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Future imaginings of being and becoming an engineer: Microassaults, microinsults and microinvalidations when girls dare to engineer in preschool

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Abstract

Not a lot is known about how early childhood teachers engage children in the future imaginings of STEM. Mostly what is known has come from the Government reports where concerns for the future of girls in STEM shows a statically dismal representation and literature where deficit positioning of teachers to engage in STEM is shown. More needs to be known about how engineering as a profession and a practice invites girls in and positions them to imagine a future career in STEM. The study examined how 5 teachers create new conditions in engineering education over 5.4 weeks (27.3hr digital observations) for 31 children (aged 3.4 – 5.5 years; mean age of 4.4 years). The practice of being engineers created new future imaginings (Bottcher & Dammeyer, 2016) where the potential for girls' agency could be realised, but due to a myriad of microagressions (Grossman & Porche, 2014), different kinds of imagining about engineering practices and professions emerged. It is argued that just at a time when societies are worried about the under representation of woman and girls in STEM there is a real need for working against early microagressions, and moving towards building disruption for a new imagining of girls in engineering.

Keywords: preschool, engineering education, cultural-historical, gender, STEM

1. Introduction

We know from previous empirical research by Bottcher and Dammeyer (2016) that "Through present interpretations of the child's abilities and future imaginings of the child's potential, parents organise developmental support in which ideas about potentials are tested, revised and actively turned into developmental trajectories" (p. 186). Yet how teachers in early childhood settings engage in the future imaginings of the child's potential in engineering is not so well understood.

Mostly what is known has come from Government reports where societies imagine a future where girls and women are productively engaged in STEM (Science, Technology, Engineering and Mathematics) (Australian Academy of Science, 2019; Kaspura, 2017), and from the STEM education literature (Aguirre-Munoz & Pantoya, 2016; Gibney, 2016; Reuben, Sapienza, & Zingales, 2014), where studies and reviews have shown an image of the deficient early childhood teacher in their confidence and competence in engineering (English, 2018). The literature also shows current problems in the engineering pipeline (Blickenstaff, 2005) and the future need and urgency for supporting girls to imagine themselves in careers in STEM (Australian Academy of Science, 2019).

In adopting a cultural-historical framework (Vygotsky, 1997; 2004), the study reported in this paper examines how teachers create new conditions for children's development through introducing a new activity setting of an engineering area within the traditional Froebelian structure of a kindergarten. In following the perspective of one child, the study shows how the collective practice of being engineers and engaging in the new practice tradition of engineering a bridge for *The 3 Billy Goats Gruff*, did not realise a new future imagining (Bottcher & Dammeyer, 2016) for career possibilities for girls in engineering. Rather, the focus child experienced a different kind of moral imagining (Vadeboncoeur, 2019), that of engineering invisibility and engineering alienation. This paper shows how male gender becomes aligned with engineering and how girls become alienated from this new practice tradition in the preschool through a barrage of micoagressions (Grossman & Porche, 2014) where girls are rendered invisible.

This paper begins with a brief historical overview of the models of practice to support girls in STEM, followed by the theoretical framework driving the research, the study design, findings and a discussion of what was learned from a study that followed one girl as she experienced engineering education for the first time in her preschool.

2. Broader educational models on changing STEM engagement

In the broader literature on girls' participation in STEM it has been noted that over time, waves of challenges and solutions have been researched and theorised (Alloway, 1995). We have seen an additive model (Harding, 1987), a feminist epistemology (women have different experiences and these can contribute to knowledge generation that is currently absent) (Bleier, 1986; Harding, 1986; Harding & Sutoris, 1987; Rose, 1986), a distinction model (Harding, 1987), an alternative pathway model (Smail, 1987), a re-structuring model (Harding, 1987) and a re-positioning model (Kelly, 1987a). More recently, the literature has focused more on the need for role models in STEM, whilst also making visible the everyday practices of women and girls in STEM where a myriad of microaggressions are experienced (Grossman & Porche, 2014). Problems persist (Morgan, Farkas, Hillemeier, & Maczuga, 2016), and therefore it is important to briefly review what is known about these models.

In the early 1980s we learned a great deal about gender and STEM (at that time it was referenced mostly as science and/or technology). What was learned is worthy of re-visiting because the historical context can inform the contemporary research need of engineering education, where only 12% of the profession are women (see Kaspura, 2017). In the additive model, it is claimed that we include or add into STEM programs content that is more likely to engage girls and women (Smail, 1987), as the contemporary research of Mulvey, Miller, & Rizzardi (2017) show when researching (and problematizing) the foundational thinking associated with changing the colour of the resources to appeal more to girls to engage in engineering. The distinction model is about re-designing STEM programs to be girl-only programs (Bentley and Watts, 1987), so that girls do not need to compete for resources (Kelly, 1987a), and can access equipment and materials needed for genuine participation in STEM. Related to this has been a compensatory model (Stage, Kreinberg, Eccles, & Becker, 1987), where girls are specifically taught to use equipment and to learn fundamental STEM concepts to catch up to the boys' skill set in STEM. Some researchers have argued that boys are thought to have had in their free play activities more experiences of using objects and construction kits in their play (Beat, 1991). This aligns with the idea of a feminist epistemology, where women's different experiences and interests are drawn upon to re-design the nature of knowledge in STEM so that it goes beyond a masculinised construction (Kelly, 1987b).

Others have captured the waves of theorising the problems and solutions in STEM and gender as framed within a biological difference argument set within a sociological frame. These can be summarised as girls' lack of academic preparation for STEM fields, girls poor attitudes and a lack of positive STEM experience in childhood; the absence of female role models in STEM, science curricula irrelevant to many girls, pedagogical practices in science favours males, the 'chilly climate' that exists for girls/women in science classes, the cultural pressure for girls and women to conform to traditional gender roles, and the inherent masculine worldview of scientific epistemology already mentioned (see Blickenstaff, 2005; Vrcejh & Krishnan, 2008).

However, biological arguments have and continue to be questioned. In the longstanding research of Smail (1987), she has shown that through early gendered interactions, girls' develop interests later in schooling that become increasingly centered on nurturing whilst boys interest appear to be more instrumental and analytical. In presenting the outcomes as a binary of boys' interests in rules, machines, fairness and justice, hierarchy and competition, analytical thought and inanimate things, and girls' interests as geared to relationships, people, pragmatism, networks and cooperation, aesthetics and the nurturing of living things, she advocates for curriculum adjustment to be more girl-friendly in order to make science more appealing to girls.

Research into girl-friendly engineering has revealed that this kind of additive model (Harding, 1987) for increasing the participation of girls is problematic (see Mulvey, Miller, & Rizzardi, 2017). Research into girl-friendly engineering, also suggests that this focus maintains existing societal structures, practices and ways of learning STEM. Girls-only STEM as also a compensatory program, is simply designed as a catch up for girls to boys' skill set and does not change the underlying reason for the differences in STEM capability. In both theoretical models (additive and compensatory), the problem and the solution appear to be the responsibility of girls.

Debates surrounding if it is "girls' STEM" or "girls in STEM" have not been resolved. It continues to be argued that "it is important to realise that the problem of girls in science cannot be divorced from the wider issues of sex stereotyping and women's position in society" (Kelly, 1987b; p. 16). According to Alloway (1995), the broader societal issues can be categorised under the umbrella of a gender as a social construction model, gender as an equal opportunity model, a gender-inclusive model, and gender as a binary between men and women. Meanwhile the statistics reported by Governments surrounding girls' and women's participation in engineering have not significantly changed. Parker, Pelletier and Croft (2015) in drawing upon the broader sociological and psychological literature, suggest that experiences of women in STEM continue to be problematic with the need to identify and make changes in interactional patterns in the workplace.

Contemporary thinking in relation to gender and STEM appears to draw upon what Grossman and Porche (2014) have named as micoagressions. It is through brief, but regular negative and subtle messaging during everyday interactions, that girls begin to doubt or question their place within engineering. Grossman and Porche (2014) in capturing gendered interactions between humans under this umbrella term, make visible small but significant acts of aggression towards girls and women in STEM. A more nuanced conception shows both microassults and microinsults. The former aims to explicitly attack a person's group identity, such as being a girl, or harm them through name calling, such as girls don't do engineering because it is not lady like. The former also involves discriminatory action, such as creating policies or allocating resources differently for girls and boys in engineering, or through some form of avoidance, such as deliberately not engaging girls in engineering. These are conscious acts of microagressions by the perpetrators to another person. In contrast, microinsults are often unconsciously delivered by the perpetrator. These are known broadly in the literature as *unconscious bias*, and can be expressed through conveying a stereotypical image of a group identity, such as expressing surprise when meeting a woman who is an engineer, or always referring to engineers with the male pronoun, or though referencing women in engineering as 'women engineers' as though it is a separate category or societal anomaly. Unconscious bias expressed through day to day interactions, can feel like rudeness or an attack on a person's identity, even though the perpetrator is unaware of their insensitivity when they deliver a microinsult.

Moroz (2015) in writing about these concerns for the field of engineering suggest that both microassults and micoroinsults accumulate, and over time girls and women in engineering experience a form of microinvalidation. That is, girls and women feel excluded, negated, and denied access to engineering. Even though their experience in engineering is less valued or their right to be involved in engineering is questioned, the negative interactions may be perceived as an irrational overreaction by the perpetrators or the victims themselves. Therefore, it is becoming increasingly important to determine when and how these reported micoragressions first begin in education. Understanding this, can help with a better conceptualisation of how girls begin to imagine themselves in, or excluded from, a future engineering profession. We now turn to a theoretical discussion of *future imagining* in order to foreground the conceptual framing underpinning the present empirical study of girls in engineering.

3. Future imaginings

An important, but often under theorised area, is the idea of *children's future developmental possibilities* (Bottcher & Dammeyer, 2016). In conceptualising *developmental time* for families with children who have disabilities, Bottcher and Dammeyer (2016) have opened up a new kind of thinking about how to research what has as yet not happened. Vygotsky's suite of concepts gives theoretical insights into cultural and historical dimensions of human development where the ideal and real forms of development are always in a dynamic relation, but how to project this forward as moral imagining (Vadeboncoeur, 2019) or future imaginings (Bottcher & Dammeyer, 2016) is new.

Bottcher and Dammeyer (2016) draw attention to the "present interpretations of the child's abilities and future imaginings of the child's potential" (p. 186). In these *future imaginings* of a child, they have noted in their research that "parents organise developmental support in which ideas about potentials are tested, revised and actively turned into developmental trajectories" (p. 186). This is more than an 'ideal form of development' which Vygotsky (1994) has conceptualised as already present in the child's environment. But rather it is about developmental trajectories and associated pathways, not yet available to the child, or in their environment, or not yet imagined as needed. They are pathways that families must create, and which require a form of future imagining that is specific for the developmental trajectory of their child. The future imagining of a child with disabilities brings together and negotiates local congruences to support the child, and this happens between families and professionals as they imagine and realise the new developmental trajectories over time. Importantly, Bottcher and Dammeyer (2016) argue that in a conception of developmental time "developmental support is not only about the present, but also about imagining and organising future developmental possibilities" (p. 187-188).

A conception of future imagining has resonance with a STEM field concerned with wanting a different kind of future for girls and women than currently exists. The concept captures the idea of different developmental trajectories for children, and in the context of STEM, this could mean a different kind of future imaging for girls. That is, imagining different developmental pathways for girls in STEM that become new everyday lived experiences that position them as having a future in STEM. However, a methodology and method to capture future imagining for girls in STEM has not yet been theorised for preschool engineering education. How can future developmental trajectories for STEM be researched when preschool children do not yet have a conception of engineering or have thought of their possible future lives and profession?

The concept of moral imagining as introduced by Vadeboncoeur (2019) provides some guidance. It is explained as a moral compass of how children are engaged in playful situations with each other, in how they self-direct in relation to others, and how play narratives are jointly developed within the different contexts they inhabit. Moral imagining is "a relational sensibility of imagining, creating and acting together that is oriented towards a shared future" (Vadeboncoeur, 2019, p. 227). The core idea of imagining a shared future may also have many disruptions or trajectories that when considered in the context of STEM and the leaky pipelines or pathways already discussed, open up possible methods for following how different developmental opportunities are created for girls and boys in STEM. It is in how children self-direct *in relation to each other within STEM activity settings*, that future imaginings in STEM could emerge. Rather than a binary of different pathways, or a compensatory or additive model to catch girls up, moral imagining is relationally understood and therefore could be relationally disrupted.

A new activity setting of engineering in the Froebelian structure of a kindergarten could give a new space for studying moral imagining in relation to STEM. How children enter into the new activity setting, contribute to or meet the new demands of the activity setting, has been shown by Hedegaard (2012) to give insights into developmental possibilities. As a holistic conception of the study context, examining how boys and girls enter into and contribute to the demands of engineering activity setting through the lens of *moral imagining* the shared play and self-direction in play (Vadeboncoeur, 2019) could reveal and help explain the predicted microagressions and *future imaginings* (Bottcher & Dammeyer, 2016) of STEM for girls and boys that are in the process of developing (Vygotsky, 1997). When children are not sensitive to the other, and where the moral compass allows for conscious assaults as part of the lived microaggressions of girls reported in the literature for older students, the concept of moral imagining could give important directions for better understanding why so few girls become engineers.

4. Study design

The study sought to better understand how the new practice tradition of engineering creates new possibilities for girls imagining themselves in engineering. Through following how one child Rita enters into the activity setting of engineering over a period of 5.4 weeks it becomes possible to see how the activity setting creates new demands on children and how the children in turn meet these demands, as well as contribute to the activity setting. In this paper only the first day of introducing the new activity setting is reported.

4.1 Participants

Rita (aged 4.1 years) is the focus of this paper. She is part of a group of 31 children (aged 3.4 – 5.5 years; mean age of 4.4 years) and 5 teachers (3 Indian Australian, 1 Sri Lankan Australia, and 1 European Australian heritage background).

Australia is a culturally diverse community. In this study the children were from a range of cultural heritage backgrounds, including Anglo/Australian 15; Euro/Australian 2; Chinese/Australian 2; Japanese/Australian 1; Zimbabwe/Australian 1; Indian 2; Indonesian 1; Italian/Chinese 1; Mongolian 1; Vietnamese 1; Mauritian 1; Papua New Guinea 2; Saudi Arabia 1.

4.2 Activity setting

A new activity setting was planned and a space for the engineering activity was created. The focus was on implementing an engineering program on civil engineering. The content of the engineering was bridge building. The social purpose for engineering was building a bridge for the set design of the popular fairytale of the 3 Billy Goats Gruff. The idea was to make a digital movie of this fairytale using a hand-held digital device and MyCreate app. The digital practices are not included in the analysis or discussed in this paper.

The engineering activity setting was located close by the block area and the home corner, but also this space was surrounded by tables where props, the digital device, and construction and drawing were possible.

4.3 Data gathering

The overall data that were generated centred on digital observations (27.3hr), photographs of practices (336), and interviews of the teachers (2.5 hours). Data collection took place over 8 visits (5.4 weeks) with each period lasting 2-5 hours. To achieve a holistic study of both the practices and the activity setting, two cameras were used to capture what was taking place in the engineering space. One hand-held camera followed Rita as she entered into the activity setting, as well as capturing the children/teachers around her. This enabled close-up observations of the children’s and teachers’ interactions. The second camera was mounted on a tripod and placed near each of the relevant activity settings associated with the bridge building and role play, plus group time and other engineering related activity settings planned or emerging over the observation period. Together, the practice of moving cameras and following children gave a holistic sense of the activity settings (Hedegaard, 2012), as well as its location within the overall practice tradition of the kindergarten. As engineering was a new practice tradition it was important to go beyond the specific engineering space and to also capture the practice traditions of for example, group time, and the transition between activity settings (Hedegaard, 2014).

4.4 Analysis

For the purposes of the gender analysis, it was important to draw upon a holistic analytical framework (Hedegaard, 2014) where the societal values and expectations, the institutional practices and person's motive orientation within the activity setting could be dynamically examined. This complex cultural-historical dynamic framed how the analysis was undertaken because examining future imaginings of girls in engineering requires strong theoretical constructs for understanding the practices and the activity settings of the preschool.

Through following how one child meets the demands of the activity setting, such as making a bridge to re-tell the story of the 3 billy goats, and contributes to this new activity setting, gives insights into how the new conditions could create developmental moments for the focus child. Hedegaard (2012) has captured this dynamic as following the motivated actions of the child, which in turn acts as a construct for determining possible interpretations of future imaginings.

In order to achieve this holistic interpretation, the digital data needed to be logged, coded and retained as raw digital data. But from this process, the raw data were copied and analysed through a succession of iterative interpretations. The iterative process can be explained using the skipping metaphor first introduced by Vygotsky (1997) to show how a cultural-historical methodology is holistic and a non-classical approach (Kravtsova, 2010).

In line with a skipping metaphor and a non-classical approach, is Hedegaard's conception of a common sense interpretation, situated practice interpretation, and a thematic/theoretical analysis (Hedegaard & Fleer, 2008). In the former, video files are tagged as moments of gendered interactions and these are related to what is already known from the literature. In a situated practice interpretation video data are viewed many times, with the task of slicing single situated practices into a series of interrelated clips, but these are always tagged in relation to the raw data (i.e., holistic interpretation). Importantly, data folders of gendered interactions are created where a sense of density emerges. However, patterns go beyond the categories. Finally, in the latter part of the analysis, the digital data are revisited in relation to the whole data set, but with the view to coding and nuancing of the interpretations. In this final phase of the iterative process, a conceptual synthesis and theorisation of the data categorisation takes place. The Hedegaardian concepts of demands and motives were used in relation to the societal values, institutional practices and the engineering activity settings where microagressions and future imaginings were used as concepts to understand the patterns of gendered interactions that emerged as well as what was categorised in relation to what is known from the literature. Together, the interrelated and iterative processes of revisiting individual files across the data set, which are organised as folders of categories (emerging and pre-established), support the answering of the research question of this study.

5. Results and discussion

Engineering education is not only a new activity setting for preschool children in Australia, but it is also new for teachers. In this study, the teachers expertly planned engineering around a social purpose of designing a drama set for the role-playing the fairytale of the 3 Billy Goats Gruff. The engineering activity setting complemented the other areas of the centre. The engineering activity setting was a dedicated space nestled between the mat area, the block area, table top activities area, and the home corner.

In order to understand how the new activity setting of engineering creates new imaginings about being an engineer, we examine how the children enter into this new practice tradition within the engineering activity setting in the preschool, through following the demands and motives of one child, Rita.

5.1 *Who can be in the engineering space contributes to the future imagining of engineering as a profession*

How Rita enters into the new activity setting of engineering a bridge for the 3 Billy Goats Gruff is introduced in Vignette 1. Rita is one of the longstanding engineers who stays in the activity setting for most of the free play time in the first observation period that is the focus of this paper. The engineering activity setting is popular with the children. Large groups of children go into the area, including Rita and two girls, and there are more children than can comfortably work on bridge building.

> **Vignette 1:** Who dominates the engineering space?
> Six children are in the engineering area and the teacher looks to the boys and asks, "Can anyone remember what did the trolls have to cross?". One child calls, "The bridge". The teacher moves out of the engineering area and gathers together a range of props and places them near the bridge building area. Rita who has remained in the engineering area, looks intently into the box. Two girls and one boy join her. The teacher looks to the four boys on her left and says, "Let's start everyone". Signalling with her hands, she says, "This is the bridge". The teacher's back is to the girls.
>
> Rita and the other two girls stand at the back near the teacher, but only the teacher can see the bridge building from above.
>
> Rita continues to observe, and does not move into the building area.

Rita has no opportunity to be close to the engineering space because first, the teacher has positioned her body to direct her gaze at the boys, affirming their right to the space and to be engineers. This is an unconscious microagression. The teacher does not engage Rita and the other two girls. Having her back to them could suggest unconscious bias against girls in engineering or it could signal a lack of expectation of girls to engineer. Whilst it is not possible to determine at this moment how this action is interpreted by the girls, later observations show that only one of the original 3 girls remained in the engineering space – suggesting their initial enthusiasm and expectation for building a bridge in the engineering activity setting was not realised.

Longstanding research into access to STEM resources has been shown to be difficult for girls (Kelly, 1987a). The second problem for Rita relates to how the original engineering space attracted more and more children (all boys) who gathered behind the original 3 boys. Over time a wall of boys emerged, circling the engineering action zone where the bridge building was taking place. This meant that there was no opening for Rita to move into the action zone comfortably and engineer. But also, this could be interpreted as a formidable space to enter because the children in the front were pushed by the children at the back, and many of the boys at the back eventually moved away, because any attempt to break into the inner space by the boys at the back was difficult as Vignette 2 shows.

Vignette 2: Who is given space to engineer? Making space for Nathan but not for Rita

Oliva, Grey and Bryce are directly in front of the bridge construction. They have been working on the bridge building for some time now. Most of the other children have left, except Rita, who has been standing close by waiting for an opportunity to add more tape to the construction, but because 3 boys are taking the prime bridge building space it is difficult to move in. She tries several times, but each attempt to position herself into the space is aborted because Oliva physically pushes her back or does not give her space to enter. Oliva also previously pushed the other boys. On this occasion, the teacher notices, as Nathan tries to move in, and is forced back by Oliva. The teacher who has been at the back of the space cutting masking tape says, "Oliva use your words. Oliva, Nathan is trying to get in here". The teacher taps Oliva as she speaks to him, and leans forward and lowers herself to make direct eye contact with him, and then says, "Nathan has decided to put the grass along here. On this bit (pointing)". This opens up a space and Nathan moves into place with his grass and contributes to the creation of the set. Meanwhile Rita is observing from a distance, and more boys join, seeming to notice the teacher's intervention. Five boys push forward behind Oliva, leaving no space for Rita.

In this example, Oliva dominates the engineering space and the teacher notices this and tries to work out solutions for giving other children opportunities to construct. The example shows expert teacher positioning of Nathan into the engineering space that is respectful of both Oliva and Nathan. However, Rita appears to be invisible. Rita is not supported or positioned to enter into the engineering space even though she has been patiently waiting. This is another unconscious microaggression towards Rita. How the teacher opens up a space for Nathan and does not notice ongoing problems with access for Rita, has been consistently reported in the literature for girls who seek to be involved in STEM activity settings (Hallström, Elvstrand, & Hellberg, 2015).

With this backdrop of access to space and resources for the very first time that Rita is involved in engineering education in her preschool, we now turn to how the teachers introduce the concept of engineering to the children.

5.2 Who is positioned to be the engineer contributes to the future imagining of engineering as a profession

We know from the research of Capobianco, Diefes-Dux, Mena and Weller (2011) that when children are asked about what is an engineer, the responses of 6 and 9 year olds suggest they do not know. Therefore, it is important for educators to introduce the concept of what is an engineer to children when they first encountered engineering education. In line with this, the teachers in this study thoughtfully embedded explanations of engineering within the new activity setting but also as they introduced the new practice tradition of engineering – as was also shown in Vignette 2 in the previous section.

As a new area of learning for preschool teachers in Australia, the teachers re-introduced the concept of engineering at different time points, creating a narrative about civil engineering over time when it was directly relevant to the bridge building they were engaged in. How this was done is shown in Vignettes 3 to 5.

Vignette 3: Head engineers have more authority
There are 2 girls and 4 boys in the engineering activity setting. Although the boys are in front of the bridge, the girls are actively involved from time to time placing tape on to the structure – but mostly to the left side of the bridge where there is less engineering activity by the boys. The teacher appears to have deemed that there is a problem with the bridge, and calls the head engineer to undertake an inspection. She says, "Oliva are you my head engineer? Oliva do you know what an engineer is?". He does not respond. "He designs the bridge. Right. Oliva, my head engineer can you come along". The teacher holds out her arm to signal to Oliva which direction to walk. She invites Oliva to stand back from the bridge and asks all the children to get out of the way, stating: "Can we all stand back a bit, so our head engineer can have a look". She then reinforces compliance by foregrounding Andrea's immediate action by saying, "Thanks Andrea, that's beautiful".

At this moment, all the girls leave the area near the bridge and go to the back or go on to another activity, and the boys all move forward again to the bridge. The teacher continues to try and move the boys back. She gives up and moves forward and discusses that there is a problem, signalling to the other end of the bridge by pointing, suggesting something is missing.

Later in the bridge building the teacher re-introduced the idea of what is an engineer to more of the children, but in this example, only the boys are present. As before, she draws attention to engineering by positioning the children as they are working on the bridge engaged in engineering practices.

Vignette 4: Engineer Number 1, 2, 3, 4
There are six boys who are working in the engineering space. The girls have left. The teacher drops her body to the same level as the children and she says as she taps each child, "Engineer Number 1, Engineer Number 2, Number 3, Number 4 and 5" and then she points to a child further away, and says, "Number 6". This child says, "I am number 6". He changes his mind and says, "I want to be Number 5". The teacher nods and says, "Ok you can be Number 5". The child smiles and stretches tall, as though very proud of this new social position in the group.

The labelling of children as engineers appears to be important. The children notice the labelling of being an engineer, being a head engineer or Number 1 engineer, as this appears to be accorded a great deal of status, as Vignette 5 shows:

Vignette 5: Why are you the Number 1 engineer?
Later in the engineering construction work Rita, Bryce and Oliva are working on the bridge. Bryce points to the bridge span and says twice to Oliva, "Look Number one". Oliva does not respond. Rita looks but does not respond, as the comments are not directed to her. Then Bryce says pointing to the two strips over the span of the bridge "2 over one", "2 over 1, Number 1". Oliva looks but does not comment.

Bryce asks Oliva, "Why are you number 1 Oliva?". Oliva says, because "The teacher says I am".

What these examples show is that boys become positioned as engineers and are named as Number 1 or 2 engineer or Head engineer. Vignette 3 showed that Rita was not given this status, yet Oliva who dominated the use of the space and resources was given the status of the head engineer and Number 1 engineer. Vignette 5 shows how children do notice and wonder why. Once again, this is a direct microagression at Rita. She is an invisible engineer.

It is difficult for teachers because the girls primarily left the engineering space and only returned for brief periods. It was only Rita who persisted and stayed. The teachers tried to solve the problem by calling for the girls to be in the engineering activity setting. In Vignette 6 it shows how Rita is accorded the status of an engineer, but it is referenced as a 'girl engineer'. This labelling of gender did not occur for the boys.

> **Vignette 6:** Girl engineers or girls in engineering?
> Rita is still in the engineering activity setting. Teacher 1 asks, "So how many *girl engineers* have we got?". Teacher 2 answers, "One only". Consequently, Teacher 2 calls out across the neighbouring area, "Come on girls". With no response from the girls, she then moves across the centre calling out, "Where are the *girl engineers*?".

Is it possible that in calling the girls - *girl engineers*- that this suggest to them that the default mode is that Number 1 engineer or Head engineer should be a boy? Is it possible that *boys in engineering* is the default mode, and the anomaly is the girls - hence being named as a '*girl engineer*'.

5.3 Do the different activity settings give different kinds of authority to children?

On the same day as the engineering activity setting was first introduced to the children, Rita was observed going in the home corner. In this different activity setting, we see a very different kind of interaction, but one that is nevertheless linked with gender, as Vignette 7 shows.

> **Vignette 7:** Rita has some authority in the home corner
> Rita is standing in the engineering space, and steps forward towards the home corner. As she does, she notices 2 boys in the home corner and runs across calling assertively, "Hey, this is our house". Harry leaves but Jackson resists and continues to play with the cups and saucers on the floor. He looks up and says, "This is our house". Rita puts her hands on her hips and assertively says, "This is our house first!". Jackson responds by saying, "But you got Shadow House". Rita emphatically says, "No" as she rocks a trolley back and forth. Jackson looks up again and says forcefully, "Yes" implying she already has a house. Rita offers a suggestion to Jackson in order to negotiate a shared play narrative within the home corner, "Let's make an ice-cream".

There are two interesting things to notice about Rita's interaction in the home corner. First, Rita commands a real sense of presence in this activity setting. She appears to be speaking from a position of authority. Her hand gesturing signal that she is in control of the space. Second, she appears to negotiate with Jackson when he resists her authority, and offers a new play narrative. Both situations demonstrate that this activity setting is a space that she can inhabit with some authority. Her assertive gesturing, lies in stark contrast to how she appears to engage in the engineering activity setting, where she seems much more pensive. Vignette 7 further illustrates this, because she does not show the same level of conviction or resistance when her access to resources is violated in the new engineering activity setting.

Vignette 7: Rita's right to resources is violated
Rita is working on the bridge, but has left a distance between herself and the left end of the bridge. The boys mostly worked on the right end. Rita has tape and is securing blocks together, in anticipation of joining them on to the left end of the bridge, so that both ends have a support and the span is then horizontal. The boys primarily stick rocks to the bridge using tape.

Rita finishes the sticking and takes the plastic goat and begins a narrative, "And he bumped on his head". She calls with great excitement to the teacher who is observing, "Hey teacher M, he bumped on his face". She places her hands to her mouth and laughs. The teacher says, "What was he saying?". Rita responds, "He bumped on his head". She continues to interact with the teacher in relation to the narrative she is developing with the prop. Oliva and Bryce who have been sticking tape to the bridge look to Rita and to the teacher. They seem interested in her narrative.

Bryce resumes sticking rocks and layering the tape and calls out to the teacher, "We need one more on here". At this moment, Oliva moves close to Rita, whilst still holding a block and tape in his hand, he pushes closely against Rita, and takes the plastic goat out of her hand.

Bryce continues to talk to the teacher about needing more tape, whilst Oliva goes back to sticking tape. He keeps a hold of the goat.

Rita puts her hands together in front of her. She rubs her hands together nervously. She reacts as though violated. She steps backwards as though wishing to avoid further assaults. The teacher continues to talk to Bryce and does not seem notice that Rita no longer has the prop for narrating her story.

Oliva, Rita and Bryce are engaged in a playful situation of bridge building, where they are together and have the possibility to play with each other, but how Oliva self-directs in relation to Rita's introduced play narrative is problematic. Vignette 7 shows an explicit microassault by Oliva towards Rita.

Drawing on the concept of moral imagining it is possible to see that Oliva's moral compass creates a different kind of space for play for Rita, but also earlier we saw this when he engaged with Nathan. The "relational sensibility of imagining, creating and acting together that is oriented towards a shared future" (Vadeboncoeur, 2019, p. 227) in Vignette 7 does not auger well for Rita as a preschool engineer.

In the home corner Rita resists and shows authority, and this suggests that this space is a place she can inhabit. Her actions within the home corner are different to the new engineering activity setting where space, resources and any sense of engineering being for her, seem to be seriously compromised. In the home corner her moral compass is to negotiate and to realise a shared narrative with Jackson, as an orientation that is moving towards a shared future (Vadeboncoeur, 2019). This is the antithesis of Oliva's interactions with her.

But in the engineering space, Rita continually experienced microassaults and microinsults. It is probable that Rita felt excluded, negated, and denied access to the new engineering experience. It is possible that through brief, but regular negative and subtle messaging during everyday engineering interactions, that Rita could begin to doubt or question her place within engineering. The unconscious bias expressed by the teachers, and assaults consciously directed to Rita, as part of her new engineering experience, could feel like an attack on her identity as an engineer in this context. When these doubts accumulate over time, the engineering experience for Rita could become a form of microinvalidation.

6. Conclusion

We know from the research of Grossman and Porche (2014) who survey 1024 secondary students and interviewed from this group 53 in order to gain more nuanced understanding of their experiences of STEM, that microagressions against women and underrepresented minorities exists. Beginning in early childhood, this paper focused on preschool engineering practices with a view to better understanding how girls' future imagining of being an engineer could be supported. As a new area of learning in Australia for preschools children, there is the possibility to develop a new kind of imagining for girls, and to change the current concerns for a lack of representation of women in engineering. But the expected outcome was not realised because this study showed that even in preschool, children experience microagressions (Grossman & Porche, 2014).

What was learned from this study centered on three major outcomes. First, in free play time it was found that the girls did not stay in the engineering area, only one girl persisted. The study showed that it was boys who primarily used the engineering area. This contributes negatively to girls' future imagining of engineering as a profession. If only boys are noticed in the engineering area, as an unconscious bias on the part of the teachers, then this can incrementally signal to girls that this new area in the preschool is a *boy's only space*. The consistent microagressions against the girls also supports this claim.

Second, the children noticed who was positioned by the teachers to be an engineer, and as the vignettes showed, they asked why? When teachers position only the boys as a head engineer or name them as engineers and do not notice the girls who are with them in the area, this contributes to the future imagining of *engineering as a profession that is for males only*. When teachers do notice that there are no girls in the engineering area, then inviting them into the area is important. But when they are named as 'girl engineers' and called into the space in this way, this contributes to the unconscious bias towards girls in engineering, because it becomes a microagression when only girls are named as 'girl engineers' and boys are named 'as engineers'.

Finally, the outcomes of the study suggest, that like the microagressions noted in the literature for secondary students, preschool children's existing interactional patterns are brought into the centre and dominant ways of interacting emerge during free play time – with a myriad of microassaults and microinsults experienced. Children's sense of authority in particular areas of the preschool were found in this study, and it was noted through the example of Rita, that she assumed authority in the home corner where she took control of the play narrative and had a voice in relation to who should be in this area. This level of authority by Rita was not found in the new activity setting of the engineering area, suggesting some form of prior gendering. Further research is needed in determining how the different activity settings give different kinds of authority to children, as well as how new activity settings for STEM should be created and introduced to children, so that girls can find a place in engineering, and can imagine a possible future in being and becoming an engineer.

In conclusion, it can be argued that this study has shown through one girl's experience how girls become alienated from engineering resources/spaces and experience a form of engineering invisibility. More needs to be known about how engineering as a profession and a practice could better invite preschool girls, and position them to incrementally imagine themselves as having a future career in STEM. Just at a time when societies are worried about the under representation of woman and girls in STEM (Régner et al., 2019), there is a real need for working against early microagressions, and moving towards building dissidents and disruption for a new imagining of girls in engineering.

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