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Disrupting school spaces to enhance mathematics teaching and learning

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Abstract

This paper is based on an argument that the disruption of school spaces can demerit the myth that Mathematics is difficult and a struggle for learners in some contexts. Combining spatial theories and the phenomenon of disruption, the paper reports from a qualitative research project that analyzed the dynamics of space and place in South African schools. From a sample of two secondary schools and three primary schools in Tshwane South, the paper reports on the data from one school where the theme of disruption of school spaces for the teaching of mathematics was drawn. Two Mathematics teachers and one Head of Department (HoD) were interviewed in the school and one classroom was observed. The findings indicate that the disruption of school spaces leads to collaboration across post levels in terms of teaching, management, and personal professional development. Such collaboration disrupts the representations of space and improves teachers' spatial practices and a potential for better learning. The paper concludes by recommending research that will explore the applicability of the conclusions it makes to the enhancement of Mathematics learners' results.

Keywords: Collaboration, Disruption, Mathematics, Pedagogical Spatial Practices

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The need to improve Mathematics teaching and learning for better learner performance has widely been a topic for research and debate in many parts of the world. Among the studies in this topic has been the focus on the use of technologies in Mathematics pedagogies (Stols, Ferreira, Pelser, Olivier, Van der Merwe, De Villiers, & Venter, 2015) and the need to position Sub-Saharan Africa in the competitive global market by enhancing Mathematics and other science subjects (Bethell, 2016; Tikly, Joubert, Barrett, Bainton, Cameron, & Doyle, 2018). Arends, Winnaar and Mosimege (2017) focused their research on the implications of classroom practices for effective learning in Mathematics. They argued for the provision of learning opportunities by the teachers and the recognition and utilization of those opportunities by the learners as means for enhancing learning in Mathematics.

In this paper we agree with all these arguments, but our contribution is on the discourse of school spaces and Mathematics pedagogical practices in schools. We narrow the meaning of school spaces to classrooms and staff rooms where planning and preparation for teaching and learning take place. We argue that while there is enormous research on Mathematics teaching and learning, there is still a gap on how the disruption of normative school spaces can foster disruptive pedagogies and students' engagement in turn. To contribute knowledge to reduce this gap, this paper draws from the findings of a multidisciplinary research project that analyzed the dynamics of space and place in South African schools. The project used spatial theories to conceptualize the implications of various spatial practices in schools, including teaching and learning, management, and activities on learner performance.

The rest of this paper is structured as follows. We first present a conceptual analysis of disruptive pedagogy and social spaces. Second, we review the literature on the relationship between space and pedagogy, with a particular focus on Mathematics teaching. Third, we present the methodological background and the processes we followed to extract data for the paper. This is followed, fourth, by the presentation of our findings, fifth the discussion of findings, and lastly the conclusions and acknowledgements.

School Space and Disruptive Pedagogy Conceptualized

Space may be taken for-granted or viewed as an objective, valueless and irrelevant topic in educational research (Benade, 2021; Gulson & Symes, 2007). Yet, space is an active aspect of teaching and learning because it is produced through (and produces) social relations and interactions in schools. Kellock and Sexton (2018:116) provide an example of how space is actively produced and producing practices and experiences in education:

> There is much importance attached to the learning space or environment in which children spend time during the school day in a functional way. There are two elements, namely materiality (such as walls, tables, teaching materials) as well as mattering (what is important) […] and how these elements are brought together […]. Each of these unique dimensions can have a profound impact on not only individuals but the whole pedagogical approach and this is often determined by the classroom teacher themselves.

This understanding about space relates to Lefebvre's (1991) theory of 'the social production of space' which positions space as socially produced and, therefore, not just a container in which practices take place. Benade (2021: S17) explains this theory - that according to Lefebvre space is produced through mental conceptions, social relations, and experiences. Lefebvre (1991) refers to this three-part production as the spatial triad, comprised of the presentations of space (designs, plans, policies about space), spatial practice (practices that are enacted in the space, which sometimes alter (or are altered by) or challenge (or are challenged by) the status quo), and representational spaces (the lived or experienced space of the inhabitants and users which overlaps the other two dimensions). This understanding of space is adopted in this paper to conceptualize the classroom and staff room spaces as consisting of several elements that the teacher can and cannot control for mathematics teaching and learning. Regarding the mathematics classroom, the representations of space may entail the ability of the mathematics teachers to use the available space to help learners to develop positive self-concepts, self-worth and confidence with mathematics knowledge and skills. Spatial practice may refer to how teachers and learners produce and reproduce mathematics knowledge from various positions in accordance with various pedagogies. Representational space encompasses the ability of teachers and learners to identify with mathematical images and symbols and to enact those images and symbols in their everyday lives. For any of these three aspects of space, there may be opposites to the ideal. For example, Kellock and Sexton (2018: 117) provide a good example of the disconnect between the representations of space and the lived space. They argue, 'There are many constraints attached to primary school classrooms, chiefly, who designed them and for what purpose. The designers (or producers) of space deliver what is in essence expected whilst 'the "users" passively experience whatever was imposed upon them'. These constraints may possibly be addressed through disruptive pedagogy.

The concept of disruption in education is commonly used to define changes in pedagogical practices, appearing as disruptive pedagogy. Disruptive pedagogy refers to the changes or transformations or innovations in the existing educational conditions. For example, Hempel-Jorgensen (2015: 532; Roberts & Venkat, 2016) use the concept of "socially just pedagogies" to describe the approaches that disrupt limits to equal access to education for social and economic benefits or even for the joy of learning towards making informed decisions. Similarly, Mills' (1997: 35) uses "normalizing discourses" as a concept that identifies the need for transformation in the educational spaces. He asserts that disruptive pedagogies disrupt the marginalizing processes by encouraging students to identify and to challenge the assumptions inherent in, and the effects created by, discourses that construct categories of dominance and subservience within contemporary society.

Space and Disruptive Pedagogy on Mathematics Teaching

We use disruption as a concept, not to refer only to the process of teaching in class, but the shift from the norm in relation to the arrangements for pedagogical practices. Thus, we use disruption to mean the rethinking and rearrangement of school spaces for mathematical practices. This process includes the modification of seating arrangement in classrooms and in the teachers' offices to enable interaction and to improve interrelations towards the enrichment of mathematics pedagogical practices. These arrangements are in consideration of the fact that teachers and learners are inherently social, cultural, and communicative, and that their "being-ness" is contextual, temporal, and grounded in shared realities that can improve practice (Kennedy, 2018). According to Dumont, Instance, and Benavides (2010: 52), 'effective learning is not purely a solo activity, but essentially a distributed one'. This implies that learning is done best when there is interaction and positive interrelations.

Kenway, Willis, Blackmore, and Rennie (1994) stated that disruptive pedagogies challenge the 'natural' or 'common sense' assumptions that legitimize knowledge. For example, the sitting arrangements in schools may be based on either historical, political, or social notions that are always viewed as natural or appropriate. However, those arrangements may promote unwarranted power relations that constrain transformed learning in schools. For example, a teacher may be at the front of the classroom and dictating the proceedings, while learners remain seated as receivers of knowledge. On the contrary, a room of grouped desks or square tables with a chair on each side conveys the importance of open communication, teamwork, and interaction for learning (Strange & Banning, 2015). In addition, Dewey (2011: 14) argues that only a 'curriculum that blends children's lived experiences with surrounding objects and familiar spaces will create lasting meaning and understandings. This is a scenario that is possible only if the school spaces are disrupted. However, Strange and Banning (2015) note that space arrangements are habitually taken for granted, with the limited realization of the ways in which space constraints or enhances the intended outcomes. In essence, the ways in which a mathematics classroom is designed shape the learning that happens in that space.

Ingram (2018) provides an interesting analysis of how a classroom is both a social and a pedagogical space and the implications of this duality on mathematics learning. She points to the probability of learners choosing to sit with friends, a situation that may influence their identities in terms of norms, values, motivation, and achievement. In this regard, Ingram argues that research often focuses on adolescent friendships as a negative influence, overlooking their possible social resourcefulness. "When two individuals form a relationship, they are gaining access to resources such as their values, social support, knowledge and skills relating to schooling and academic subjects, and emotional support for the meeting of challenges" (Ingram, 2018: 282). We agree with Ingram and our assumption is that the sitting arrangement of learners in the classroom may either maximize or minimize the possibility of this kind of access to social and academic resources in the classroom. Similarly, Anthony and Walshaw (2009) view a mathematics classroom as a community of practice where the teacher encourages learners for 'togetherness', care, safety, and interrelationships, but simultaneous independence. Similarly, teachers' or staff room and interaction matter. McGregor (2003: 45) points to the fact that among other school spaces, staff rooms are often regarded as fixed, bounded and modernist. Yet, a closer look at these spaces might reveal hierarchical arrangements that determine where the authorities sit in relation to their subordinates. This way, staff rooms like other spaces, are constituted through interactions between people and, depending on how those people constitute these spaces, they may be tools for improved pedagogical practices. This speaks to space being always under construction rather than fixed (Massey, 2005).

In addition, in this paper we associate the space and disruptive pedagogy with what Kennedy (2018) refers to as the philosophical space in mathematics curriculum. He argues that a philosophical space is where mathematics abstraction can be facilitated to widen a horizon of interpretations for critical thinking by both teachers and learners. For example, through the philosophical inquiry space, the depth in understanding triangles in Geometry could be interrogated through (a) the usefulness of triangles in everyday life (b) triangle connections with other figures and (c) the limitations of presence and absence of triangles in human life. Mun and Hertzog (2018) argue that mathematics teaching and learning in a philosophical space favors a shift from doing mathematics to mathematical thinking. Our view is that such abstract thinking can be improved through the disruption of school spaces for transformed practices.

Our engagement with literature in the preceding sections is selective rather than comprehensive about social spaces and disruptive pedagogy. The rationale for this selectivity is that the study from the paper reports was conducted in a particular context where only the mentioned aspects of these two concepts are applicable. The context for data collection was the township schools in South Africa (details in the methodology). Many learners, in such contexts, find mathematics difficult and a struggle. Therefore, they rely on assistance from their teachers. The possibility of this kind of teachers' assistance is often limited by the physical classroom size versus the number of learners in the classroom. For example, Graven (2015: 342) argues that "large classes, with little space for teacher movement between desks, often work against opportunities for individualized learner attention". The concept of 'built pedagogy' is noted as having been used in literature to associate specific pedagogical practices to learners' experiences and behaviors (Byers, Imms & Hartnell-Young, 2014; Monahan, 2002). Similarly, in some of the township and rural schools in South Africa, some teachers are not fully qualified to teach the subjects they teach, but they get placed to teach those subjects due to the insufficiency of expertise. Therefore, apart from the shortage of rooms for teacher engagements, teachers with expertise may choose to sit close to the less experienced for the sake of mentoring and support.

METHODS

This paper took from a qualitative study that, as indicated, analyzed the dynamics of space in South African schools. The main question of the project was, 'How do school spaces enable or constrain teachers' and learners' practices towards the required or ideal performances? Following a multi-case study design (Baxter & Jack, 2008), three senior secondary and three primary schools in one of the townships in the Tshwane district were sampled based on proximity to the researchers. However, this paper reports only on the findings from one of the secondary schools in which the theme of disruptive pedagogy was developed from data analysis. The school is situated in the middle of an informal settlement which was an extension at the back of a township in Tshwane, South Africa. This was a good setting for this research project to develop a qualitative understanding of how spaces in less-resourced schools relate to the research question. In this school, two data collection methods were followed, that is classroom observation and semi-structured interviews with two mathematics teachers, and one head of the mathematics division. One of the researchers visited the classrooms during the mathematics periods and became a non-participant observer (Briesch, Volpe, & Floyd, 2018; Cohen, Manion, & Morrison, 2017). The researcher sat at the back of the classroom to minimize disturbance during the lessons and to see how the teacher interacted with the learners within the classroom space. The interviews were conducted after the classroom observation process with each teacher. The idea was to not only speak about the preset interview questions but also to reflect with the teachers on the observed lessons. The HoD was interviewed last.

The participants were allocated pseudonyms, H for the HoD, and TA and TB for the first and second teacher respectively. TA was responsible for teaching Grades 8 and 9 while TB taught Grades 10, 11 and 12. TB was a novice teacher with two and half years teaching experience while TA had six years of teaching experience. H had eight years of experience as a mathematics teacher in a different school, but he had three months experience in the management position in the school where research was conducted. The sample was purposefully selected such that H participated in the study in his capacity as a mathematics teacher and a member of the school management team (SMT). This is because usually issues of allocation of work and physical space for teachers are handled by the SMT.

In this school, data were collected through classroom observations and semi-structured interviews with two mathematics teachers and one HoD. The research ethics were followed, including the sourcing of ethical clearance from our institution, permission from the district and the school as well as consent from the participants.

Data were analyzed thematically, following the stages from coding, categorizing and the development of themes (LeCompte & Goetz, 1982; Peel, 2020). The first step was to transcribe the interviews, which had been recorded with the consent of the participants. Some coding took place during the transcriptions, but more was done afterwards. Similar codes from all the transcripts and from the observation notes were categorized and then developed into themes. Thematic analysis became useful in this study because it enabled us from a constructionist methodological position to draw meanings that H and the teachers attached to the teaching and learning space, the significance it had to pedagogy in relation to effective mathematics teaching and learning, and mostly their social construction of that space. At the same time, it also enabled us to examine the reality of participants' utilization of mathematics classroom and office space, the material and social contexts and whether those spaces constrained or enabled mathematics teaching and learning.

RESULTS AND DISCUSSION

The analysis of data brought about two themes that related to disrupting school spaces for mathematics teaching and learning. These were: disruption of school space for teachers and disruption of school space for teaching and learning. Each of these themes had categories that indicated how such disruption either enabled or constrained the execution of Mathematics practices, interactions, and relations.

The Disruption of School Space for Teachers

The norm in some township schools in South Africa is that the heads of department (HoDs) have offices where they sit alone and perform or prepare for both management and pedagogical practices. Teachers usually have a staff room where they sit and prepare or mark learners' work if they are not in the classrooms as the class teachers. The staff rooms would be occupied by teachers of different disciplines rather than one. Those that are under the HoD's department would come to the office for consultation and other needs. These norms were disrupted in this school because H and the mathematics teachers were using H's office as a discipline space. This disruption had both pros and cons which are presented below.

Empowerment with Content and Pedagogical Knowledge

The teachers were asked how they experienced the situation whereby they shared an office with the HOD. They indicated that using the HoD's office was an empowering arrangement. For example, TA stated,

> ... Ideally [H] was supposed to sit alone. He prefers to sit with his Maths teachers so that when they have problems, they can discuss with him.

This response indicates that the sitting arrangement in this case, was not for policing or imposing a surveillance measure on the mathematics teachers, but for empowerment with pedagogical and content knowledge. TB confirmed this benefit by commenting that the arrangement enabled him to consult easily with the other teachers in the discipline when he had problems with some sections in the subject. He narrated,

> I can discuss with them [the other teachers] the issues that I have in class if there is a content area with which I am not comfortable. Before I go to class, I will tell them that, 'gents, I'm not comfortable with this. How would you go about teaching this?' Then we discuss things like, 'no, try this way and that way'.

TB did not find the arrangement to share the office as an imposition on him. Instead, he regarded it as a means for knowledge sharing. To illustrate further how this cooperation worked in his office, H gave disciplinary and practical examples,

> … we talk about Euclidean geometry, construction (a construction) [for] Grade 9, where learners perpendicularly bisect lines. [This topic] is also there in grade 11 but now represented and defined in a circle. We … discuss as colleagues such that the one teaching in Grade 9 is fully aware of the developmental concepts connected with a current lesson.

When H was further probed to cite one or two examples where learners approached him or any of the teachers about a mathematics problem and illustrate how he handled the request, he responded:

> […] 'Oh yes, one of the Grade 12 learners approached me during breaktime that he was unable to draw one of the differential calculus cubic graphs I had given for homework. It was so interesting to see some of the errors that our students do and how this calls for basic

knowledge in mathematics that the learner should be bringing to the final class. After helping the learner, I took a photo of the work so that we could discuss it with the other teachers especially those who teach lower grades. Look, here is the learner's work, I still have it on my phone'.

He shared with us the learner's work as illustrated in Figure 1, and explained:

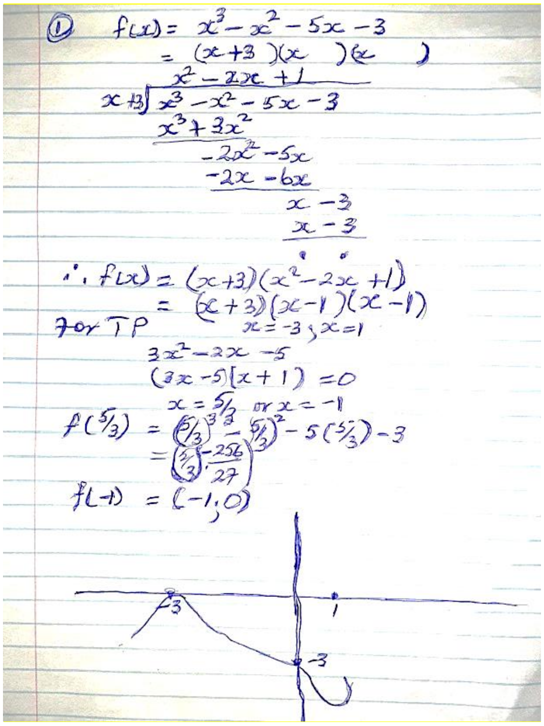

Figure 1: Learner's work

Our discussion started with the error made by the student when factorizing the given cubic function and ended up not able to draw the correct graph. The first error was made in the long division when the learner thought $x^3 - x^2 - 5x - 3$ could be factorized as $(x + 3)(x^2 - 2x + 1)$. This meant binomial factors, he would not get the -3 given as the last term of the original function. This was the first error, and when the learner multiplies out the cubic function was the problem, because now it appears that the student knew all the rules of finding stationary points, the expected shape of the graph, and y-intercept. We all discussed this in the office trying to understand why it was a problem for this learner.

H was further asked to indicate where the problem lied in the learner's response and how discussing it with the other teachers in the office helped. He explained that:

No, you know what? Mathematics can be tricky. Just by missing a sign in one of her brackets in the initial factorization of the cubic function, the y-intercept, he knew was down the y-axis at y = -3. But now the turning points that the student got were not directing the graph to meet the y-axis at y = -3, as you can see, the student was trying here. (Pointing at the problem on his phone). What was more interesting was to find that even the other teachers could not easily identify this error until we all discussed it together. Thank God the learner was no longer with us.

He further elaborated that he had to use the space available to all of them as mathematics teachers (his office) to stress the importance of ensuring that the learners were well-grounded in factorization from the lower Grades 8 and 9. He commented:

> … if a learner has problems with factorization, that learner will definitely struggle with mathematics in higher Grades. Factorization in mathematics, as prescribed by CAPS [curriculum document], is found in almost all sections of our mathematics except trigonometry. What is important is that the student must also be able to verify the correctness of his expression break down, master the multiplication of signs and be able to identify an error if it is done.

When H was requested to share another example of content that they talked about with his colleagues, he shared that,

> … learners are always performing very poorly in geometry. You know what I have been telling my colleagues that geometry is the easiest section, and if taught well, that is where our learners could score the most, especially if they are taught all the facts about it in lower classes. For example, if the students learn all the features of a triangle in lower classes, those features do not change at all. When they now must solve riders in Grades 11 and 12, they will still remember and apply that knowledge.

This process would not be easy if these mathematics teachers were in the same staff room with teachers of other subjects. Also, the teachers teaching in lower grades would not get an opportunity to learn from such discussions to enhance their own practices on similar topics. H also indicated that the support they were giving to each other motivated the teachers to see the need to upgrade their qualifications. Although each teacher could make an individual decision to upgrade qualifications, regular togetherness and knowledge sharing were seen as having motivated this process for the improvement of their practices. H commented,

> The other thing is to update each other on the developments [in our subject (translated)], AMESA's (Association of Mathematics Education in South Africa) workshops, and also to share [research] findings and strategies that [researchers] used that did or did not work when teaching particular lessons.

H gave high regard to such knowledge sharing indicating that it was empowering and developing. He commented, "... two of us have now registered for master's to further our studies and be lifelong learners." In addition to its value for sharing pedagogical and content knowledge, the HoD's office was seen as a space where the physical, mental space and social space coincided for the promotion of effective mathematics teaching (Kenway et al., 1994). This view was elaborated on by H:

> We have grown to be friends; we talk about anything and everything. Sometimes learners from different classes come and ask questions on mathematics. They do not have to wait for a particular teacher. Whoever is available in the office assists the learner. I think that this exposes the learners to different approaches to address mathematics problems and

> increases learners' chances of understanding. Also, more than anything else, we use this space to share our worries and teachers' concerns. For example, [When a teacher says that his/her learners are failing (translated)], then we can sit and advise [the teacher]. One teacher may share a certain strategy that he/she used, and it worked. In that way, the one complaining gets motivated to go and try something else in the classroom. And I think in this space we got to be very close to each other, share the same sentiments and also our personal relations have been strengthened.

This comment suggests that H realized the relationship between positive social relations among the subject teachers and the ease of knowledge sharing. Because of the proximity to each other, teachers were able to share best practices for the whole school improvement of mathematics pedagogy. This realization is consistent with Peters' (1992: 423) view that, "In fact space management may well be the most ignored – for inducing culture change, speeding up innovation projects, and enhancing the learning process ...". While some studies have indicated discomforts in sharing office spaces, these findings indicated that such discomforts may be either contextual or subjective. In the case of the teachers in this school, sharing the office space was found to be beneficial for both professional and pedagogical development. One of the resolutions taken by the mathematics teachers in that school was to always ensure that when teaching a topic in mathematics, it is important to connect it to previous knowledge acquired in lower classes.

When TB was requested to give an example of how using H's office was resourceful in his practices, his comment was:

> …… Yes, I remember, by the way I teach Grade 11. We were doing the section on solving problems in two dimensions when using numerical values or variables. That question usually carries many marks, but you find that learners struggle with it. Of cause, there are many other underlying concepts that need to be applied when doing those solutions, like applications of Pythagoras's theorem, which learners do in Grade 9, the sum of angles of a triangle, properties of triangles, even before they can apply the sine and cosine rules. So now, I had to go back with the learner, this is done in the office space because sometimes when this is done in class, other kids laugh at the child. He/she becomes embarrassed and cannot ask any more questions even if he does not understand.

This comment is echoed by Ma and Xu (2004) who assert that teachers need to know the mathematics they teach as well as the horizons of that mathematics, where it can lead and where their students are headed with it. Also, the principles, standards and expectations of mathematics teaching and learning as prescribed by Boaler (2014) stress that effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well. Students learn mathematics with understanding, by actively building new knowledge from experience and prior knowledge. Thus, the office space enabled the teacher to revisit fundamental trigonometric concepts with the learner without embarrassment from his/her peers.

Disruption of School Space Improves Human Resource Management

The district office officials in Tshwane, South Africa often visit schools for various reasons, including subject advising and support, workshopping, and other management issues. H found the arrangement of sitting with the teachers in his office to be enabling as it facilitated easy management of staff members during such visits. He commented that he did not have to go around looking for the mathematics teachers if there were such visits for the subject because he would know exactly where each teacher was. The teachers would also not have a way of dodging such visits in these arrangements because if they were not in class, then they would be in the same office. In this case sharing the office made micro-management easy. The other example of how this arrangement enabled easy micro-management is demonstrated in the comment by H below.

> The other thing for me is to monitor that we all go to class on time. This is important so that the time allocated to a [lesson] is used maximally daily.

Although this statement could be seen as suggesting policing of teachers' practices, it also indicates that H was taking punctuality with high regard, for the benefit of learners.

Co-Disciplining and Co-Supporting in the Disrupted Space

Sometimes teachers need support, not only on content and pedagogical knowledge and skills. Disciplining learners can also demand teamwork. One of the teachers shared how the disrupted sitting arrangement enabled the smooth operation of such teamwork.

> [....] when I have a discipline issue, I can bring the kid to the office, and we talk to the kid together and show the kid that disrespecting us won't contribute to [good results]. So, we share approaches, we share discipline measures, and we work as a team.

This was an interesting finding because teamwork is often discussed in relation to teaching or school leadership and management. In this case, however, it showed that teamwork can be included in micro-classroom management. In addition, the seating arrangement became resourceful for teachers to co-support learners rather than to provide individual support. Co-supporting, in the context of this paper, refers to a situation where teachers do not individualize learner support to specific teachers, but any or all of them would support a learner as the need was identified. For example, H commented,

> Sometimes learners from different classes come and ask questions on mathematics. They do not have to wait for a particular teacher. Whoever is available in the office assists the learner. I think that this exposes the learners to different approaches to address mathematics problems and increases learners' chances of understanding.

These comments attest that the mathematics learners in the school benefitted from all teachers' expertise rather than single class teachers. They also indicate that shared classroom control was enabled and a platform where mathematics teachers in this school-worked together, learnt from each other and collaboratively assisted learners in mathematics were available. Mathematics teachers were also enabled to constructively critique each other while adding relevant information that would have been left out should such disruption of space not have been activated.

Easy Sharing of Resources

In many township schools, the teaching and learning resources are insufficient. Teachers must work together and share the limited resources for the success of their pedagogical practices. Sharing an office space made this cause easy in the school. TB commented,

> The resources are available, textbooks, laptops, and everything. Everything that I need in that office is there. I think it's one of the reasons [why the maths HoD] decided that we stay in the same office because everything that we need is in there.

In this case also, the teachers would not have to waste time looking around the school for the resources because the teachers with the required resources at a particular time would be either in the classrooms or in the same office.

Strained Relations among Disciplinary Teachers

The form of disruption of school spaces that is discussed in this paper can have inherent constraints. We found that the arrangement strained relations between the mathematics teachers and the teachers of other disciplines. TA commented,

> ... Mostly some of our colleagues do not have anything positive to say about the [mathematics] department ... Most of our colleagues would prefer for [the office] to be not just a maths office, but for anyone who needs an office to be in that office. So, it is always those things that ['these ones think they are better than everybody' (translated)].

The problem with this strained relationship is that in a school space, teachers need each other for support, regardless of the disciplines. The interactions and interrelations are among the better components of the social space. Therefore, while the disrupted school space was mainly beneficial for the mathematics teachers, it had minor but significant constraints. It was, however, interesting to find how the participants found ways to appease the situation between themselves and their colleagues. For example, TB commented,

> I learnt that as we supported each other directly, even in staff meetings, they [the other teachers] respected the members of the mathematics department ... We then also extended our help to assist them with ICT techniques, timetabling and all other related matters. We also have tools that we use to check the learners' books, on whether they do their work efficiently. We also share those with the rest of the staff.

The participants' positivity, rather than allowing the negativity from other teachers to deter their work, extended to be a mechanism for a whole school's support for knowledge and resources. All this was the result of the disrupted spaces in the school. The next theme that we identified was about the participants' experiences regarding the disrupted teaching and learning spaces.

Disruption of School Space for Teaching and Learning

It has become a norm in many township schools in South Africa that teachers are fewer than the required number for a balanced teacher-learner ratio. This situation leads to overcrowding in the classrooms and constraints regarding activities, actions, and interactions in the classrooms. In such situations teachers become compelled to give individual or pair rather than group learners' activities because desks are arranged in rows. In this study, however, we found that the teachers were able to disrupt this norm in their mathematics classrooms. In one classroom, we observed that the learners' desks were placed along the classroom walls such that the teachers' desk was at the center of the classroom. This arrangement enabled the teacher to have a full view of all the learners. This way he was able to give them full attention and to identify those who struggled with classwork. In line with Ingram's (2018: 281) analysis of how a classroom is both a social and a pedagogical space and the implications of this duality on mathematics learning, during the interview, TB stated,

> With learners realizing that nobody sits behind others in the class, there has been a change and improvement in their culture of learning. Nowadays, almost all students do their homework, even though they might not be correct, but a learner knows that he or she cannot hide behind ... I also see some traits of responsibility, accountability and, most of all, owning their performance in mathematics.

This observation relates to Forster's (1947: 67) argument that "a room may have a view, four walls, and a ceiling and floor, but that tells us nothing about it unless we know what meanings it contains, represses, opens up, or resonates with".

Discussion of Findings

The next question for us was what these findings meant in relation to the way the disruption of school spaces disrupted pedagogical mathematical practices in return. The findings indicate a combination of Lefebvre's (1991:12) social space and disruption as a phenomenon towards a change in the spatial practices in the school. There are norms in the education system (such as overcrowded classrooms) and in the school from which data were developed (such as the separation of the staff room from H's room). However, the findings indicate that the teachers' representational or the lived/experienced space enables the disruption of the norms. The participants indicated a refusal to conform to the norms which, according to their experiences, are neither productive nor supportive to the wellbeing or development of their learners and careers. This refusal is in line with an understanding of Mills' (1997) "normalizing discourses" because the participants identified a need for transformation in the educational spaces and they disrupted the marginalizing norms in the school or the educational system. The mental refusal to conform led to the disruption of the norm which, in the context of the school concerned, is based on the historical, political, social conditions of the South African school system (Kenway et al., 1994). Although this disruption is sometimes difficult (as in the overcrowded classrooms), the teachers showed that the will for change, rather than to conform to status quo, creates possibilities where there could be impossibilities.

In line with Lefebvre (1991) and Massey (2005), the findings demonstrate that the school is a space for interrelations and interactions and that when there is positivity in these aspects there is a possibility for success. Mathematics teachers worked collaboratively in every respect that concerned their practices. Their positive interrelations and interactions transferred to the sharing of knowledge and skills to a wider school community. Therefore, it can be said that their decision to disrupt the spatial status quo improved relations and abilities beyond the mathematics discipline. This situation confirmed Edwards and Usher's (2003: 5) argument that people's interaction in space "construct, disrupt, and resist meanings and understandings" to create new meanings of the space. This interaction and collaboration, which the teachers and the HoD in the school demonstrated, contradicts McGregor's (2003) note of hierarchical and authoritative seats in school spaces, where the powerful sit at different positions to their subordinates.

The study extended the meaning of disruption to more than just the use of technology in the classrooms as is the case with the literature that was reviewed for this paper (Hedberg, 2011; Stevenson & Hedberg, 2011). Instead, the changes that are meant to provide positive outcomes in pedagogy, whether technological or not, are a disruption of the representations of space. It can therefore be said that in this study disruption showed to be in line with the social justice conceptualization as presented by Hempel-Jorgensen (2015) and Roberts and Venkat (2016).

CONCLUSION

This study did not prove Bligh and Crook's (2017) argument that there is a positive relationship between learner outcomes and specific types of learning spaces. However, based on the findings and the discussion presented above, we could make three conclusions in this paper. First, the disruption of school spaces has the potential to improve mathematics teaching and learning for better learner performance. This conclusion emanated from the observation that the disruption of the school space resulted in the disruption of normative hierarchies between the manager (HoD) and the managed (mathematics teachers). This disruption went beyond improved communication, collaboration, interaction, and knowledge sharing, to shared resources, classroom management, informal teaching, staff management and professional development. It also transferred to staff members outside the discipline, a situation that has the potential for cross-disciplinary collaboration for improved pedagogical practices in the subject concerned. These are the changes that have the potential to improve learner performance.

Second, a will to improve practice requires creativity and the disruption of school spaces. In this study, a teacher refused to allow the conditions of the school to dictate his practices and this situation improved learners' completion of homework and class work. This conclusion is therefore related to the first one because the teacher's creativity in this case has a potential to improve learner performance in mathematics. It motivates learners to work harder than they would in normative spaces. Third, while research is still needed to determine the role of disrupted school spaces on learner performance, it can still be concluded that even in township schools, the disruption of school spaces can demystify the notion of mathematics as a difficult subject that learners struggle with.

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