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Online learning and peer support: Exploring the use of WhatsApp in first-year mathematics

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The outbreak of COVID-19 and the consequent lockdown took the world by surprise, forcing the trimming of the school curriculum and institutions of higher learning to urgently adopt online platforms to continue teaching and learning. This article is a case study that explores the use of a social media platform, WhatsApp, to improve peer learning and peer support in a South African context. The study sought to explore the nature of peer-to-peer learning that took place, and how peer support contributed positively to a student's conceptual understanding of the mathematics concepts. It involved a cohort of 180 entry-level students of an undergraduate engineering mathematics course. Guided by social constructivism, we analysed the data qualitatively using grounded theory. The results suggest that WhatsApp served as a viable platform for communication and peer-to-peer learning of engineering mathematics concepts. The study also found that the WhatsApp postings peer support alleviated the negative effects of remote learning. Some implications of the study as well as recommendations are suggested.

Contribution: This study focuses on peer learning in an online social media context and proposes the use of categories for analysing students' engagement with critical mathematics topics.

Keywords: mathematics; online learning; peer learning and peer support; procedural and conceptual learning; WhatsApp platform.

Introduction

The sudden emergence of the COVID-19 pandemic forced many educational institutions to adopt online teaching and learning as a way of attaining educational objectives. Some of the institutions used a combination of face-to-face and online, or hybrid, teaching and learning as a means of making a smooth transition (Trust & Whalen, 2020). It became evident during the transition that the advantages of face-to-face proximity in the teaching and learning process have been mainly taken for granted (Seri & Yoni, 2021). Most of the university mathematics entry-level cohort of 2021 experienced anxiety due to the COVID-19 pandemic because the school curriculum they had followed was streamlined and, consequently, they were not properly prepared. While other social media platforms such as Facebook and YouTube have been used extensively for educational support and learning, the use of WhatsApp is a relatively new and affordable technology. A few studies suggest that WhatsApp provides a useful platform for student learning (e.g. Nsabayezu et al., 2020).

This article explores the use of WhatsApp as an online teaching and learning tool in an engineering mathematics course. We used the social constructivist theory to analyse the conceptual development, and categorised the WhatsApp postings using the grounded theory approach. This study is primarily qualitative and sought to determine if WhatsApp communication assisted peer learning and conceptual development.

The article also interrogates the social impact of bringing together in one virtual group on a social platform students whose comfort zone for teaching and learning had been in a face-to-face environment. The benefits of face-to-face proximity have been largely taken for granted. The COVID-19 pandemic increased anxiety about mathematics among the entry-level cohort, especially those who were underprepared.

Context

This study involves 180 first-year students doing a mathematics course in an engineering department at a university of technology in South Africa. Their mathematics course forms part of a diploma programme for engineering technologists and students typically enter the programme with a 50% pass in the school-leaving mathematics examination. As a result of their generally poor mathematics backgrounds, some students have difficulty in coping with the course from the start. With the face-to-face restrictions forced on the society by the COVID-19 epidemic, the use of the university's learning platform, Blackboard, became, de facto, the default means of teaching and learning the university's programmes. Because access to Blackboard proved to be cumbersome and was often dependent on a laptop as opposed to a smartphone, the students came to rely more on WhatsApp for their interaction among themselves, for all course information, and for contact with the lecturing staff. As a result, WhatsApp became a useful, flexible, and more readily available additional tool as means of communication for staff and students alike.

Students were placed in a course that had lectures every Monday from 9 am to 12 noon. This was followed by an optional tutorial after the lunch break (1–2 pm), and a compulsory quiz at the end of the day.

Purpose

The purpose of the study was to explore the use of WhatsApp as a tool for peer support and peer learning of mathematics. It also investigated what the nature of the peer support and peer learning was and how it facilitated the students' understanding of key pre-Calculus and Calculus concepts.

Research questions

The study aimed to address the following research questions:

- What was the nature of the students' engagement on the WhatsApp platform?
- How did peer learning and conceptual development take place on the WhatsApp platform?
- What were the students' attitude towards, and perception of the use of, the WhatsApp platform for learning mathematics?

Literature review

Peer learning

Peer learning or peer-assisted learning (PAL) is a concept used to express a pedagogical approach where students learn from each other (Dobbie & Sadhbh, 2009; Roberts, 2008). As students engage in peer discussions, they question each other's views, seek clarification, and refine their own concepts (Crouch & Mazur, 2001; Fagen et al., 2002; Gok & Gok, 2017; Yildirim & Canpolat, 2019). Peer learning has been found to result in higher conceptual gains compared to traditional instructional methods (Gok & Gok, 2017) because students question their own approaches, construct their own understanding of the concepts, and gain self-confidence. Furthermore, it helps them acquire problem-solving skills and develop useful skills needed in their future professions, such as collaboration with peers to attain shared values (Crouch & Mazur, 2001; Yildirim & Canpolat, 2019).

In peer learning, the teacher is a facilitator and guide, asking questions that could challenge the students' conceptual understanding. This approach aligns with dialogical argumentation and assessment for learning instructional methodology (DAAFLIM), where the teacher often gives an assignment in the form of a multiple-choice question, giving students time to solve it individually, and then to discuss their solutions with their peers, justifying their methods (George, 2021). In doing so, they learn to justify why their answers are right, or learn to understand why their conceptual understanding might be faulty when their peers point out flaws in their method of finding a solution (Chou & Lin, 2015; Henderson, 2019; Klymchuk, 2009).

Peer learning and students' affective domain

Peer learning has been found to have positive effects on student motivation, self-confidence in developing problem-solving skills and student thinking (Balta et al., 2017). Peer learning has also been credited with positive interdependence (Cheng & Walters, 2009; Chou & Lin, 2015) where students working collaboratively believe that the joint construction of knowledge is more beneficial for the group and for individual conceptual understanding than when working alone. In the South African context, this collaborative learning falls in line with the concept of ubuntu (Muwanga-Zake, 2009; Scholtz et al., 2008).

Working in collaboration with peers also results in gains such as individual accountability (Chou & Lin, 2015; Henderson, 2019). Balta et al. (2017) suggest that peer learning is more effective with short courses of at most nine weeks than with longer courses and is more effective in countries that cherish collective endeavours over individualistic ones. A study by Lasry et al. (2008) showed that the use of peer learning resulted in reduced attrition in physics. Peer learning as a source of motivation for learning was confirmed by the study of Simon et al. (2013). The authors found that peer learning in a computer science course resulted in feelings of comfort and enjoyment of the course. It also resulted in increased socio-psychological factors as the students developed a sense of belonging to a community of learners struggling to learn and felt able to freely ask for help from peers. In that study, students were reportedly excited to learn that the taboo of giving a wrong answer was turned into an asset where they could discuss not only correct answers but learn why some of the answers were wrong.

Several studies have reported on how the affective domain influences the learning of mathematics. For example, Chamberlin and Parks (2020) studied young mathematics learners aged 7–8 years old in a large Rocky Mountain region of the United States. They found that: (1) learners classified as good in mathematics also had higher self-esteem and higher self-efficacy in solving mathematical tasks than their peers, and (2) the performance of the mathematically strong and their peers were not significantly different in other constructs such as attitudes, values, and interests, as well as aspiration and anxiety.

A recent study by Khoza (2020) also revealed that the study of mathematics using a digital platform of WhatsApp involved socio-emotional off-shoots. The study revealed three patterns of WhatsApp use by students: (1) social, (2) disciplinary and (3) personal.

In another study by Mota and Ferreira (2020), an analysis of WhatsApp postings showed that the students used the digital platform to interact with each other, going beyond the normal scope of the classroom. They also gained communication and social skills as they progressively gained collaborative autonomy. Their self-confidence and self-efficacy were also enhanced as they communicated mathematics with each other, refuting or validating each other's claims. In conclusion, these studies point to the fact that peer learning that involves collaborative discursive interactions, such as those that take place over digital media such as WhatsApp, involves affective components.

Peer learning of mathematics on digital learning platforms and conceptual understanding

The mathematics classroom has been transformed for good as the internet has become a key tool in the teaching and learning of mathematics after the COVID-19 pandemic (Borba et al., 2016; Engelbrecht et al., 2020a, 2020b). With this transformation also comes the transformation of the peer support systems that are very necessary for improving the pass rate of first-year mathematics students. Many studies report on the various degrees of preparation and engagement of online peer support systems that were adopted in South Africa to withstand the effects of the pandemic, and hence save the academic year (Durandt et al., 2022; Trenholm & Peschke, 2020). At the University of Johannesburg, for instance, a distance programme was developed to help the situation. This programme involved online weekly lectures and tutorial sessions, online resources, discussion forums between tutors, students and lecturers, online tutor support, among others. The results of the study revealed that students showed an interest in studying mathematics, although they believed that it was a difficult subject. Students became more familiar with online learning as the semester progressed and accessed the online environment more often when there was formal assessment approaching. The main complaint from students was login difficulties.

The studies (e.g. Clark-Wilson et al., 2020) suggest that the present trend of using digital online tools will continue for some time. However, there are some disparities between the universities in providing these technologies to students. Engelbrecht (2020b) identifies trends in mathematics classrooms taking three directions: (1) the application of design principles to design online courses and blended learning environments, (2) the use of online social interaction and the construction of knowledge, and (3) the use of digital tools and resources to provide different contexts for teaching and learning mathematics.

In the constructivist paradigm, the students construct their own understanding of mathematical concepts. During group discussions with peers, the students might face the challenge of having to explain their process of arriving at a mathematical solution when they are asked by their peers. Research has shown that while constructing explanations, students refine their concepts more accurately. For example, Yildirim and Canpolat (2019, p. 140) report that 'sharing different suggestions and questioning different opinions during peer discussions helped effect changes in students' conceptual misunderstandings of subjects and helped students consolidate the learned information'.

Their conclusion echoes the findings of several researchers. For example, Cheng and Walters's (2009) study concluded that those students who attended PAL sessions had 10 times the chance of succeeding in the mathematics course than those who did not. The results of a study by Ginsburg-Block et al. (2006) suggest that PAL interventions that focus on academics could also result in social and behavioural gains. In another study by Duah et al. (2014), the PAL programme was designed to reduce the phenomenon of 'cooling off'. This is the phenomenon where first-year mathematics majors rapidly lose motivation and interest in pursuing their studies. The results of that study showed that students who attended the PAL sessions had much higher achievement rates and increased motivation to continue the course than those who did not.

Peer learning on the WhatsApp platform

The sudden emergence of the COVID-19 pandemic forced many educational institutions to adopt online teaching and learning as a way of attaining educational objectives (Engelbrecht et al., 2020a, 2020b; Trenholm & Peschke, 2020). Some of the institutions used a combination of face-to-face and online teaching (what is popularly known as blended learning) as a means of making a smooth transition between the two methods. While other social media platforms such as Facebook and YouTube have been used extensively for educational support and learning, the use of WhatsApp for that purpose is relatively new (Khoza, 2020). However, there have been some studies involving its use as a digital platform for student learning of mathematics. For example, WhatsApp was used to enable online learning by students in three high schools in the Central Java province, Indonesia (Nida et al., 2020). The aim of Nida et al.'s (2020) study was to measure the effect of blended learning on mathematical creative thinking skills and mathematics anxiety. The results showed that the use of WhatsApp resulted in better mathematical creative thinking skills, although mathematics anxiety was better reduced in face-to-face classes.

In an exploratory study, Mota and Ferreira (2020) used WhatsApp as a digital tool to facilitate collaboration among students in three Portuguese secondary schools. They wanted to find out how the students used WhatsApp to communicate their mathematical ideas, difficulties, and questions, and how they obtained solutions via the WhatsApp platform. Another aim of the study was to find out how interactions within each WhatsApp group promoted student mathematics learning. An analysis of WhatsApp postings within the WhatsApp groups showed that the students used the WhatsApp digital platform to freely post their questions and doubts, and share ideas, and that these went beyond the curricular topics. The use of the WhatsApp platform resulted in better communication skills, progressive collaboration in problem-solving, and interaction through collaborative discussions to find mathematical solutions. The teacher also gained more information about the students' mathematical thinking and difficulties, enabling her to better adjust her instruction accordingly.

The above studies, among many others, suggest that PAL taking place on digital platforms such as WhatsApp is a useful approach applicable to different online contexts for improving mathematics learning outcomes. The present study was an attempt to add to the body of knowledge on PAL using WhatsApp as a teaching and learning platform among a cohort of engineering students from different socio-cultural backgrounds in the context of the COVID-19 pandemic.

Theoretical framework

This study is guided by social constructivism, exploring how students construct knowledge while interacting on the WhatsApp social media platform (Seimears et al., 2012). In the constructivist perspective of learning, the student actively takes part in constructing meaning, either individually or through the help of more knowledgeable others. A recent systematic review of literature about the use of social media for educational purposes revealed that social constructivism is one of the main theoretical approaches undergirding social media research (Al-Qaysi et al., 2020). This study employed Vygotsky's (1978) social constructivist theory's concept of the zone of proximal development (ZPD), to explain how the space between the actual and potential development level is traversed when they are provided with scaffolds or supported by more knowledgeable peers (Churcher et al., 2014; Schreiber & Valle, 2013). The DAAFLIM is also used to highlight the intra- and inter-argumentation taking place on the WhatsApp platform (George, 2021). In the case of online social platforms such as WhatsApp groups, tutors and peers can provide the necessary scaffolding for students to construct knowledge. Many studies suggest that the use of online asynchronous discussion groups, which are present in many communication platforms, results in greater opportunities for knowledge construction (Kent et al., 2016; Lai, 2015; Schellens et al., 2005; Schellens & Valcke, 2006). The processes of knowledge construction in a constructivist environment are best captured by observing, documenting, and analysing activities and interactions.

This study also employed grounded theory as a useful methodological approach to capture what is happening in the learning environment. Grounded theory is an inductive approach that permits researchers to organise data and analyse it to come up with interpretive themes emerging from the data (Thomas & Cooper, 2016). Pidgeon and Henwood (2004) highlight some key strategies for using data to generate theory. These include the development of open coding schemes to capture details of data, the use of theoretical sampling to fine-tune data, and, most especially, the use of constant comparison of data instances, cases and categories until a point of saturation is reached. Grounded theory is used to analyse qualitative data from interviews, discussions, and other qualitative data by using strategies such as open-coding techniques to capture the details of conversations. The coded text is then arranged into categories and themes by the researcher, constantly comparing data instances, cases and categories to determine if there are similarities and differences in what is known as the 'constant comparison' method (Pidgeon & Henwood, 2004; Saldaña, 2013). Grounded theory was found to be relevant because of the initial exploratory nature of this study, where no assumptions were made about the outcome before the study. Any emerging conclusions had to be derived from the data. For these reasons, we made use of grounded theory as our methodological framework.

Methodology

We made use of an exploratory case study with a mixed methods approach located within the interpretive research paradigm (Creswell, 2014). To investigate the effect of using the social media platform WhatsApp as support for an online mathematics course at the tertiary level, we chose the entry-level cohort of 180 students of the Electrical Engineering Department at a university of technology as our sample. The course was focused on standard pre-Calculus topics and Calculus. Due to COVID-19 restrictions on face-to-face lectures and tutorials, the course was conducted fully online. The official learner management platform was Blackboard Collaborate and the WhatsApp platform was an additional resource made available to the cohort.

We focused particularly on the student interaction about substantive mathematics topics such as *complex numbers* and *matrices*. The frequencies of the discussions by students on certain topics were taken one week before each assessment or assignment for three months in the study. Data that dealt with staff notices and information were excluded, except in cases where these led to mathematical discussions between peers.

The WhatsApp interactions between the students were monitored over one semester. Data collected from the student communication on the platform were initially coded by the third author and categorised in themes using a thematic analysis approach (Maguire & Delahunt, 2017). One month into the use of the WhatsApp platform, the third author started coding the data using open coding (Saldaña, 2013), with the first two research questions as a guide. Then he started arranging the codes into themes, after which he presented this initial coding to the other authors during weekly discussion meetings for their critical input. From time to time, the themes were modified after the three authors came to a consensus. This process of critically reviewing and modifying the themes continued throughout the research.

At the end of the course, the students were given a survey to find out their perceptions about the use of the WhatsApp platform as support for their learning of mathematics.

We used the survey data provided by students to answer the third research question. The third author did the coding and grouped the codes into themes and sub-themes. Then he presented the initial work to the other researchers for a critical review. After the review, they arrived at a consensus of three overarching themes, namely *participation*, *motivation*, and *utility*.

Participation referred to how frequently the students used the WhatsApp group and how frequently they offered or received help from their peers via the WhatsApp group. The *motivation* theme considered what the students enjoyed and how they felt about participating on the WhatsApp group. *Utility* dealt with the extent to which the students thought the WhatsApp group was easy to use, affordable, and useful as a source of mathematical help and information for the course.

Analysis of the data

We used Vygotsky's ZPD (Churcher et al., 2014; Schreiber & Valle, 2013) to analyse the discussions on the posts, tracking a student's post from when students asked for help to the point where they expressed satisfaction that they understood a concept that was not clear before. We also focused on the scaffolding process, where the more knowledgeable peer did not just give a solution but referred the student seeking help to some material, concept, theory, or explanation. Furthermore, we highlighted emerging patterns in the data and categorised them in terms of grounded theory.

In analysing the survey data, the column 'Not at all' on the Likert scale was eliminated because no student used it, while the columns 'Good' and 'Very good' were collapsed into one column and simply labelled as 'Good'. The frequencies in the Likert scale were transformed into percentages.

Ethical considerations

The students gave informed consent and volunteered to take part in the study. Ethical clearance to conduct this study was obtained from the Cape Peninsula University of Technology Fundani Ethics Research Committee (no. 0607/2021).

Results and discussion

Exploring the nature of WhatsApp engagement

The student engagement on the WhatsApp platform revealed certain trends. We focused on the following themes which emerged from the data:

- Theme 1: Initial request for explanation without attempts.
- Theme 2: Brief explanation or response to initial request.
- Theme 3: Follow-up on response or initial request with attempts.
- Theme 4: Elaborate explanation or response to the follow-up question or initial response.
- Theme 5: Correct, succinct solution or response to the initial request.
- Theme 6: Non-mathematics engagement.

From the total of 144 WhatsApp postings, 91 (63%) were mathematics-related postings, and 53 (37%) were non-mathematics postings. We only used mathematics-related postings for analysis and separated them into two main categories: (1) postings requesting explanation to problems, and (2) postings referring to the solution of the problems. The first main category includes Themes 1 and 3, and the second main category includes Themes 2, 4 and 5. The number of postings for the first main category was 41 postings (45%), and for the second main category was 50 postings (55%).

Further breakdown of the postings in the main categories indicates that for the first main category, there were 29 postings (32%) of Theme 1 (initial requests) and 12 postings (13%) of Theme 3 (follow-up requests). For the second main category, there were 10 postings (11%) of Theme 2 (brief responses), 13 postings (14%) of Theme 4 (elaborate responses) and 27 postings (30%) of Theme 5 (solution responses). Figure 1 illustrates the summary of the mathematics-related WhatsApp postings by the students.

The request postings of Theme 1 and Theme 3 were mainly requests for help to understand mathematics problems and follow-up requests for further clarification or understanding in cases where the initial responses were unclear. In responses to the request postings, peers uploaded solutions, and gave explanations, hints, and guidance in the response postings (Themes 2, 4 and 5). Figure 1 indicates that the number of response postings (50) were more than the request postings (45), which suggests that more students assisted peers than students requested help. Furthermore, the relatively high number of elaborated solution responses (27) compared to the brief responses (10) suggest that students did not only assist superficially but provided substantive explanations. This observation suggests that dialogical argumentation did take place during the WhatsApp communication, because the students asked for further explanations, provided

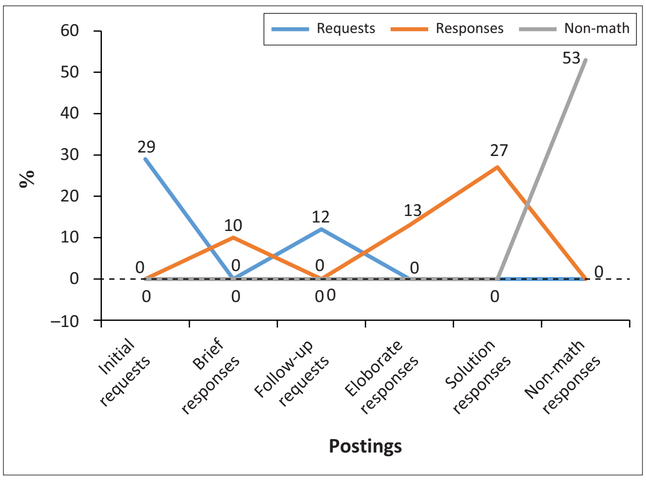

FIGURE 1: Summary of the number of mathematics-related WhatsApp postings (*N* = 144).

rebuttals, compared solutions, pointed out procedural errors, and realised their conceptual errors (George, 2021). This interaction is also supported by Vygotsky's social constructivism, where some students act as the knowledgeable others scaffolding their peers through the ZPD.

The students used the WhatsApp group throughout the day and night and tried as much as possible to respect and encourage one another. The types of mathematical areas with which students engaged included problem-solving, content knowledge and knowledge about concepts. Most often, the students focused on understanding mathematical concepts only when they wanted to solve problems for assignments, tutorials, or past questions in preparation for an approaching test or an examination. They also used the platform to exchange information about assignments, marks, tests and schedules. There was also much background noise such as uploaded animated videos and jokes. Although these posts were sometimes a distraction, there was no attempt to censor them.

The high number of non-mathematics postings (53) from most of the students indicates active participation from students who might not have contributed to the solutions of the problems. These postings consist of affirmations, encouragement, emoji pictures and motivations. Although the non-mathematics postings do not contribute directly to the solutions, they give the students the feeling that they are part of the community of practice and discourse taking place on the WhatsApp platform, which is aligned with the ubuntu philosophy principles (Scholtz et al., 2008).

Peer learning and conceptual development on the WhatsApp platform

Peer learning and conceptual development were initiated by a student requesting help to understand a particular mathematics problem. The peers responded to the appeal in various ways until the initial request was satisfactorily addressed with the correct solution, as shown below.

Requests for explanation

The students in the WhatsApp group sought assistance from their peers in mainly two ways: (1) uploading a problem without any attempt at a solution, and (2) uploading a problem with attempts to solve it. When requesting assistance according to the first way, which was mostly used (32%), students asked for help without an attempt. In Figure 2 the student asked for the solution of a complex number problem, and after a delay repeated the request.

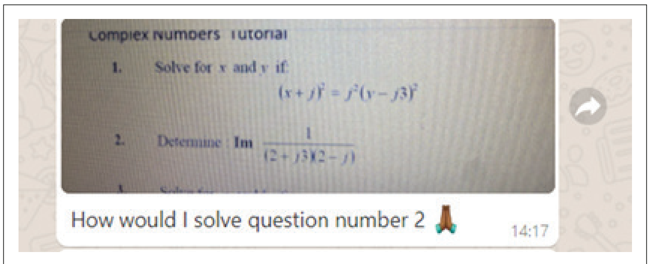

FIGURE 2: Student requesting help without posting their attempts.

In this instance, the WhatsApp interaction is of a very low level because the requester is solely depending on their peers for the solution who were hesitant to respond. This is a typical posting of Theme 1 where no construction of knowledge or conceptual development took place.

The second way of requesting assistance falls within Theme 3, where students upload a problem with attempts to solve it. In Figure 3 the requester asked peers to confirm the attempt to solve the matrix problem, and to aid.

In this instance the student showed effort to determine the transpose matrix (which was a successful attempt). The peers responded quickly to confirm her successful attempt, and some even asked for explanations. This posting demonstrates construction of knowledge and intra-argumentation, which is a result of self-directed learning, placing it on a higher level than the previous posting.

Responses to requests for assistance

The students responded to the requests for assistance in three ways: (1) brief explanation responses to initial requests, (2) elaborate explanation responses to requests, and (3) succinct correct solutions. In Figure 4 a student provides a brief explanation to a peer who requests support after

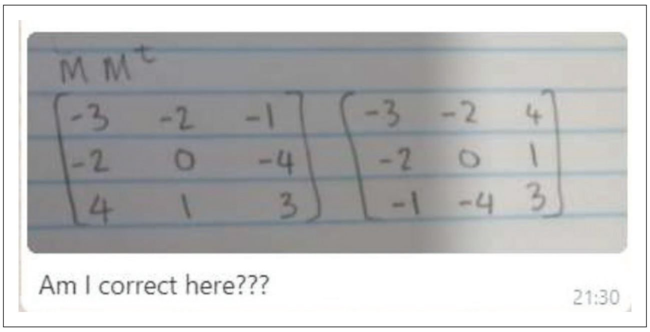

FIGURE 3: Student requesting help with an attempt.

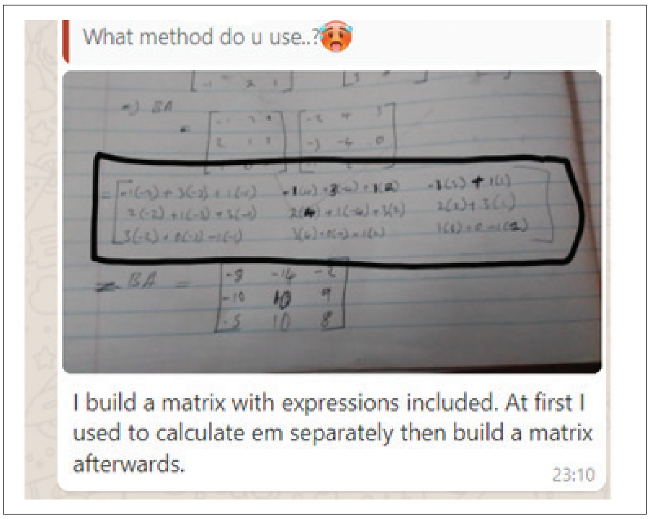

FIGURE 4: Brief response to a request with an attempt.

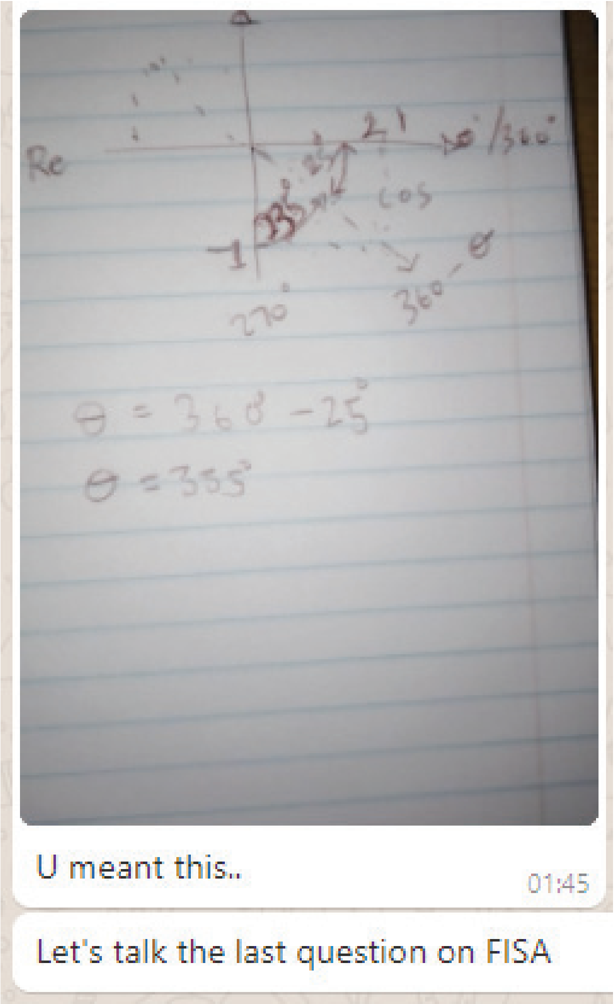

FIGURE 5: Elaborate response with sketch and calculations.

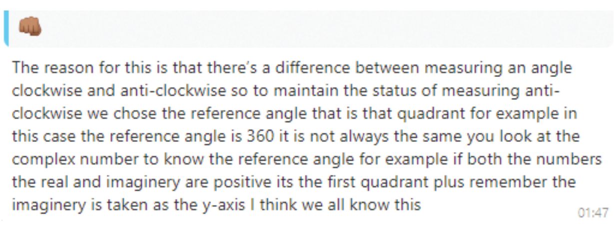

FIGURE 6: Elaborate response with text.

unsuccessfully attempting to solve the multiplication of two matrices. It is evident that the respondent does not give the solution to the problem, but useful advice to solve the problem. This is a typical case of peer learning where the respondent acts as a scaffold to move the requester to a higher conceptual level.

This WhatsApp interaction is typical of the 10 postings of Theme 2, where students provide hints and guide each other to solve the problems. This is also an increased level of conceptual development and inter-argumentation because of peer learning.

In Figure 5, Figure 6 and Figure 7 three students respond to a question about the nature of the angle of a complex number.

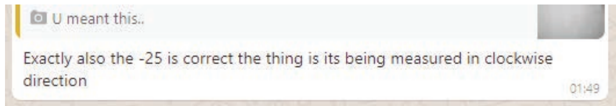

FIGURE 7: Succinct correct solution.

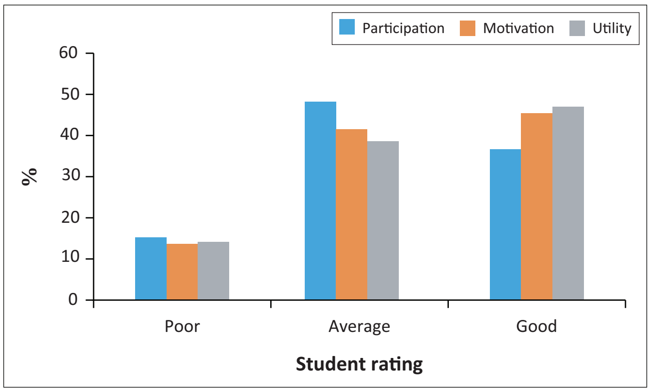

FIGURE 8: Results of end-of-course survey on the use of the WhatsApp group.

The first student gives an extended explanation by means of a sketch and calculations and relates the question and explanation to a previous final summative assessment (FISA) question. This response immediately attracts many responses from the other students, resulting in an active discourse in the WhatsApp group. The second respondent provides an elaborate explanation in text of the solution, which is aligned with Theme 4. The third respondent provides a succinct correct solution of the problem.

Boud and Sampson (1999, p. 415) opine that 'peer learning emphasises students simultaneously learning and contributing to each other's learning'. The students engaged in peer learning on WhatsApp as a method of collaboratively enhancing their knowledge. During face-to-face collaborative learning, students learn alongside each other synchronously, while on WhatsApp students learn from one another remotely, synchronously and asynchronously.

The interactions of students on WhatsApp demonstrated conceptual development, which is arguably the most substantive and important component of knowledge construction and can be considered the first step toward building theory or, when using grounded theory, second after application (Egan, 2002).

Non-mathematical communication was also evident. There were positive outcomes from this data set. For example, effective support is an important part of learning, and this was very present in student engagement.

This study showed that the use of the WhatsApp group as a platform for peer learning enabled the students to better interact with and assist one another. The use of the platform went much further than academic assistance to include motivation, corroborating many earlier studies (Duah et al., 2014; Longfellow et al., 2008; Mota & Ferreira, 2020; Nsabayezu et al., 2020).

Attitudes and perceptions of students about using WhatsApp

Affective learning gains include learning gains in attitude, confidence, enjoyment, enthusiasm for a topic, feeling comfortable with complex ideas, interest in a topic, motivation, satisfaction, and self-efficacy. The students used WhatsApp to assist each other, especially within the context of the COVID-19 pandemic, when they faced anxiety and uncertainty.

Student participation in the WhatsApp group was mostly rated as 'average' (48%) or 'good' (37%) while 15% of the students rated participation as 'poor' (see Figure 8). A more detailed analysis of the results revealed that 22% of the students rated their assistance to their peers as 'good' while 25% rated their assistance to peers as 'poor' (Figure 8). This shows that more students received help compared to the help they offered to others.

Regarding motivation, 41% of the students rated their motivation as 'average', 45% as 'good', and 14% rated it as 'poor' (Figure 8). Motivation is very important in social media participation as this could encourage the students to make more effort to work harder to understand the concepts and to pass the final examinations in the course (Gregory et al., 2014). Over 95% of the students said that the WhatsApp group made them realise they were not the only ones having difficulties with mathematics problems. Similarly, for more than 85% of the students, the WhatsApp group made them feel good as they enjoyed the interaction with their peers and knew that there was always someone to turn to when they encountered difficulties. More than 90% of the students found WhatsApp easy to use. Over 80% said it was affordable, that they used it to access information, get help beyond the course, and would like to use the WhatsApp platform again in the future (see Figure 8).

Conclusion

This case study explored the use of a social media platform, WhatsApp, as a means to improve peer learning and student support in a South African university of technology. The study documented the nature of peer-to-peer learning that took place, and how peer support contributed positively or negatively to students' conceptual understanding of the mathematics course. The results suggest that WhatsApp served as a viable and effective platform for peer-to-peer learning of engineering mathematics concepts. In addition, the study showed that non-mathematical (affective) communication was another significant factor.

This study contributes to future quantitative research that investigates student participation in the WhatsApp platform. Additionally, their participation and performance can be stratified in terms of race, gender and socio-economic background.

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Competing interests

The author(s) declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

M.S.J., F.G. and D.A. contributed to the conceptualisation, methodology, formal analysis, and writing and editing of the original draft.

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Data availability

The data that support the findings of this study are available on request from the corresponding author, M.J.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy of any affiliated agency of the authors.

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