STEM disciplines (physics, engineering, interdisciplinary STEM, computer science), and at different career stages (student, doctoral researcher, assistant professor, professor).

Data protection protocols were established in consultation with the local data protection office at Hochschule Zittau/Görlitz. All data were processed and analysed in anonymized form.

All interview participants had spent at least part of their educational or professional careers in Saxony. The interviews were semi-structured, conducted in German, and guided by questions such as (questions and quotes are translated from German):

- How did you come to work in your current position?
- What role did your perception as a woman play?
- What positive or negative experiences have you had related to gender?
- What helped you overcome (gender-related) challenges?
- What would you like to see changed to reduce these challenges?
- How do you see your future in STEM?
- What should be improved in the STEM field?

These questions should encourage the interviewees to share their experiences in the field as well as their perspectives on the given hierarchies and conditions. Their responses allowed us to extract *purposeful activities* of various actors (A) and owners (O), as well as insights into the political and cultural dynamics of the system.

The interviews were conducted in person or via video conferencing platforms (Zoom, BigBlueButton), recorded, and transcribed using a combination of the AI-based software NoScribe, and manual correction and anonymisation. For model creation, five out of nine transcripts were selected based on diversity in position, discipline, and institutional affiliation.

To analyse this material, we developed a deductive coding scheme based on SSM principles. Segments where interviewees described actions – either their own or those of others within the system – were coded as *purposeful activities*. These were paraphrased, chronologically ordered, and colour-coded by actor (A) type, using the software Mural to create visual models (see Figs. 1, 2 and 3 in the Results section). In contrast to the original suggestion (Checkland and Poulter 2010) and other published SSM studies where models are structured in clustered activities (e.g. Wilson 2001, Óskarsdóttir 2021) we chose a visualisation according to the chronology of actions enabling a clear overview of the different system participants involved. We chose this method because the narrative data collection and the focus on *purposeful activities* of the actors (A) naturally resulted in a chronological structure.

In the next step, aiming to enable the structured discussion envisioned in SSM, we identified sequences within the models that illustrated problematic actions or situations that hinder the career development of women in STEM. We defined *problematic actions* by comparing the suspected purpose of actions in the model with both of our root definitions. If an analysed action served the purpose of our status quo root definition, it would qualify as a discussion-topic for the workshop because they reproduce what we recognize as patriarchal patterns. Actors (A) of these problematic *purposeful activities* were identified as male pro-

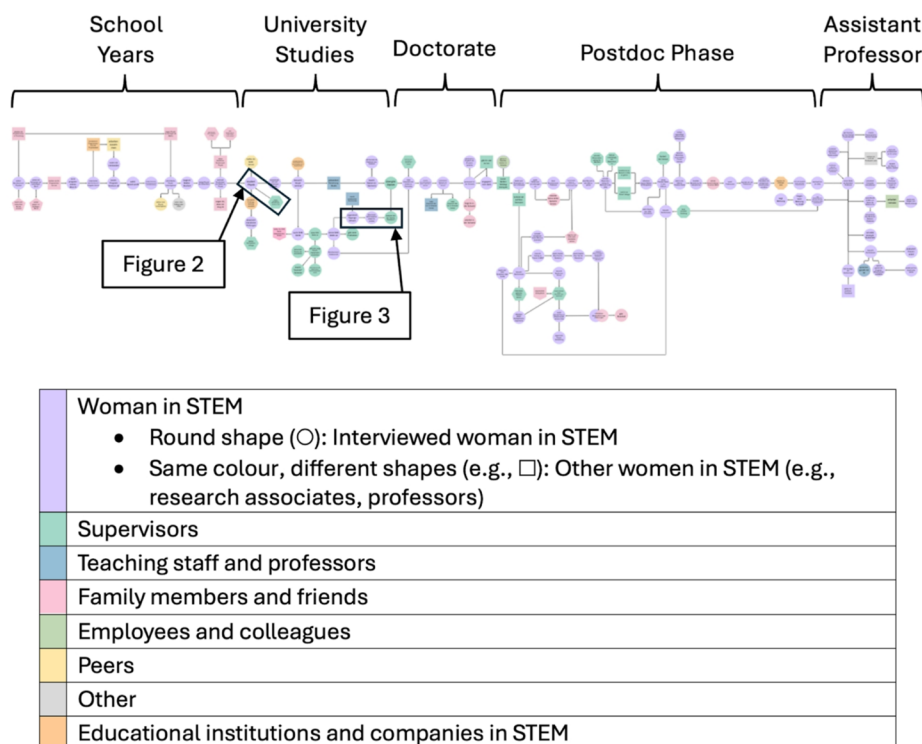
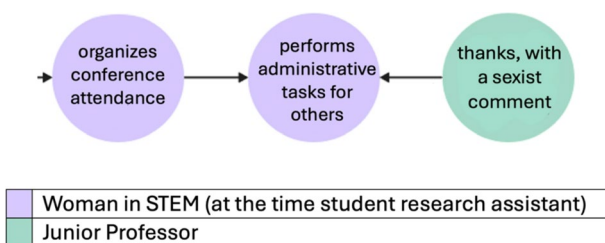


Fig. 1 Stylised example model showing *purposeful activities* for one woman in STEM (purple circles) interacting with others throughout her life, black frames show excerpts of Figs. 2 and 3

Fig. 2 Excerpt from the university studies phase of the *purposeful activity* model of a female assistant professor in engineering

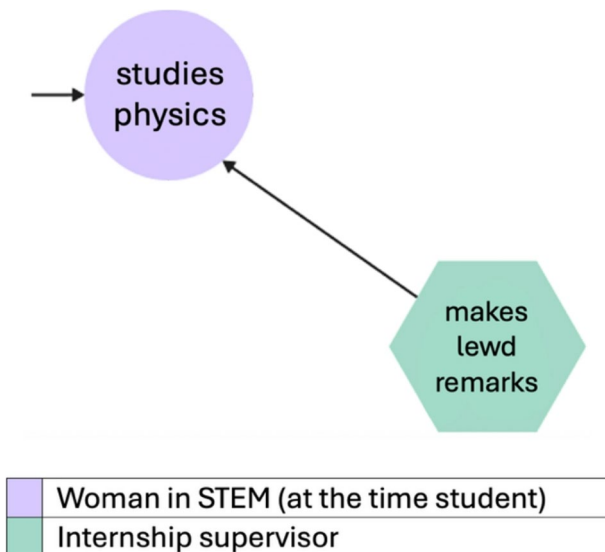


fessors, colleagues and supervisors. With this target group in mind the following workshop concept was developed.

Workshop Design and Implementation

To explore and discuss these problematic *purposeful activities*, we developed a workshop format aimed at these male actors (A). To ensure that the participants have a similar epistemic position, at least from a formal perspective, we conducted a workshop with professors and a workshop with academic staff individually and selected the model extracts to be discussed according to the actor group (A).

Fig. 3 Excerpt from the university studies phase of the *purposeful activity* model of a female assistant professor in engineering



There were two objectives of the workshop format. Firstly, we expected to find specific alternatives to the presented *purposeful activities* which we could directly use as a foundation for generating actionable recommendations. Secondly, we wanted to converse with the actors (A) to initiate self-reflection. Therefore, we decided on a systemic setting of the discussion to create an open and accepting atmosphere that would inspire the participants not only to freely share their perspectives on the presented examples but also enable them to issue their own experiences and reflect on them (e.g. Senge, 1994). This is also the moment for the worldview (W) of the participants to be presented and be involved in the development of alternative actions.

The workshops were held in German (questions and quotes translated) and began with a brief introduction, followed by a short input on systems thinking, SSM, and core principles of systemic consulting (e.g., assuming positive intentions). The modelling process was then explained, including the colour coding and structure of the models. During the interactive segment, participants discussed selected model segments including original quotes, guided by the questions:

- What is the actor's underlying purpose?
- What positive assumption can be made about the action?
- What alternative action could fulfil the same purpose?

Although the main target group of the workshops were male, it was important to us that women also took part. In this way, we wanted to ensure that the resulting 'feasible solutions' were not formulated exclusively by men – i.e. by people who had never been directly affected by the problems themselves - and that female perspectives were reflected in the proposed solutions. Additionally, we need to stay aware of the fact that women not only are customers (C) in the system but depending on their positions (professors or supervisors) can also be actors (A).

Workshop Procedure and Results

Two workshops have been conducted so far at the University of Applied Science Zittau/Görlitz, one with professors and one with research associates. Both workshops included male as well as female participants. We are convinced that even though our focus was to challenge and change the male perspectives with the workshops, it is important to include female participants as well to keep their perspective present at all stages of the research.

The workshop with professors was held online, and the audio was recorded and transcribed (again using NoScribe and manual correction and anonymisation). The workshop with associate researchers was carried out in person being part of a more extensive training program on gender inequality in academia and STEM. Due to practical and spatial conditions, it was not audio-recorded but logged to keep the main points of the discussion for further analysis.

Although the aim of the workshops was to provide actionable recommendations, for which we also worked out the basics, the discussions and the possible accompanying changes in attitude were the main result. Therefore, the analysis presented in the following chapter focused on identifying whether and how awareness of patriarchal structures and systemic patterns was raised among these responsible but previously unaffected actors (A).

Results and Interpretation

Modelling

The model building process resulted in five *purposeful activity* models, each representing the career of one of the interviewed women in STEM. One of the models, an assistant professor in engineering, is shown in Fig. 1.

Based on the coded interview phrases describing *purposeful activities* and the constructed models of the *purposeful activities*, we identified 13 problematic situations involving professors or supervisors, and seven problematic situations involving male colleagues or researchers acting as superiors. This selection happened in preparation of the energetic discussion in the workshops and was supposed to focus the conversation on the problematic situations.

The following are two exemplary excerpts from the model in Fig. 1 that were also used in the workshops.

I was very good at organising things for others, and especially physicists, and 22-year-olds aren't all good at that. In other words, because of the large group, I partly organised that we all went to a conference together, and I did the booking and stuff, and not a secretary somehow, because that was also a junior professor, who didn't have that much power in the department. And [...] when I got my diploma from him, the group meeting, he gave me a very proud handshake and said, yes, you were like a little secretary. - Oh, ouch. And that's just... you can't say that. And I mean, it was immediately clear to me at the time that you're not allowed to say that and so on, but I would never have, he always said things like that, I only realised when I was away, that it was always there subliminally, that you were treated like, oh, it's surprising that you're here too. (female Assistant Professor A, interview)

That was also a negative experience during my studies, one of the internship supervisors always made lewd remarks. He always, I don't know, made faces when he said the word "mammography" a lot. He was in the radiation examination. And he was always a bit uncomfortably close... So he didn't do anything seriously bad, but he always gave you the feeling that you'd rather be somewhere else and were happy not to be alone with him. (female Assistant Professor A, interview)

The combination of the very precise and clearly arranged model sections with the original quotes was supposed to show accurate connections and chronology while also providing enough detail to comprehend the atmosphere and procedure of the situation. The use of these examples during the workshops will be described in the following section.

Workshops

During the workshops the participants were shown excerpts from the models including the graphics as well as the original quotes from the corresponding interviews. While the workshops were designed to generate specific action recommendations, it was the discussions themselves, and the shifts in attitudes they sparked, that proved to be the most valuable outcome. The workshops created an atmosphere that encouraged open reflection rather than prescribing the "right" behaviour.

A key element in creating this atmosphere was the principle of positive attribution: even in the face of strikingly problematic examples, participants were encouraged to assume good intentions of the person showing problematic behaviour. This not only enabled constructive discussion of past mistakes by others, it also avoided lengthy consideration about the problem and its origin and made it easier for participants to reflect on their own behaviour without fear of blame. In doing so, we inspired solution-oriented thinking, and the 'question of guilt' was shifted away from individuals and reframed as a shared opportunity for learning and growth.

Male participants began to engage deeply with the presented examples, connecting them to their own experiences. In reflecting on the problematic actions of others, they realized they have shown similar behaviour in their past too.

This process of recognition and self-reflection laid the groundwork for genuine insight and personal learning for the professors as well as the research associates. Due to the different recording situations, the following examples are exclusively from the workshop with professors:

My takeaway from this is that there are still a few things that need to be thought about a little more carefully – especially those offhand or careless remarks. [...] I'm not excluding myself here. I'm sure I've already... I mean, right now I only have male colleagues, and I might have made some flippant comments that weren't really okay. (male Professor B, workshop)

"All I know is that I carry things around with me – things I've said, where afterwards I think: no, that wasn't okay. And sometimes you just don't get the chance to make it right again." (male Professor C, workshop).

These empirical examples imply that the professors were aware that women in STEM face particular challenges and should, in principle, have equal opportunities. Nevertheless, the examples also reveal that the specific actions of the professors participating in the workshop did not consistently reflect this awareness, but instead – even if unconsciously – contributed to the reproduction of existing patriarchal structures. The gap between self-perception and behavioural impact appears to be shaped by systemic factors rather than personal flaws. This framing makes the problematic behaviour more accessible for critical reflection – and thus, potentially changeable.

An example of the professor's self-perception and the actual impact of their actions became evident when the participants were confronted with the “secretary”-example (Fig. 2). One professor commented that both sides probably suffered from “inferiority complexes” and that the problem could be solved by simply meeting each other at eye level. This belittled the responsibility for the discriminatory comment and distributed it to both parties. This statement illustrates how structural power imbalances are depoliticised and personalised through psychological interpretations and how the systemic dimension of discrimination is lost sight of in the process. It is particularly remarkable that the underlying case description does not contain any indications of insecurity or an “inferiority complex” on the part of those affected – on the contrary: the woman in STEM describes herself as competent, forward-looking and committed. Nevertheless, the professor attributed insecurity to her and simultaneously puts the derogatory behaviour of her superior into perspective. The professor speaks with supposed interpretative authority about a reality that he himself has never experienced – not because he is deliberately ignorant, but because his privileged position as a man in a patriarchal society denies him access to the everyday experiences of structural disadvantage. This epistemic position allows him to generalise the situation without recognising its gender-specific dimensions and to attribute responsibility to those affected instead of looking at the system level.

Without our deliberate methodological premise, that it is not the women, but rather the responsible unaffected system participants who need to change, supposedly *genuine accommodations* would likely have emerged at this point. These would have followed precisely this logic, for example by recommending that women in STEM participate in training, coaching, or mentoring programmes to overcome their alleged “inferiority complexes” and better assert themselves within the existing system.

The presence of female professors was crucial for repeatedly bringing the female perspective back into focus whenever underlying patriarchal assumptions resurfaced during the discussions. This female presence ultimately enabled a productive, solution-oriented discussion, with her alternative perspective serving as both a contrast and a catalyst for deeper reflection.

A particularly illustrative example from the model was presented and it centred on the topic of oral examinations. One interviewee had described how, during her own studies, she felt consistently treated with a degree of scepticism – not overtly discriminatory, but subtly undermining:

I think it was only during my oral exams in [Saxony] that I realised some people really couldn't handle the fact that women study physics. And I was treated worse than others. Not in the sense of 'you're a woman, you get a worse grade,' but always a bit more distant, with a vibe of 'Does she really know this?' (female Assistant Professor A, model).

In response, the male professors shared their own perspectives, which largely aligned. One of them put it precisely: *“So I always begin by deliberately questioning the candidate’s competence and assessing whether it is there or not. I have to do that with everyone.”* (male Professor B, workshop).

His comment reflects a logic of formal equality – the same standard for everyone – which, from within his worldview (W), seemed fair and neutral. This approach was not recognised as potentially problematic, precisely because it aligned with the dominant epistemic perspective. From this position, no structural shift is likely, as the male worldview (W) remains unchallenged. Yet it is this logic that can have disproportionately negative effects: questioning competence may appear universal in intent, but it impacts students differently depending on their position within the academic system. Individuals from groups that are generally marginalised – especially in androcentric fields like STEM – are more likely to internalise such doubt, be discouraged, or even consider leaving the system altogether. In contrast, male students who conform to the dominant norm are less likely to be seen as ‘atypical’ and tend to experience such challenges as less identity-threatening. Moreover, the presence of unconscious bias (American Association of University Women 2016) casts doubt on whether students are truly treated equally in practice, even when identical formal standards are applied.

The male professor’s perspective was only destabilised when a female professor presented her contrasting pedagogical perspective. She stated a general principle (using ‘you’ in the general sense): *“So fundamentally, you go into an exam assuming that the person across from you has potential and has studied.”* (female professor D, workshop).

Her contribution not only opened a new interpretive space but also highlighted the value of strengthening marginalised worldviews (W). While she herself may not have gained new insights from the exchange, her presence functioned as a crucial counterpoint that enabled the others – particularly the men – to question their own assumptions.

What stands out is that the workshop did not primarily generate new behavioural strategies. Rather, it initiated a process of reflection on values, attitudes, and professional responsibility. This makes sense, considering generating alternative behavioural strategies first requires an acknowledgment of the problem itself and a critical reflection on one’s own role in it.

Within the context of designing teaching and leadership approaches that support all students, including women, it became clear that only the female professor was able to offer a perspective that redefined what responsibility toward students might mean. The male professors, by contrast, remained primarily oriented toward institutional standards and did not initially recognise their own role in shaping a more inclusive examination culture.

This reflection process became evident in one participant’s later comment: *“So essentially, I’ve become more sensitised to certain things again. I think the example with the exams is definitely one of those points that really got me thinking.”* (male Professor B, workshop).

What became particularly clear across the examples, and in the way male participants engaged with them, is that men often set the implicit rules of the system (e.g., in oral exams), without these assumptions being questioned in male-dominated settings. These tacit norms are passed on unchanged, and the power to shape institutional culture stays unrecognised and contributes to the stability of the very system that marginalises others. Our analysis suggests that if the participating men were to fully understand this mechanism and reflect on the power inherent in their own position, this awareness could fundamentally shift their actions, and in doing so, open the possibility for systemic change.

Discussion

A Systemic Contradiction: between Awareness and Action

Our study set out to strengthen marginalised perspectives, challenge androcentric structures, and foster a deeper awareness of systemic barriers for women in STEM fields. From interviews with women in STEM fields, we extracted problematic *purposeful activities* of male actors (A) that served as a foundation for a discussion in workshops involving men. While these workshops did not produce a comprehensive list of policy recommendations enforcing behavioural changes in the responsible system participants, they engaged the participants in a reflective process that inspired a change of their attitudes and revealed the tension between their individual self-image and behaviour. Hence, our main recommendation for addressing the targeted change of the responsible, but unaffected system participants are similar workshops.

From a systemic perspective, the contradiction between normative values and the practical consequences of actions is not primarily a sign of individual failure. Rather, it can be understood as a systemically conditioned discrepancy: male professors in STEM often view themselves as fair, progressive, and well-meaning. If asked, they would likely articulate values such as equal opportunity, merit-based assessment, and support for individual development. Yet, the empirical material reveals how these same actors (A) – even when expressing awareness of structural disadvantages – tend to reproduce patriarchal patterns through their own actions. The resulting discrepancy was not only visible in the examples, but also in the ways in which the participants interpreted and discussed them.

The Ownership Dilemma

This discrepancy raises a fundamental question in the use of SSM: Who holds ownership (O) of a system and is thus responsible for its transformation? According to Checkland and Poulter (2010), ownership (O) is characterised by three criteria: awareness of the problem, power to change the system, and the ability to challenge or even abolish it. If one applies these criteria, male professors in STEM arguably fulfil the role of systemic owners (O), not because they are explicitly aware of their power, but because they operate from a position of structural dominance. At the same time, in their everyday professional roles, they often operate as actors (A) implementing institutional routines without questioning their wider implications.

This dual role of simultaneously being actor (A) and owner (O) creates a conflict: While some participants demonstrated a high degree of awareness during the workshop, they struggled to connect this awareness to specific changes in their own behaviour. The separation of structural insight and individual action hindered genuine transformation. Paradoxically, those who are best positioned to drive change are also those most embedded in the system's reproduction. Addressing men as key system participants, considered both as actors (A) and, from a power-critical perspective, as owners (O), highlights their central role and responsibility in shaping and maintaining institutional logics, emphasising the importance of changing their mindsets to enable systems transformation.

The Role of Women in the Process

The research was designed with the premise that women are not the ones who need to change, but the responsible system participants are. This assumption led to our formerly presented root definition describing the influence of gender stereotypes on women carrier paths in STEM. Based on this root definition it was consistent to categorise women as customers, because according to Checkland and Poulter (2010), customers should be the ones affected by the system. Still, we are aware that women being analysed as customers (C) in the process of modelling the system put them in an epistemically more passive position, even though we were acutely aware of the fact that there are women among the responsible actors (A). This classification as customer (C) reproduced the fundamental problem of making marginalised perspectives visible: it is difficult to enable visibility of those perspectives without simultaneously placing them again in a segregated position. At the same time, looking at the produced models, it becomes obvious that the categorisation as customers (C) combined with our specific approach of modelling did not separate the women's perspective - but on the contrary - centred them as an essential source of insight as suggested in CSH. Also, we decided to not model any other perspectives (e.g. male professors or students) to keep focused on the women's perspective during the modelling and conceptualising phase of the research. Hence in the workshops, we wanted the male participants to first identify with the perspective from the presented female examples to only later integrate their own male perspective in the scenario.

Considering the premise, our focus was on working with male participants and encouraging them to reflect on their assumptions and behaviour. In this sense, the workshop succeeded: participants reported changes in perspective and recognised problematic dynamics they had previously ignored. However, it remains an open question to what extent these changes in perspective will persist over time and translate into lasting behavioural change.

Furthermore, we are ambivalent about the role of women in the workshop. On the one hand, female professors and research associates brought essential alternative perspectives and served as a crucial counterpoint, enabling men to challenge their own assumptions. On the other hand, this positioned them once again as service providers of 'female insight', rarely beneficial to their own learning. This mirrors the traditional logic of women's advancement policies, which seek to 'support' women within unchanged systems rather than altering the systems themselves.

Workshop Procedure

The workshop was designed to stimulate discussions about problematic situations for the women, targeting a behavioural change among the men. To enable self-reflection, one of the greatest strengths of the workshop was its emotional safety. The principle of positive attribution helped participants to speak freely about their past behaviour, reflect without fear of blame, and focus on growth rather than guilt. Yet, this principle may not be sufficient to trigger sustained transformation. Systemic change requires more than temporary insight; it demands ongoing reflection, reinforcement, and institutional commitment.

The distinctive features of the workshop were its combination of participants with high levels of trust from a shared professional context, and an open format. Whether similar results or even more intense discussion could be achieved in more anonymous, less cohesive groups, remains an open question. We suggest that in a less familiar setting, more

time should be allowed for getting to know each other, e.g. warm-up questions or similar activities. What our case shows, however, is that even a single systemic component – here, the male worldview (W) – requires significant analytical and pedagogical effort to understand and shift. This underlines the importance of focused, reflective interventions as part of broader systemic change strategies.

This observation is also relevant when assessing the limited scope of the workshop. Therefore, a small follow-up survey was conducted approximately 10 months later, in which participants were asked to what extent they had thought about the content of the workshop in retrospect, whether the content and reflection within the framework of the workshop had led to changes in their dealings with students and/or employees and colleagues, and finally whether they would like to see a similar offer on a regular basis. While the answering participants clearly admitted that they had not intensely engaged with the topics over the long term and that there had been no occasions where they deliberately changed their behaviour, they were able to answer the last question with a resounding yes, indicating their acceptance of the workshop's approach and the perceived relevance of regular reflection and supervision. Taken together, the workshop format seemed promising, highlighting the potential and interest in the provided insights. However, further studies need to focus and evaluate possible behaviour changes of the participants and emerging changes of the system.

Limitations of Sampling

The results of the study are restricted concerning generalizability, since both samples (of the interviews and the workshops) were very small. Beside the size, the sample was limited by the requirement that the interviewees should have completed at least one stage of their education and career in Saxony. This regional focus was due to the especially severe underrepresentation of women in STEM in Saxony making it especially important and challenging to induce changes there. Hence, under such circumstances successful approaches could be promising for other regions as well. While this limitation may seem very restrictive, it should be emphasised that a specific examination of the individual life and career paths of the interviewees shows that many of them actually only spent one or a few stages of their lives in Saxony and completed several degrees and professional stages nationwide and internationally.

With only two workshops held at the same institution so far, it is possible, that we over- or underestimate the effects of the workshops. While we definitely provided a prove of concept of the new workshop format, we have to examine in the future, whether it can be transferred to other institutions as well.

Methodological Reflections

Our use of SSM sought to extend its logic through a critical, power-critical lens. We therefore modified SSM to a significant extent, strengthening the perspective of marginalised women. In its classic application, SSM often remains neutral to power hierarchies, attributing ownership (O) based on formal position rather than systemic privilege. However, if we understand patriarchy not as a cultural backdrop but as an active structuring logic within the system, it becomes clear that men in STEM, by virtue of their dominance, function as true owners (O). Failing to recognise this, renders transformative aspirations ineffective.

Moreover, the distinction between actors (A) and owners (O) blurred in our case. Many participants oscillated between both roles, diagnosing problems of the system dynamics, but failing to link them to their own agency. This points to a lack of reflexivity about one's own positioning – a barrier to transformation that cannot be resolved through procedural interventions alone. What is needed is a more integrated approach that explicitly addresses epistemic privilege and the interplay between individual roles and system dynamics. Meanwhile, the emphasis of SSM on dialogue and mutual learning should be maintained to satisfy a systemic understanding of social interaction.

Hence, the way we applied SSM is rather a mixture of SSM and CSH following methodological pluralism (Jackson 2019). It combines, on the one hand, the specific problem and system structuring as well as the focus on dialogue of SSM, and, on the other hand, the sensitivity towards power dynamics and epistemic injustices of CSH.

However, our approach had its drawbacks. First, the narrative approach of the interviews and the systematic analysis of the interview data with respect to *purposeful activities* turned out quite time-consuming in comparison to common SSM analyses. It has to be evaluated further if the resulting refinement concerning the critical, power-critical perspective justifies this expense.

Second, we did not implement specific changes to improve the situation, nor did we evaluate their impact. It remains open whether the elicited self-reflection and insights of the male actors (A) will yield significant behavioural changes. Furthermore, it is open, if the workshop procedure will be similarly effective under different circumstances and with different, for example obligated participants. This calls for further research.

Third, we recognised that the process leaned more toward understanding and working with male perspectives than conducting a full system analysis. While our initial use of SSM provided valuable entry points, the method's limitations became apparent when dealing with deep-seated power asymmetries, highlighting the need for further methodological innovation to merge critical and systemic thinking. Addressing men and their perspectives as responsible system participants does not mean merely shifting individual blame or correcting isolated misbehaviour. Rather, it focuses on the attitudes and practices that uphold systemic inequalities – making men pivotal leverage points for transformative change at the structural level.

Our *power-critical application of Soft Systems Methodology* can serve as inspiration for further research, bridging SSM and *Critical Systems Heuristics* to address problems involving structural power-imbalances.

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Data Availability The data that support the findings of this study are available from the researchers, but restrictions apply to the availability of these data, which were used under licence for the current study and so are not publicly available. The data are, however, available from the authors upon reasonable request.

Declarations

Compliance with Ethical Standards The study adhered to the principles outlined in the Declaration of Helsinki as well as the ethical guidelines of the German Psychological Society. According to German law, ethical approval was not required, as the interviews included no intervention and the workshops were part of the gender and diversity program of the university. All individuals taking part in the interviews and the workshops were fully informed about the study's purpose and procedures and provided their informed consent in written or digitally, prior to the recording.

Clinical Trial Number not applicable.

Competing Interests The authors declare no competing interests.

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