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Engaging mathematics student-teachers in an Open Distance e-Learning context

Abstract

Isolation, lack of connection and/or belonging, difficulty maintaining engagement and motivation for learning are common complaints for students separated from teaching and support staff in distance education. Using a mixed-methods approach, this article utilises dimensions of student engagement: cognitive, emotional and social behaviour to argue on student-teachers' engagement in mathematics learning for teaching in the Open Distance e-Learning (ODeL) context. A survey was administered to 654 students in an institution registered for Postgraduate Certificate in Education mathematics didactics course. Furthermore, five of the students were interviewed using emails and audio-recorded telephone calls. Findings reveal that student-teachers sometimes feel hopeless due to connectivity and data issues, which then impacts their time to engage with mathematics content. They also revealed that when they engage in discussion forums, they enjoy learning mathematics with their peers. It was also revealed that feedback on their assignments guides them on the correctness of their solutions as they otherwise would not have been able to do this on their own. It is recommended that further work be done to establish how cognitive engagement with mathematics can be positively impacted in an ODeL context.

Keywords: *engagement; Open Distance e-Learning (ODeL); teaching; students; learning; FET Mathematics; online discussions; classroom practice.*

1. Introduction

The preparation of mathematics teachers through Open Distance e-Learning (ODeL) has been a challenge due to the nature of communication with student-teachers and material delivery during instruction. In addition, Alfonso (2012: 2) defines ODeL as a "form of education provision that uses contemporary technologies to enable varied combinations of synchronous and asynchronous communication among learners and educators who are physically separated from one another for part or all of the educational experience". It has been further observed that while the provision of teacher education shares many common features in goals and structure across countries, it is strongly influenced by local conditions and norms, and by cultural notions of the knowledge that is considered essential in framing how quality is to be defined and operationalised when learning to teach the subject (Tatto, Rodriguez & Lu, 2015). According to the Mathematics Teaching and Learning Framework for South Africa, a balanced and multi-dimensional approach to teaching mathematics for understanding should be conducted in a learner-centred classroom where learners and teachers engage actively, discuss and experiment with mathematical ideas (Department of Basic Education, 2019). Drawing from the modification of Kilpatrick *et al.*'s five strands of mathematical proficiency (Graven & Stott, 2012), the proposed framework prescribes that for the transformation of mathematics teaching in the country, teachers must (i) teach mathematics for conceptual understanding to enable comprehension of mathematical concepts, operations and relations; (ii) teach so that learners develop procedural fluency that involves skill in carrying out procedures flexibly, accurately, efficiently and appropriately; (iii) develop learners' strategic competence in which the ability to formulate, represent and decide on appropriate strategies to solve mathematical problems is promoted; (iv) provide multiple and varied opportunities for learners to develop their mathematical reasoning skills with capacity for logical thought, reflection, explanation and justification; and (v) promote a learner-centred classroom that enables all of the above, supported by teachers engaging with learners in ways that foreground mathematical learning for all (Department of Basic Education, 2018). Mathematics teacher preparation should be an intuitive process that equips learners with skills that enable learning and the construction of the concepts in their own minds.

The South African Millennium Development Goals (MDG) considers mathematics as a fundamental requirement essential to pursue a career in an economic sector for development and growth (Mogari, 2014). This article uses dimensions of student engagement: cognitive, emotional and social behaviour to explore student-teachers' engagement in mathematics learning for teaching in the ODeL context. Student-teacher engagement refers to the degree of attention, curiosity, involvement, optimism and passion that they display while being taught, and this is related to how much they learn and retain, as well as their persistence and enjoyment in completing tasks or assignments given. For the student-teachers enrolled for the Further Education and Training (FET) mathematics didactics course, learning mathematics occurs from the perspectives related to (i) mathematics and teacher preparation courses, (ii) pre-service field experiences and (iii) schools of employment. It is the student-teachers' engagement over varying periods in different contexts that they refine their conceptions about their craft of the big ideas of mathematics, mathematics-specific pedagogy and sense of self in becoming a mathematics teacher.

In line with re-imagining thinking, additional resources for the subject didactics' module in the form of readings, digital lessons and some open educational resources are uploaded for student-teachers to access online. All those additional content types were provided in order to support the student-teachers and unpack the content in simpler terms. This article reports on a study that was conducted with the University of South Africa (UNISA) student-teachers enrolled for a Postgraduate Certificate in Education with specialisation in Subject Didactics in mathematics. The mode of delivery was ODeL. The module is delivered through a study guide that is divided into six units, each of which addresses various topics from a different perspective. The units cover the exploration of what it means to "do" mathematics, the development of understanding in mathematics, mathematics in the FET band, teaching through problem-solving, planning in the problem-based classroom and the building of assessment into teaching and learning respectively. All the aforementioned topics are compiled such that the training of student-teachers is appropriate for them to teach FET Phase mathematics.

Students are expected to engage with the content in this module and submit four compulsory assignments. The fourth assignment is submitted as a portfolio that represents evidence of the extent of mathematics professional development and readiness of the student to teach the subject at FET level.

I became interested in understanding how student-teachers engage with ODeL mathematics teaching when I received a phone call from one of my subject didactics mathematics students in September 2020. He asked me about examples of relevant activities linked to student-teachers' lives outside the classroom that can empower students with the capacity to transform and reform their lives. Usually, all the assignments would have been submitted and student-teachers would then prepare for a two-hour venue-based examination. It was also observed that their interest became invested in the writing of either assignments or examinations and very rarely on "becoming professionally developed FET Mathematics teachers". The challenge became: How do I ensure that the student-teachers engage with mathematics concepts taught in an ODeL context? I will not repeat the considerable evidence pointing to the several challenges that ODeL student teachers usually face in learning mathematics. Such evidence is available in abundance (Simon, 2008; Thorpe, 1993; Rameli & Kosnin, 2016, Musingafi *et al.,* 2015). This study contributes to the new explanations of how mathematics student-teachers engage with mathematics concepts in an ODeL context.

2. Literature review

Attard (2014: 1) defines engagement in a mathematics classroom as "a multidimensional construct, consisting of three domains: operative, cognitive and affective". In addition, authors such as Team (2006) as well as Fredericks, Blumenfeld and Paris (2004) note that the coming together of those domains lead to students feeling good, thinking hard and actively participating in their Mathematics learning. From a framework of engagement, Attard (2014) suggests that an engaging Mathematics classroom pedagogical repertoire includes (i) a substantive conversation about mathematical concepts and their applications to life; (ii) challenging tasks that provide an opportunity for all student-teachers to achieve a level of success; (iii) provision of student-teachers with an element of choice; (iv) technology embedded and used when appropriate to enhance mathematical understanding through a student-centred approach to learning and (v) relevance of the mathematics curriculum explicitly linked to learners' lives outside the classroom and empowering students with the capacity to transform their lives. With real-world experiences being key for conceptual learning, student-teachers must recognise that it is not only a teaching strategy that is required, but also ensuring that their learners learn and can relate the mathematics learnt to their everyday situations.

Those suggestions can work if Mathematics lessons regularly include a variety of tasks that cater for the diverse needs of learners. Fredricks (2011) asserts that higher engagement in classrooms is characterised by student-teachers' development of strong relationships with their lecturers and peers; where lecturers support student-teachers' autonomy; hold high expectations, give consistent and clear feedback; use varying, challenging, interesting and meaningful tasks. In this ODeL setting, the latter is applicable since it is the main tool used to interact with student-teachers' submitted assignments. In addition, student-teachers communicate with lecturers in an ODeL setting through emails, WhatsApp and phone calls. However, research (Maboe, 2019; Paolini, 2015; Panthi & Belbase, 2017) has consistently shown that those student-teachers in many cases, require support either in the form of clarifications of the content in the study guide and/or suggestions on additional resources they should consult.

Leversha (2014) asserts that understanding a piece of mathematics involves explaining mathematical concepts, making logical connections between different facts and concepts, recognising the connection when one encounters something new inside or outside of mathematics. Student-teachers registered for the didactics course must understand mathematical symbols, visualise patterns and understand mathematics concepts (Debrenti (2013). Riccomini *et al.* (2015) assert that those teachers must understand mathematics vocabulary words and be able to build mathematics knowledge using mathematics language. More specifically, the student-teacher must understand how mathematics concepts are related. For example, after learning the factor theorem in algebra, the learners should be able to use it to find zeros or roots of cubic functions in drawing cubic graphs in differential calculus. This implies that student-teachers' conceptual understanding is knowing more than isolated facts and methods about mathematical ideas. It also infers the ability to transfer their knowledge into new situations and apply it to new contexts.

Currently, challenges identified in open distance learning institutions include high drop-out rates and late completion of programmes (Musingafi *et al.,* 2015). Student-teachers registered for the Postgraduate Certificate in Education with specialisation in Mathematics have also experienced this challenge. In most cases a student would succeed in all other modules for this qualification, except mathematics. Those challenges according to Berge, Muilenburg and Haneghan (2002) have been found to be situational, epistemological, philosophical, psychological, pedagogical, technical, social, and/or culturally related challenges. Situational challenges are classified by Rameli and Kosnin (2016) as a) self-factors such as negative perception, low self-regulation, b) student-teachers' behaviors, practices, and characteristics c) lack of cognitive, emotional and financial support, d) negative attitudes, behaviors, lack of support and e) others factors such as the nature of mathematics and assessment pressure. In addition Maboe (2019) identified (i) computer illiteracy, (ii) students staying in rural areas having problematic or no internet connectivity,(iii) students experiencing stress due to the uncertain security of their information, (iv) multiple roles of students, leading to a lack of time to go online regularly and (v) minimal communication between peers and lecturers as barriers to online learning in an ODeL context. According to Musingafi *et al.* (2015), strategies to improve student engagement in mathematics learning in ODeL include ongoing engagement with student-teachers in focus groups, motivation from the lecturer and encouragement to prepare for their assessments timeously, continuous assessment and group discussions.

It is common to find that when student-teachers in the ODeL context work on multiple simple and mundane algorithms, they may be behaviourally engaged and yet bored, frustrated and mentally unchallenged (Maboe, 2019). This could be associated with the habit observed when student-teachers interact with the study content in the tutorial letters only when they must hand in assignments that are due. Consequently, those student-teachers fumble through the guide without knowing relevant sources to correctly respond to tasks prescribed in the assignment. Musingafi *et al.* (2015) assert that challenges experienced by the student-teachers include failure to cope with ODeL learning strategies such as video/audio tapes material and the internet, a lack of self-motivation due to isolation from tutors and peers and difficulty in forming study groups due to differences in how they use time. Online library access is a facility readily available to all student-teachers registered in the institution in which the study was conducted. According to Cranton (2006) and Mezirow (1991), preservice teachers are adults that come to the university classrooms with prior assumptions and knowledge about mathematical concepts that need to be challenged in order to transform their thinking.

Moreover, Sriwongchai, Jantharajit and Chookhampaeng (2015) affirm that the creative thinking skill should be improved by new concepts and flexible concepts and that the lecturer should realise the relationship among the components of mathematics and be able to design problem-based learning activities.

3. Theoretical framework

This study was underpinned by the Framework for Engagement with Mathematics (FEM), (Attard, 2014). According to Attard (2014) engagement with mathematics occurs in a combination of cognitive, affective and operative student-teacher involvement. In that process the student-teacher reflects on a deep understanding of mathematical concepts and applications, values that the knowledge is useful to them outside the classroom and can therefore participate in group discussions, practical and homework tasks. I chose this framework because Durksen *et al.* (2017) used it as a a qualitative framework for teacher-student interactions in motivation and engagement in mathematics. This is a framework that can provide student-teachers with the foundations necessary for learners to engage with mathematics. Moreover, Attard (2014) asserts that the FEM highlights that it is not simply the pedagogical repertoires or the resources that teachers use that influence student engagement, it is the deeper level of pedagogical relationships that develop between students and teachers that are a necessary foundation for engagement to occur. There is therefore a need to prepare student-teachers to design learning experiences that help learners to learn mathematics and choose teaching and learning strategies most suitable for a chosen lesson to be taught. Abbott (2016) asserts that student-teachers' engagement with mathematics learning can either be intellectual, emotional, behavioural, physical, social or cultural. In applying Attard's (2014) framework in the mathematics subject didactics course, student-teachers were supplied with several readings such as Murray and Olivier (1998) on learning through problem-solving, together with Bereiter (1992) on referent-centred knowledge and problem-centred knowledge. They had to use these elements of an educational epistemology as sources from which they could draw their intellectual knowledge. In addition, some positive emotions such as immediate feedback on their submitted assignments facilitate the learning process and minimise negative behaviour of non-compliance with assignment submissions. This collaboration amongst student-teachers enhanced their social interactions and established a sense of belonging amongst them since those registered for the module belong to diverse backgrounds.

In addition, Fredricks, Blumenfeld and Paris (2004: 62–63) identify the behavioural, emotional and cognitive engagements as three dimensions of student-teachers' engagement. Consequently, it is envisaged that student-teachers who are behaviourally engaged would typically comply with behavioural norms such as timeous submission of assignments and involvement in discussion forums. Moreover, according to Sesmiyanti (2016), cognitively engaged student-teachers would be invested in their learning, would seek to go beyond the requirements and would relish the challenge. Christenson *et al*. (2012:161) associate cognitive engagement with strategic learning strategies and active self-regulation that enables student-teachers to display independent learning and flexible problem-solving skills. Cognitive engagement is also defined as the thinking that student-teachers do while engaged in the academic learning tasks (Clarke, 2001), motivational goals and self-regulated learning (Sharan & Geok, 2008). In this study, student-teachers' engagement with mathematics concepts is informed by the four forms of cognitive engagement namely, (i) self-regulated learning where students' cognitive processing is driven by a higher-order or metacognitive component, (ii) task focus in which students use task-specific planning and self-monitoring, (iii) resource management in which student-teachers draw help from external sources, and (iv) recipience, in which student-teachers respond passively with little mental investment, often to instruction that has short-circuited their self-regulatory cognitive process (Clarke, 2001).

4. Methodology

From critical research and interpretivist epistemologies, this article reports from an explanatory sequential mixed-methods approach research project that analysed how student teachers in an Open Distance e-Learning context engaged with learning FET mathematics. Those paradigms were chosen in this study because they involve a methodology that recognises the importance of cognitive, emotional, social and behavioural variables that impact the engagement with mathematics content and that these interconnections cannot be ignored (Maroun, 2012). I began with collection and analysis of quantitative data, followed up on specific quantitative findings, and explained those responses through qualitative data collected by conducting semi-structured interviews with some respondents (Wisdom & Creswell, 2013). Six hundred and fifty-four (654) student-teachers in an institution's Postgraduate Certificate in Education mathematics didactics course participated in the study.

Data were collected using a structured online questionnaire administered to the 2020 student-teachers cohort, and semi-structured interviews were conducted with five purposely selected student-teachers based on their responses in the questionnaire. The online questionnaires were sent to six hundred and fifty four student teachers. Interviews were conducted by telephone call or email. The survey included questions on cognitive, behavioural, emotional and social student-teacher engagement with mathematics. The first section of the questionnaire required the participants to give their biographical information, namely the previous degree or diploma completed before enrolling for the course, gender and the year in which they completed their schooling. There were six questions to which the participants had to respond freely in their own words. The open-ended questions included, among others, if students enjoyed mathematics, do activities in discussion forums, how they felt about feedback on assignments, interest, creativity and innovation. No limit was set on the length of the responses and there were no predetermined options. Thus, the questionnaire acted as a writing prompt for the participants. The questions intended to probe the student-teachers' engagement and experiences with mathematics from the four assignments prescribed in this course. Ethical considerations included, among others, stating the research aim, indicating voluntary participation, ensuring anonymity with pseudonyms, together with the right to withdraw from the study at any time without penalty. This study formed part of a multi-case study conducted by the College of Education lecturers at the University of South Africa to enhance the Scholarship of Teaching and Learning (SOTL). Ethical clearance was also obtained from our institution in the College of Education at UNISA (Ref: 253 2017/09/13/90188500/44/MC).

The researcher used the following stages of data analysis, namely the initial stage that involved the contextual coding of the qualitative data. I adapted Miles and Huberman's (1994) technique to analyse data collected from the questionnaires and interviews to identify the frames of analysis, which are levels of specificity within which the examination of the data took place. The coding of the data resulted in the formation of categories. After the data reduction process, constant comparison analysis together with content analysis, were applied in the coding and identification of underlying themes. Quantitative data were analysed statistically using graphical representations.

5. Results and discussion

5.1 Biographical information

Of the 654 student-teachers who participated in this study, 273 were males while 381 were females. Their previous degrees included diplomas in engineering studies and commercial subjects. Approximately 74% of them passed their matric mathematics thirty years ago, before 1990. Five student-teachers were interviewed, two were males and three were females. Four were from either a rural or township setting while one was from an urban setting. During interviews some indicated that they enrolled for the mathematics education teaching course because of the scarcity of mathematics teachers in the country. This was a guarantee that when they qualify, they will be absorbed by the education system.

In line with the organisation of the questions in the survey, data are presented and discussed following the themes identified. Those are (i) cognitive student-teacher engagement, (ii) behavioural student-teacher engagement, (iii) emotional student-teacher engagement and (iv) social student-teacher engagement. In the following section, results and discussions on cognitive, behavioural, emotional and social student-teacher engagement with mathematics are presented.

5.2 Cognitive student-teacher engagement

Cognitive engagement was measured quantitatively through questions about student-teachers' certainty regarding providing correct responses, thinking about different ways in which they can solve problems, connecting new information learnt with older knowledge, being able to detect mistakes in their work, together with their choice to do easy problems and leave out the hard tasks in their assignments. Positive cognitive responses involve deep understanding of mathematical concepts and applications, and expertise in how students wrote their assignments. For example, 518 of the 654 (79%) students could not think about different ways in which they could solve problems given in the assignments they wrote. That is a cognitive negative response. Results are displayed in Figure 1.

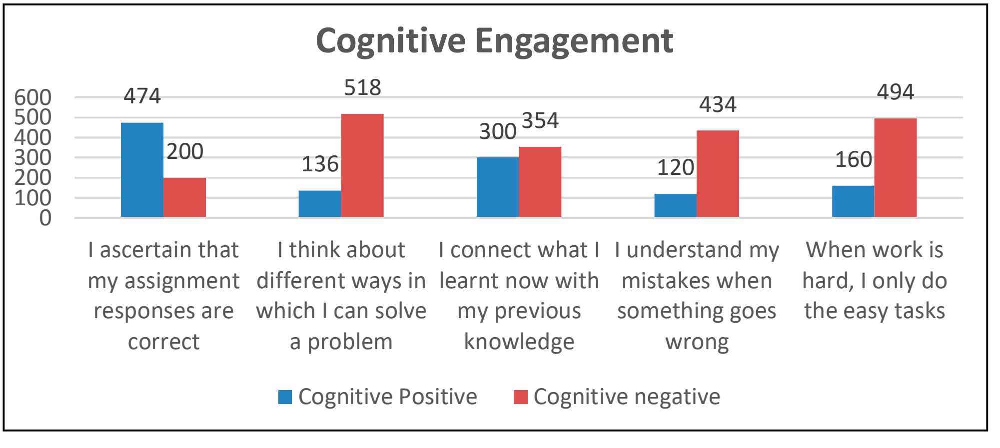

Figure 1: Student-teachers' cognitive engagement with mathematics

The cognitive engagement levels displayed in Figure 1 indicate that 79% of student-teachers often do not think of different ways of solving a task or problem and 75% of them noted that they are reluctant to try harder tasks when the tasks are difficult. Both findings signify “cognitive negative” responses. However, the same student-teachers are expected to design learning experiences that can help their learners learn mathematics using different and suitable strategies for specific mathematics concepts to be understood. This could perhaps be associated with the fact that during the interviews, some student-teachers indicated that they last engaged with learning mathematics almost twenty years ago. They had this to say:

> S1: I last did my school mathematics in 2008, I have now forgotten most of it.

Asked why he is interested in teaching mathematics, the student-teacher said:

> S1: You know I never thought I would teach mathematics, I studied Electrical Engineering, but now I have not been employed for the past four years after I completed my diploma. Also, I thought I would easily understand and enjoy teaching Mathematics since I did Engineering Mathematics, calculus to be precise. But now, I find it hard to do my assignments.

Student-teachers were also asked if they were able to try different approaches to doing the same problem. Some of the responses were:

> S5: Yhoo, that one is not possible, you know I am usually battling even to finish the assignment, so I just start with the easy tasks and then go and try the easier ones.

> S3: It would be great to try several methods as I can imagine that when I teach this will be necessary to accommodate the diverse nature of the learners in my classroom. But I’ll be honest with you, these assignments take a lot of time, you just have to finish the assignment and submit.

Asked about the connections they make with their previous knowledge; they revealed that:

> S4: Yes, sometimes I do, for example, I had to remind myself about the mathematics I did on parallel lines in Grade 9 to be able to make sense of the circle geometry that I’ll be teaching in Grade 11. However, for me, I always find it difficult to take content learnt in algebra for example and apply it in Trigonometry sometimes. But I have since realised through this course that sections like factorisation, for example, should be applied across the curriculum.

> S2: To refresh my mathematics knowledge, I made it a point that I collect textbooks and download mathematics material from Grades 9 to 12 so that I can remind myself of the content required in teaching FET mathematics. It becomes very difficult to connect the prior knowledge, I think it evaporated, it has been too long since I last studied mathematics.

> S3: I am so fortunate to be teaching Grade 10 mathematics as a temporal teacher now. So, connecting previous knowledge to new mathematics is what I follow almost every day. Learners easily understand if you build on what one already knows.

The cognitive engagement levels indicated that 66% of the student-teachers did not understand their mistakes when something went wrong. This cognitive negative response indicates that students lacked understanding of mathematical concepts. In such a case, Sesmiyanti (2021) suggests that students’ cognitive engagement should involve the students thinking during the task, be motivated to improve their ability in learning and also participate actively in the classroom. Clearly, results in this study indicate that the student-teachers could not engage cognitively with the tasks prescribed in their assignments. On understanding and being able to detect their mistakes when doing tasks, one of them had this to say:

> S1: That one is tricky; it is not easy to even notice that there is a mistake in response to a task. I become aware when I get feedback on the assignment submitted. But I remember calling my lecturer one time when we had to indicate how we would help learners to draw a graph from a quadratic equation that could not be factorised or had no real roots. To my surprise, she noted that the problem was deliberately meant to allow us as student-teachers to explain in diverse ways why it could not be factorised and how it should be corrected. I think this was teaching us to first attempt problems before we give them to our learners.

It is clear from the above responses that few student-teachers think about different ways in which they can present a task because of time constraints. It is not that they are unaware of other ways in which tasks can be solved. This skill, as suggested by Attard (2014), that an engaging mathematics pedagogical repertoire includes student-teachers' choice of methods that explain how problems are solved was found lacking among the participants. This skill is needed to prepare student-teachers to accommodate the diversity of their own learners. In addition, from Figure 1, fewer students had a deep understanding of how to connect new mathematical knowledge to previous knowledge. This finding shows that this is a skill to be further developed, echoing the finding of Sriwongchai, Jantharajit and Chookhampaeng (2015), who assert that the creative thinking skill should be improved by new concepts and that the teacher should realise the relationship among the components of mathematics and be able to design problem-based learning activities. This is a skill that mathematics teachers need to develop with their learners. Moreover, according to Sesmiyanti (2016), for student teachers to be cognitively engaged, they should seek to go beyond the requirements prescribed in an assignment and relish a challenge.

5.3 Behavioural student-teacher engagement

There were four different assignments in this course. The first was a multiple-choice question with four options to choose from, based on calculations. The second and third assignments assessed the methodological applications of mathematics teaching and mathematics content related questions respectively. Assignment 4 was a portfolio of learning composed of activities and selected samples of the student-teachers' work throughout the year that demonstrate their professional development towards becoming a competent Mathematics teacher.

Behavioural engagement was measured through questions posed to student-teachers that included how often they talk about mathematics, giving up when they do not get answers, waiting for help from others, doing assignments timeously, putting effort into learning mathematics, staying focused and only doing easy tasks. Student-teachers' responses that agreed with the given statement were recorded as behavioural positive, while those who did not agree were recorded as behavioural negative. Results are displayed in Figure 2.

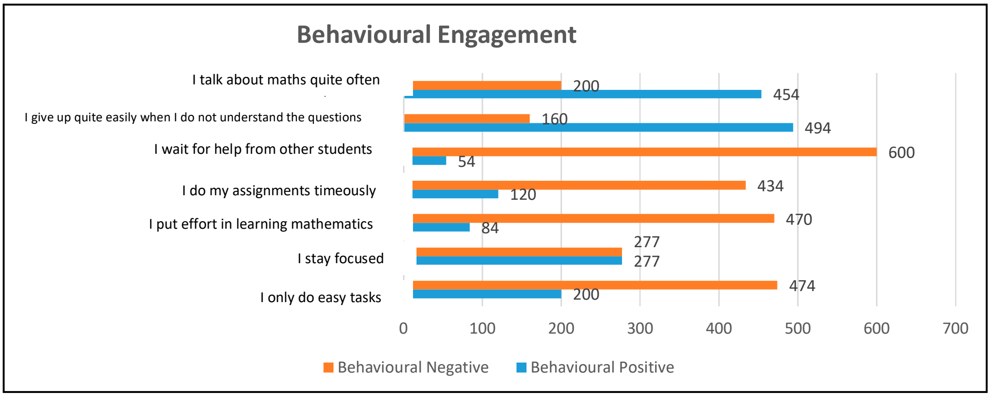

Figure 2: Student-teachers' Behavioural Engagement with mathematics

It can be noted from Figure 2 that 69% of the student-teachers indicated that they talk about mathematics quite often. Additionally, only 8% indicated reliance on other student-teachers for help with mathematics tasks. Furthermore, just 13% of the student-teachers indicated that they put an effort into learning mathematics. However, an equal percentage of them indicated that they could stay focused on studying mathematics as compared to those who could not focus. When the student-teachers were asked about the relevance of the mathematics curriculum to students' lives outside the classroom and if it empowers students with the capacity to transform and reform their lives, they had this to say:

> S2: You know I have noticed that some of the examples in the study guide bring in scenarios relevant to our everyday lives. I could mention for example those questions on application of calculus. But one does not know how to apply them to transform one's life.

> S4: Sometimes as I browsed through the assignment or the study guide, I noticed some familiar instances in which real life situations were used. However, it is not easy to engage with it as one always worries about which formulas to use when and how.

> S5: You know what? I will not lie. Given the fact that most of us usually do the assignment in the last minutes, it is not easy to really engage with the activities, you just do as many as you can just to get the assignment done without making meaning of it or looking at its relevance one's life transformation.

> S3: Since I last did my maths some time ago, it is not easy for me to understand how to do the activities, I usually wait for my group members to meet and draft them, but now it is so hard, we cannot meet because of the pandemic.

From the results, it appears that some students could identify the relevance of activities in the study guide to daily situations. However, those students were unable to apply or see how those activities could transform their lives. It appears that although a substantive number of students often talk about mathematics, many of them give up quite easily when faced with difficult tasks. Also, while a few of them do not wait for other students to do their tasks, very few put an effort into engaging with mathematics. This concurs with Attard (2014) who asserts that in engaging with mathematics, there must be a substantive conversation about mathematical concepts and their applications to life.

5.4 Emotional student-teacher engagement

Emotional student-teacher engagement was measured through questions about emotional reactions to engaging with the course such as being worried about learning new things in mathematics, frustration about learning mathematics, feeling good when doing mathematics, wanting to understand what is learnt in mathematics, enjoying learning new things in mathematics and looking forward to doing assignments and tasks in mathematics. From the results displayed in Figure 3, it can be observed that 80% of the student-teachers want to understand how to teach mathematics. However, only 59% enjoy engaging with mathematics, and 58% indicated that they look forward to engaging with their assigned tasks. Most student-teachers felt worried (emotional negative response) about learning new things about mathematics and frustrated whenever they had to do their assignments.

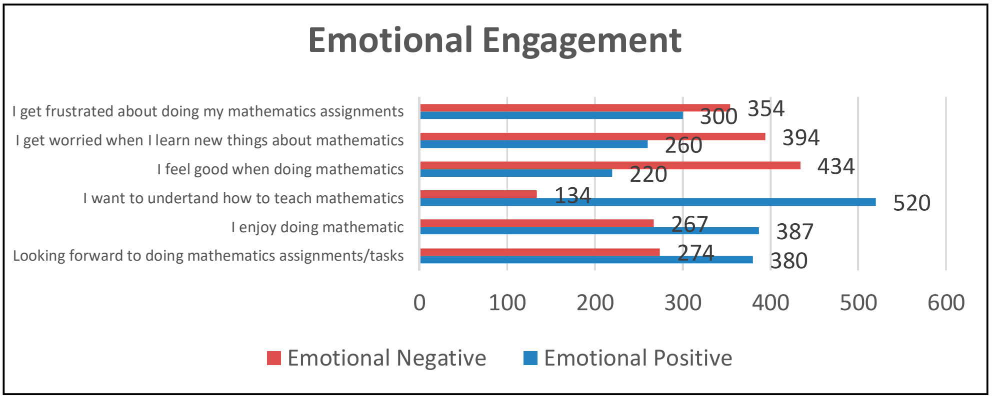

Figure 3: Student-teachers' emotional engagement with mathematics

During the interviews, the participants had this to say regarding their frustrations about doing mathematics assignments:

> S5: Most of us who chose online schooling did that because we are working, we have family and other obligations. What frustrates me most is that I was not strong in mathematics even at school, and so I take time to do even one activity. Time is always not on my side and that frustrates me. I wish I had time to join study groups because I also need to learn mathematics.

> S2: I get frustrated because the content that one must learn and respond to is huge, it is therefore not easy to submit a handwritten assignment. I get frustrated therefore when I must type mathematics symbols or draw graphs.

> S1: You know, sometimes I have mixed emotions. I enjoy doing mathematics and I feel good when doing it, but I wish submission dates were flexible enough to allow one to collect all the relevant information needed in the responses before the due date. But sometimes it is issues of connectivity, we don't have access to the internet in my area. Most time when I can connect, data issues are at play. That makes me feel hopeless.

Results indicate that the students participating in the study had to juggle multiple elements in their lives, which made it difficult for them to spend as much time as they wanted to on the study and doing their assignments. Student-teacher engagement is negatively affected due to technological issues such as poor connectivity and a lack of mobile data. There was also a link between positive emotions and satisfaction where those student-teachers who were satisfied with their learning experience were more likely to use emotions such as "hopeful" or "energised" to describe how they currently felt about their studies. Those student-teachers were always looking forward to engaging with their mathematics tasks. These results concur with Hewson (2018) who recognises the importance of relationships amongst student teachers as peers as much as technology, and that lecturers need to pay attention to personal relationships that must exist behind the screen for online learning to be a shared experience, not just ingestion of mathematics content. In addition, several studies suggest the importance of emotion in learning (Maguire *et al*., 2017; Oriol *et al*., 2016), but Hewson (2018) delves deeper and shows that the type of emotion experienced by learners is important: autonomous motivation.

5.5 Social student-teacher engagement

Social engagement was measured on how student-teachers build on others' ideas, how they understand other people's ideas in mathematics, how they collaborate with others, help those who struggle with mathematics and whether discussion forums were useful (good for them). Results are displayed in Figure 4.

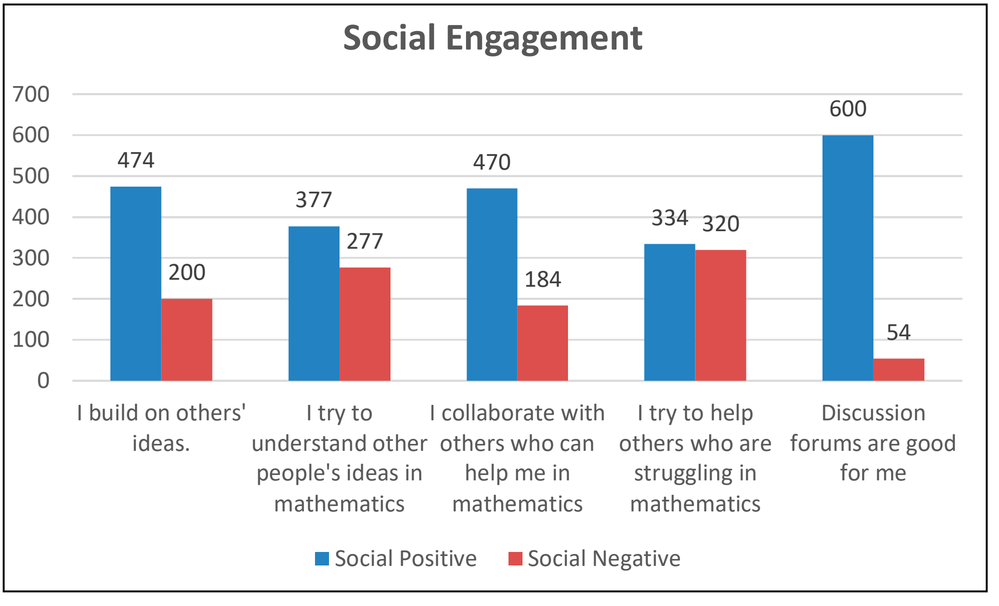

Figure 4: Student-teachers' social engagement with mathematics

From the results, 92% of the student-teachers note that discussion forums were good for them (social positive response). Also, 51% of the student-teachers tried to help others who struggled with mathematics and 58% tried to understand other people's ideas when engaging with mathematics. In addition, positive social engagement about collaboration with peers and building on other student-teachers' ideas was registered. In explaining this social engagement, S2, S4 and S5 said:

> S2: The other time, I did not have a clue of how to attempt the trigonometry section in my assignment 3, guess what? My friend who is also registered for this module guided me

> through a WhatsApp voice note, explained each step as if she was teaching and sent it to me. That example helped me to be able to tackle the rest of the task.
>
> S4: You know the other time, I was assisted by other students in the discussion forum. My study guide had some missing pages, and thus I had missed some questions. But as I followed discussions in the forum from other peers, the other students shared the missing activity questions with me.
>
> S5: Mathematics being one of my best subjects, I always do my assignments in advance. I do this because I always avail myself to assist other struggling students. I teach them using WhatsApp voice notes. This always helps me to polish my own work and correct some mistakes that I had made.

Student-teachers' access to discussion forums appears to favour their positive social engagement with mathematics. Several student-teachers indicated that they were able to build on others' ideas and collaborate with others who can help them in mathematics. However, Letseka and Pitsoe (2013) worry that it might not be easy to validate or authenticate ODeL students' written work and to ascertain whether the work they have submitted is theirs and that it constitutes a true reflection of their level of content knowledge and understanding of the subject matter. This implies that while students collaborate with each other when engaging with activities, some might not be aware of each student's mathematical abilities and learning needs. Moreover, Maboe, Eloff and Schoeman (2019) note that the students must actively interact with peers, lecturers, study materials and the university using online tools. This is a call for ODeL institutions to prescribe technological tools for the students to interact online, support distance students academically, cognitively, administratively, institutionally and affectively. In that way, social engagement with mathematics tasks will also be improved.

6. Conclusion

In this article, I have tried to outline how student-teachers engage with mathematics in an Open Distance e-Learning context. Data were collected via a questionnaire and semi-structured interviews to measure cognitive, emotional, behavioural and social engagement. Findings revealed that student-teachers sometimes feel hopeless due to poor connectivity and issues relating to lack of data and that this impacts their time to engage with mathematics content. This indicates that there are external factors that influence student engagement. However, participants also revealed that when they engage in discussion forums, they enjoy learning mathematics with their peers. This emphasises the need for social engagement in learning mathematics. It was also revealed that feedback on their assignments guides them on the correctness of their solutions as they are unable to correct their work without it. Thus, lecturers must make themselves available in discussion forums by initiating and posing questions that will prompt student-teachers to talk about mathematical concepts. Moreover, the assignments, especially portfolio assignments, should allow students to reflect on their own understanding while making sense of and critiquing the ideas of others. I suggest that the assignments should include questions that have incorrectly represented responses to tasks wherein student teachers must critique the response and correct it. Additionally, a collaborative and supportive learning environment can be created for student-teachers to peer review their own responses, thereby learning from each others' contributions and support achievement of higher order thinking skills. In that way student-teachers can make conjectures, connect prior knowledge to current understanding, reason about mathematics, refine and amend their approaches, and take ownership of their mathematical knowledge. Further research needs to be done to establish how cognitive engagement with mathematics can be positively impacted in an ODeL context.

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