

## Anonymous WhatsApp-based high school mathematics learning: Comparing teachers' and students' perspectives on social-emotional support

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### Abstract

This mixed-methods study examines how an anonymous WhatsApp-based mathematics learning program addresses students' social-emotional needs, comparing the perspectives of 152 students and 24 teachers participating in Israel's *Bagroup* project. This project creates nationwide WhatsApp groups of 100 previously unacquainted advanced mathematics students with one expert teacher, providing 24/7 peer and teacher support for matriculation exam preparation. Using questionnaires with Likert-scale items and open-ended questions and analyzing them through factor analysis and thematic content analysis, we identified key components supporting students' social-emotional learning (SEL): availability, accessibility, peer learning, anonymity, and immediacy. While both groups valued the platform's SEL benefits, significant differences emerged: teachers emphasized pedagogical opportunities, while students prioritized practical support and peer assistance. Anonymity features uniquely reduce mathematics anxiety by eliminating the fear of judgment. These findings indicate potentially how large-scale, anonymous digital platforms can create emotionally safe environments for mathematics learning while revealing important perception gaps between educators and learners that should inform implementation strategies.

**Keywords:** WhatsApp, social-emotional learning, availability, accessibility, peer learning, anonymity, immediacy

### INTRODUCTION

The years between 2006 and 2014 saw a sharp decline in the number of students taking advanced-level (5-unit level) mathematics matriculation exams in Israel. This decline stemmed from multiple factors: a shortage of qualified teachers, students' difficulties with advanced mathematical content, and limited supportive resources, particularly for students from lower socioeconomic backgrounds. This trend was especially troubling because success in the 5-unit level mathematics matriculation exam is crucial for admission to prestigious university programs and the inability to pass this exam subsequently affects career opportunities and earning potential (Zeedan & Hogan, 2022).

To address this challenge, a project called *Bagroup* was initiated. This innovative project leveraged WhatsApp as a supportive platform for students preparing for advanced mathematics matriculation. The project's unique feature was its national scope: each

group comprised approximately 100 students and one teacher from different schools across Israel, meaning that they had probably never met in person. Such a structure aimed to create an anonymous learning environment where students could potentially seek help without fear of judgment. The teachers used blended learning to teach various important concepts, answered questions, and oversaw the dialogues between the students regarding questions.

In this study, we adopt Garrison and Vaughan's (2008) definition of blended learning as the intentional integration of face-to-face and online instruction, where both modalities are pedagogically aligned rather than merely coexisting. The *Bagroup* project implemented this through two complementary modes:

- (1) synchronous weekly sessions where teachers conducted real-time WhatsApp lessons on selected mathematical topics, with all students participating simultaneously in structured dialogue and

### Contribution to the literature

- This study introduces the “invisible scaffolding” concept, showing how anonymous digital environments provide SEL support that operates below conscious awareness, challenging traditional models requiring explicit emotional skill development.
- It provides the first systematic comparison of teacher-student perspectives on WhatsApp-based mathematics learning in high school, addressing the scarcity of research in this age group.
- It expands Vygotsky’s zone of proximal development (ZPD) theory through the “collective ZPD” concept, where large-scale anonymous groups enable crowd-sourced scaffolding that normalizes help-seeking. It also reveals how identical technological features simultaneously serve different functions—pedagogical innovation for teachers, practical *survival for students*—requiring multi-dimensional implementation approaches.

(2) asynchronous continuous support where students posted questions at any time, receiving responses from peers and teachers.

This design ensured that WhatsApp interactions were not supplementary but integral to the learning process, with both synchronous instruction and asynchronous peer support contributing to mathematical understanding and exam preparation.

The project designers hypothesized that utilizing a social network for mathematics learning would enhance peer collaboration and enable flexibility, anytime learning. This assumption was based on research indicating that exposure to diverse peer groups could accelerate learning processes (Biton & Segal, 2021, 2024; Naidoo & Kopung, 2016, 2020; Segal & Biton, 2024) and that immediate feedback enhances understanding (Hadijah et al., 2022). Previous studies have also shown that exposure to peers’ mathematical thinking improves problem-solving skills and helps address learning difficulties (Biton & Segal, 2021; Freeman et al., 2016; Greenhow & Askari, 2017).

Furthermore, integrating learning processes into social networks aligns with contemporary educational trends. As Schleicher (2019) notes, smartphone technologies have created diverse opportunities for learning, developing critical thinking skills, and evaluating information. WhatsApp is ubiquitous among Israeli students at every socioeconomic level. A 2015 survey found that 83% of Israeli children aged 8-15 years had a smartphone, and using WhatsApp was one of their main activities (Sarid, 2015), and it probably follows that the percentage among older children would be even higher.

The present study is part of a larger study (Biton & Segal, 2024; Segal & Biton, 2024), aimed at comparing teachers’ and students’ attitudes with respect to how the *Bagroup* project supports students’ social-emotional needs while preparing for their advanced mathematics matriculation exam. The findings of this study can contribute to our understanding of how social media platforms can be effectively leveraged to support both academic achievement and social-emotional well-being in mathematics education, particularly for advanced-level students.

## LITERATURE REVIEW

### Integrating Social-Emotional Learning and Mathematics Learning

Teachers must be aware of the emotional and social aspects involved in learning, especially when learning includes utilizing social media, as this requires special focus on how to promote well-being and cultivate a safe social and emotional learning environment for their students (National Council of Teachers of Mathematics [NCTM], 2021).

It goes without saying that most students are eager to achieve high academic grades in mathematics, especially since this is widely considered a key to future success. However, to accomplish this, they must have the cognitive skills and confidence to meet the challenges of learning mathematical concepts at higher levels (Zeedan & Hogan, 2022). To this end, teachers must not only present engaging tasks and collaborative learning opportunities but also support and encourage their students and build their confidence (Wilkie & Sullivan, 2018). That is, teachers must understand the many aspects of social-emotional learning (SEL).

SEL is the development of social and emotional abilities and the skills to recognize and manage emotions. These abilities include showing empathy towards others, making responsible decisions, defining and achieving positive goals, establishing positive relationships, and being able to face challenging situations with composure (OECD, 2024). “Challenging situations” can also be related to problem-solving. SEL can be implemented in parallel with other experiential learning processes where teachers and students must exhibit self-awareness (understanding one’s own emotions and how they affect learning processes), self-management (managing one’s emotion and making conscious choices to achieve individual and group goals), social awareness (understanding and empathizing with others’ perspectives), relationship skills (being able to establish supportive relationships and effectively navigate with diverse individuals and groups), and responsible decision-making (making caring and constructive choices about personal behavior and social interactions across diverse situations)

(Collaborative for Academic, Social, and Emotional Learning [CASEL], 2020; Dusenbury et al., 2015; Sears et al., 2022; Weissberg et al., 2015).

Several factors are important for developing social-emotional skills. One is granting autonomy in learning: students who take responsibility for their understanding tend to become fully engaged in the task and grow as learners (Dusenbury et al., 2015; NCTM, 2021; Reeve, 2006). Another is requiring students to give feedback to each other, thus creating opportunities for students to develop and share their ideas (Dusenbury et al., 2015; NCTM, 2021; Safir & Dugan, 2021). A third is encouraging collaborative work and forging trusting relationships between teacher and students (Anderson, 2021; Dusenbury et al., 2015). Other factors include providing opportunities for independent work, praising and encouraging students' efforts, providing cues for further progress if a student seems stuck, and attending to students' questions and comments (Reeve, 2006; Reeve & Jang, 2006). Learners who are given the autonomy to manage and develop their learning, make their own decisions, communicate, support, cooperate with, and care for their peers will have increased motivation to continue investing efforts in learning (Deci & Ryan, 2012; Ryan & Deci, 2000).

Incorporating SEL skills into mathematics education is especially crucial due to the common negative attitudes toward the subject. Thus, teaching should be managed to develop both SEL and mathematical skills simultaneously by encouraging self-awareness and self-management. This will allow students to identify, manage, and analyze their emotions, deal with frustration, and feel comfortable seeking help when needed (CASEL, 2020, 2022; Sears et al., 2022). It will encourage clear and safe communication, critical examination of their peers' reasoning, and active engagement with the subject matter. A safe, judgment-free environment for asking questions is crucial for creating a positive learning atmosphere that supports emotional well-being, personal growth, relationship skills, and learning strategies (Rusticus et al., 2023).

SEL is closely tied to classroom mathematical discourse, which fosters active engagement with the mathematical subject matter (Joswick & Taylor, 2022; Zhu & Kaiser, 2022). It also promotes social awareness, respect toward others, and empathy, and encourages students to communicate their ideas, ask questions, and evaluate the content being studied, thus enhancing a positive, supportive classroom community (NCTM, 2021; Roche et al., 2023).

Following Vygotsky's (1978) sociocultural theory, mathematical knowledge is constructed through social interaction. The ZPD is particularly relevant in WhatsApp environments where students receive scaffolding from both teachers and more capable peers. This aligns with Sfard's (2008) commognitive

framework, which views mathematics learning as participation in mathematical discourse—a process inherently social and emotional.

Having established the importance of SEL in mathematics education, we now examine how digital platforms, particularly WhatsApp, can support these social-emotional needs.

### **Learning and Teaching via WhatsApp, a Social Network**

Social media platforms have fundamentally transformed educational communication, with WhatsApp emerging as the dominant platform in K-12 mathematics education (Boyd, 2010; Engelbrecht et al., 2020). While platforms like Instagram, Facebook, and YouTube serve various educational purposes, WhatsApp's unique combination of accessibility, ease of group management, and familiar interface has made it the preferred choice for classroom communication in many countries (Rosenberg & Asterhan, 2018; Zan, 2019).

The educational adoption of WhatsApp extends beyond organizational functions to active content delivery and pedagogical innovation (Greenhow & Lewin, 2016). In typical classroom implementations, dedicated WhatsApp groups connect students and teachers, extending learning beyond school hours and bridging formal and informal educational spaces. These groups enable message exchange, collaborative problem-solving, resource sharing, and continuous academic discourse among familiar participants.

WhatsApp offers several distinct advantages for mathematics education. First, it creates emotionally safe spaces where students can express confusion without fear of judgment, freed from traditional classroom hierarchies (Kizel, 2017). Second, it facilitates peer-to-peer knowledge sharing and enables teachers to build more personal connections with students (Bouhnik & Dshen, 2014; Greenhow & Lewin, 2016). Third, the platform's multimodal communication—text, images, voice notes—allows students to express mathematical thinking in diverse ways, potentially improving conceptual understanding (Midgett & Eddins, 2001; NCTM, 2019).

Research demonstrates that WhatsApp-mediated learning enhances student engagement, collaboration, and academic performance (Durgungoz & Durgungoz, 2022; Tong et al., 2021). The continuous availability of peer and teacher support particularly benefits students struggling with mathematics anxiety, providing immediate assistance when frustration might otherwise lead to disengagement (Nida et al., 2020).

Despite these benefits, WhatsApp-based learning presents significant challenges. The platform's chronological message format complicates tracking mathematical discussions, as solutions may be separated

from their corresponding problems (Yilmazsoy et al., 2020). Teachers must vigilantly monitor conversations to correct errors before they become misconceptions (Borba et al., 2016; Zan, 2019). Additionally, typing mathematical notations on smartphones remains problematic, potentially limiting the depth of mathematical expression.

The shift to digital communication also disrupts traditional teacher-student dynamics and requires careful management to maintain appropriate boundaries (Bouhnik & Deshen, 2014). Teachers face the additional burden of deciding when to provide direct solutions versus scaffolding support, while ensuring all students have equitable opportunities to participate in discussions (Chapin et al., 2013; Morge et al., 2020).

WhatsApp naturally supports blended learning approaches, combining online and face-to-face instruction to create rich learning environments (Borba et al., 2016; So & Brush, 2008). This integration exposes students to diverse problem-solving strategies and promotes autonomous learning skills. The asynchronous nature of WhatsApp discussions allows students to engage with content at their own pace, potentially increasing motivation and deep learning (Bahri et al., 2021; Engelbrecht et al., 2020).

While extensive research examines WhatsApp use in higher education settings with motivated adult learners (Konyefa & Nwanze, 2020; Moodley, 2019; Robinson et al., 2015), studies focusing on K-12 mathematics education remain limited. Given teenagers' ubiquitous social media use, understanding how WhatsApp-based learning supports both cognitive and social-emotional development in mathematics education is crucial. Teachers must recognize that digital platforms don't merely digitize traditional instruction but fundamentally reshape how students experience mathematical learning and peer support (NCTM, 2021).

## THEORETICAL FRAMEWORK AND CONCEPTUAL MODEL

### Integrating SEL and Mathematics Learning

This study is grounded in the intersection of SEL theory and sociocultural perspectives on mathematics education. We employ the CASEL (2020) framework's five core competencies as our primary lens for understanding SEL in digital mathematics learning environments:

- (1) **Self-awareness:** Understanding one's emotions, strengths, and challenges in mathematics learning,
- (2) **Self-management:** Regulating emotions and behaviors when facing mathematical challenges,
- (3) **Social awareness:** Recognizing and empathizing with peers' mathematical struggles,

- (4) **Relationship skills:** Building supportive connections for collaborative problem-solving, and
- (5) **Responsible decision-making:** Making constructive choices about learning engagement.

### Sociocultural Foundation

Vygotsky's (1978) sociocultural theory and Sfard's (2008) commognitive framework provide the theoretical foundation for understanding WhatsApp-based mathematics learning. Both frameworks emphasize that mathematical knowledge develops through social interaction and discourse. The ZPD manifests uniquely in WhatsApp environments, where students simultaneously receive scaffolding from teachers and peers, creating multiple layers of support for mathematical understanding.

### Digital Environments and SEL

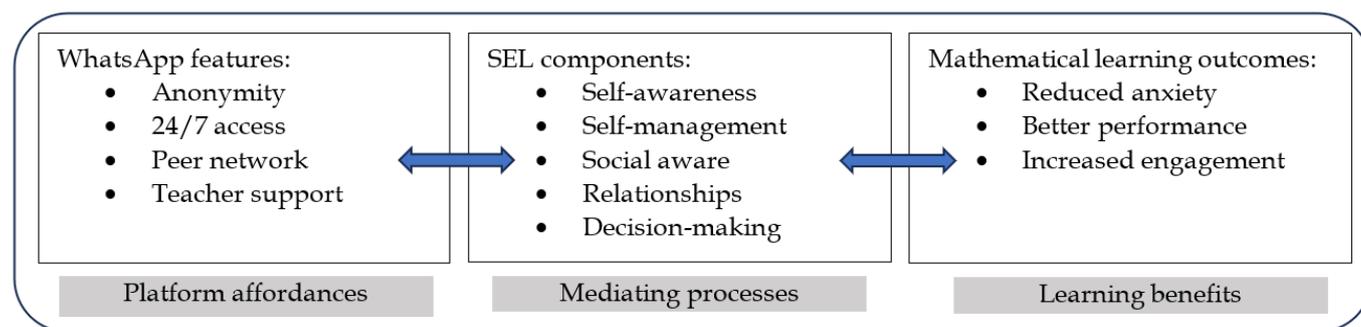
Digital platforms transform traditional SEL dynamics. Greenhow and Lewin (2016) identified that social media creates "affinity spaces" where learners connect around shared interests rather than imposed structures. In WhatsApp-based learning, three unique features influence SEL: temporal flexibility, 24/7 availability that reduces anxiety about time-limited help, anonymity that removes social hierarchies and fear of judgment, and multimodal communication, which supports diverse expression methods (text, voice, images).

### Proposed Conceptual Model

Based on the integration of the CASEL framework with sociocultural learning theory and digital affordances literature, we propose a conceptual model that illustrates the theoretical pathways through which WhatsApp-based mathematics learning supports students' social-emotional needs (Figure 1).

This model hypothesizes that WhatsApp's technological features create conditions that support SEL components, which in turn mediate mathematics learning outcomes. The model guided our research questions (RQs) and analytical framework, helping us identify which aspects to examine in both teachers' and students' perspectives. The model conceptualizes learning in the *Bagroup* project as a three-stage process:

1. *WhatsApp platform features provide unique affordances:* According to our conceptual model, the anonymity feature may help diminish social hierarchies and alleviate fear of judgment that often inhibits participation in traditional classroom settings (Kizel, 2017). The 24/7 accessibility may facilitate that support is available when students need it most, during homework completion or exam preparation,



**Figure 1.** Conceptual model of WhatsApp-based mathematics learning and SEL integration (Adapted from Biton & Segal, 2024; CASEL, 2020, 2022; Segal & Biton, 2024)

rather than being limited to school hours. The large-scale peer network (100 students per group) creates a diverse learning community where students are exposed to multiple problem-solving approaches and perspectives.

2. *These features activate and support SEL processes:* Anonymity fosters *emotional safety*, allowing students to express confusion or ask “basic” questions without embarrassment, thereby developing self-awareness about their learning needs. The continuous availability supports *self-management* by enabling students to regulate their learning pace and seek help when frustration arises, rather than abandoning difficult problems. The peer network facilitates *social learning* through observing others’ mathematical thinking, recognizing shared struggles, and developing empathy, key components of social awareness and relationship skills.
3. *Enhanced SEL processes lead to improved mathematics learning outcomes:* When students feel emotionally safe, they are more likely to engage with challenging mathematical content, leading to reduced mathematics anxiety. Improved self-management skills enable persistence through difficult problems, contributing to better academic performance. The social learning dimension increases engagement and motivation through peer support and collaborative problem-solving.

While our conceptual model (Figure 1) could potentially apply to other subjects, mathematics learning presents unique characteristics that make this SEL-digital integration particularly critical: First, mathematics anxiety affects 20-25% of students (Barroso et al., 2021), substantially higher than in other subjects. The abstract, hierarchical nature of mathematics means emotional blocks can completely prevent problem-solving, unlike subjects where partial engagement remains possible. Second, mathematical errors compound if not immediately corrected, making the WhatsApp platform’s immediacy and peer correction mechanisms vital. Third, digital mathematical communication requires specialized notation (fractions,

exponents, symbols) that standard keyboards cannot easily produce. This technical barrier, combined with embarrassment about notation errors, makes anonymity’s emotional safety particularly crucial. The relationship between SEL components and mathematical outcomes is uniquely tight. Reduced anxiety directly enables problem-solving capability (Ashcraft & Moore, 2009). While core model elements (anonymity, 24/7 availability, and peer networks) could benefit other subjects, mathematics’ specific combination of high anxiety rates, notation challenges, and hierarchical knowledge structure makes this SEL-digital integration especially necessary for mathematics education.

#### *Bidirectional relationships and feedback loops*

While the model presents a linear progression for clarity, we acknowledge bidirectional relationships. For instance, reduced anxiety may encourage greater platform participation, creating a positive feedback loop. Similarly, improved performance may enhance emotional safety and willingness to help peers. This conceptual model guided this research in several ways:

1. **RQ formulation:** We examined both teachers’ and students’ perceptions of how platform features support SEL components (RQ1) and compared their perspectives (RQ2).
2. **Instrument development:** Our questionnaire items were designed to capture elements from each level of the model—platform features (e.g., “The anonymity of WhatsApp allows participation without fear”), SEL processes (e.g., items about emotional support and peer learning), and outcomes (e.g., reduced anxiety, improved understanding).
3. **Analytical framework:** The model provided categories for organizing our qualitative analysis and interpreting the relationships between quantitative findings.
4. **Interpretation lens:** The model helps explain why certain features were valued differently by teachers and students—they may focus on different

stages of the process or perceive different connections between components.

By grounding our investigation in this conceptual model, we aim to move beyond descriptive accounts of WhatsApp use in education toward a theoretically informed understanding of *how* and *why* digital platforms can support both the cognitive and social-emotional dimensions of mathematics learning. This framework also enables the identification of where teachers' and students' perceptions align or diverge, providing insights for optimizing the implementation of similar digital learning initiatives.

## METHODS AND MATERIALS

This study employed a concurrent mixed-methods design (Creswell & Plano Clark, 2017), collecting quantitative and qualitative data simultaneously through questionnaires to provide complementary perspectives on the same phenomenon. This design was chosen to capture both the breadth of participants' attitudes (quantitative) and the depth of their experiences (qualitative).

### Context: The *Bagroup* Project

The *Bagroup* project was originally initiated in 2014 in Israel by the Ministry of Education and the Center for Educational Technology as a response to the sharp decline in the number of high school students opting to matriculate in mathematics at the highest level. Leveraging social media's potential to offer a unique extra-classroom learning environment, its aim was to help high school students preparing for their mathematics matriculation (*Bagrut*) exams deepen their mathematical knowledge and improve their performance (Biton et al., 2014; Biton & Segal, 2021). Groups focused on specific parts of the five-unit-level math curriculum, complementing students' regular school classes. Although it began in the Facebook environment, in 2016 it was adapted for use on WhatsApp. The project creators hoped that providing students with the opportunity to address any difficulties and frustrations that came up while preparing for the exam, with access to professional support outside of school hours, would encourage more students to aim for this goal.

To this end, three months before the matriculation exams, a call goes out across the country, both over social networks and from school principals, inviting students studying advanced (fifth level) mathematics to "sign up" for this program that offers anonymous, 24/7 access to expert teachers and diverse peers nationwide. This study examines the cohort that participated in 2018.

To address the documented risks of online disinhibition (Suler, 2004), the project implemented comprehensive safeguarding measures. The *Bagroup* project's anonymity was carefully engineered through

strategic group composition. Groups were deliberately constructed with no more than ten students from any single high school among the 100 participants, ensuring true anonymity where students could not identify peers based on familiar names or local contexts, and the teachers also had no information about the students' academic abilities or what school they attended. This "distributed anonymity" design prevented the formation of pre-existing social hierarchies that could enable targeted harassment. Before joining the project, all students explicitly agreed to behavioral standards that required respectful interaction with peers and teachers, along with clear consequences for violations, and immediate removal from the group. This established what Postmes et al. (1998) identify as crucial group norms for positive anonymous interactions. Moreover, this proactive approach to managing anonymity's risks while preserving its benefits represents a critical design feature that enabled the positive outcomes reported by both teachers and students.

### Participants

#### *Students*

Approximately 4,000 fifth-level students (out of a total of 18,394) responded to the call. The administrative coordinator, alongside a team of experts, divided them into about 40 groups, each comprising one teacher and about 100 students. The makeup was such that within each group, there were no more than ten students from any one school. This ensured a heterogeneous country-wide population and, more importantly, an opportunity to remain anonymous: students did not personally know their peers, and the teacher also had no information about the students' academic abilities nor which school they attended (these proved both an advantage and a disadvantage, to be discussed later).

While approximately 4,000 students participated in the 2018 *Bagroup* cohort, only 152 (approximately 3.8%) responded to our questionnaire. This low response rate introduces potential self-selection bias, as responding students may represent those with particularly positive or negative experiences rather than typical participant. Thus, our findings should be interpreted as reflecting the experiences of engaged participants willing to provide feedback, not necessarily the entire student population.

#### *Teachers*

The teachers, 40 in all, were selected based on recommendations of mathematics pedagogical instructors. All had at least five years of experience teaching mathematics. The teacher monitored the group to ensure consistency, but most of the learning was peer-to-peer.

Also included were pedagogical coordinators, who monitored the groups (with the assistance of additional

teachers) to address any specific challenges and an administrative coordinator, who managed the technological side of the project (alongside a team of experts).

Note that participation in *Bagroup* did not negate attendance in the students' and teachers' regular school classes, meaning that students had two "sets" of classmates: those they knew in school and those they did not know in *Bagroup*.

### Teaching and Learning Process

The *Bagroup* project incorporated blended learning and SEL principles. It offered the advantages of

- (1) **mobile learning** (the smartphone supplemented classroom instruction anywhere and anytime),
- (2) **equality** (anyone with a smartphone could access the free WhatsApp technology and receive educational support without the need for expensive after-school tutors),
- (3) **immediacy** (interaction was not time-dependent),
- (4) **variety** (exposure to numerous learning and problem-solving methods), and
- (5) **encouragement** (peers and teachers helped strengthen understanding, capability, and self-confidence).

The groups operated on two levels. The first was to have the teachers available to assist students. The students could post any difficulties they had solving mathematical problems at any time of the day and receive suggestions from their peers on how to tackle them. Indeed, the bulk of the discourse comprised questions, responses, solutions, scholastic content, and explanations from the students and ran to hundreds of thousands of messages.

The second was having the teachers offer synchronous and nonsynchronous lessons. The synchronous learning program for each group was designed by the pedagogical coordinator, who created the syllabus and located appropriate digital teaching material such as PowerPoint presentations, ready-made widgets to illustrate mathematical concepts, information pages, worksheets, and more. Teachers could also add their own material. Each topic consisted of two or three 45-minute-long lessons presented by the teacher (one lesson per day) alongside questions and problems that were to be solved within the group. The teacher announced the time that the lesson would take place, and the students were expected to attend the chat in "real-time" when the teacher presented the material, asked for feedback, and responded.

For nonsynchronous learning, the teacher presented information or relevant links for the students to access at their convenience. This was often based on a question submitted by a student. Thus, learning was continuous

(24/7) and facilitated by text messages, voice messages, photos, videos, problem sets, presentations, and more.

### RQs

- RQ1.** How do students and teachers perceive the role of WhatsApp-based mathematics learning in addressing students' social-emotional needs?
- RQ2.** What are the similarities and differences between teachers' and students' perspectives on these SEL needs?

### Data Collection

#### Questionnaires

The questionnaires were distributed to all the teachers and students who participated, of which 152 students (grade 11 and grade 12) and 24 teachers responded. Nonprobability sampling was based on students' availability and willingness to reply to the questionnaire. The questionnaire provided for both qualitative and quantitative data; it comprised 16 Likert-type statements (scored from 1, do not agree, to 6, completely agree). Examples of quantitative data items are presented in tables, including statements about anonymity benefits ("the anonymity of WhatsApp allows participation without fear of embarrassment from making errors"), learning effectiveness ("I managed to understand/explain the material in the WhatsApp environment"), and platform preferences ("the written discourse in WhatsApp is preferable over the verbal discourse in a regular class"). In addition, the questionnaire contained 14 open questions where the respondents could elaborate on why they scored the statements as they did and present relevant examples or explanations for three statements of their choosing. It allowed the respondents to express ideas that were not necessarily specifically mentioned in the statement section of the questionnaire. Examples of quantitative data items: "present three advantages of learning via WhatsApp in the *Bagroup* project" (both teachers and students); "present three disadvantages of learning via WhatsApp in the *Bagroup* project" (both teachers and students); "how did you handle inactive students in the group and during lessons?" (teachers only); "How did you manage highly active and strong students who consistently answered exercises first?" (teachers only); "how did you cope with active and strong students who were always first to respond to the teacher's exercises?" (students only). These open-ended questions allowed participants to elaborate on their Likert ratings and express perspectives not captured by the structured items, providing rich qualitative data about their experiences with the platform's SEL dimensions.

The questionnaire was designed by five experts in mathematics education who also ascertained the validity of its structure and content. Items for which at least four

of the judges agreed on the wording of the items were selected.

### Data Analysis

Data analysis employed a mixed-methods approach combining quantitative analysis of Likert-scale items with qualitative thematic analysis of open-ended responses (Braun & Clarke, 2006). The qualitative coding framework was developed deductively from CASEL’s (2020) five SEL competencies: self-awareness, self-management, social awareness, relationship skills, and responsible decision-making, and then refined inductively through initial data analysis. Each competency was operationalized into specific codes (e.g., recognition of learning difficulties, frustration regulation, peer support). Three independent coders applied this framework to all qualitative responses, achieving 88% inter-rater reliability, with discrepancies resolved through discussion until consensus was reached. The coding process revealed systematic linguistic differences between teachers and students, with students using concrete, personal language (“I felt less anxious asking anonymously”) while teachers employed pedagogical terminology (“students developed empathy through observing peer struggles”), a pattern that informed subsequent interpretation of perception gaps.

## RESULTS

The results are organized in three sections: quantitative findings on SEL support components, qualitative themes regarding perceived advantages, and an integrated analysis comparing both perspectives against our conceptual model.

### Quantitative Findings: SEL Support Components

Factor analysis of the Likert statements revealed that five items ( $\alpha = .79$ ) load strongly on a single factor representing “SEL support through WhatsApp”. Both teachers (mean [M] = 3.56, standard deviation [SD] = 0.89) and students (M = 3.51, SD = 1.15) reported

moderate to positive perceptions of SEL support from both groups, with minimal variation between them. However, examination of individual components revealed notable variations (Table 1). The highest-rated component for both groups was “understanding/explaining material” (students: M = 3.84; teachers: M = 3.33), while the lowest was “preference for written discourse” (students: M = 2.80; teachers: M = 2.50).

For ease of presentation, the original six Likert scores were reduced to three levels: disagree (all answers originally scored as “1”), somewhat agree (all answers originally scored as “2” or “3”), and agree (all answers originally scored as “4,” “5,” or “6”) (Table 2).

Most notably, 70.8% of teachers strongly agreed that written discourse was preferable, compared to only 28.3% of students. Another difference was with respect to how easy it was to “following the lesson”. Here, 100% of the teachers were at least somewhat satisfied, but 13.8% of the students maintained that they could not follow the lessons easily. However, note that for the teachers, this concerns tracking the students’ progress, which they managed to do without difficulty, but for the students, this concerns following the information regarding the lesson.

### Qualitative Findings of Perceived WhatsApp’s Advantages

Analysis of open-ended responses revealed distinct patterns in how teachers and students conceptualized the advantages of WhatsApp-based mathematics learning. While both groups identified similar broad categories, their emphasis and interpretations differed significantly.

Analysis of the Likert-style statements restricted us from fully understanding the participants’ feelings regarding the *Bagroup* project; an analysis of the responses to the open-ended questions allowed us to ascertain what they thought were the key advantages and disadvantages in their own words. The teachers and students differed in what they considered the

**Table 1.** Ms and SDs of the five major factors that contribute to learner’s emotional needs as reported by students and teachers who participated in the *Bagroup* project

Statement	M (SD)	
	Students	Teachers
Learning through WhatsApp allowed me/my students to meet the specific needs as a learner/student more than in a regular classroom.	3.72 (1.61)	4.04 (1.20)
The written discourse in WhatsApp is preferable over the verbal discourse in a regular class.	2.80 (1.53)	2.50 (1.41)
The anonymity of WhatsApp allows participation without fear of embarrassment from making errors.	3.73 (1.68)	4.14 (1.39)
I managed to understand/explain the material in the WhatsApp environment at the same level as in a regular class.	3.84 (1.30)	3.33 (1.05)
I managed to follow the lesson during the WhatsApp discourse/I managed to track the students’ progress.	3.46 (1.65)	3.83 (1.17)
<b>Overall results</b>	<b>3.51 (1.15)</b>	<b>3.56 (0.89)</b>

Note. N = 152 for students & N = 24 for teachers

**Table 2.** Comparison of the percentage of respondents with respect to levels of agreement regarding five major factors that contribute to learners’ emotional needs

Statement	S/T	Score (% of respondents)		
		High	Medium	Low
Learning through WhatsApp allowed me/my students to meet the specific needs as a learner/student more than in a regular classroom.	S	53.9	35.6	10.5
	T	25.0	37.5	37.5
The written discourse in WhatsApp is preferable over the verbal discourse in a regular class.	S	28.3	45.4	22.3
	T	70.8	25.0	4.2
The anonymity of WhatsApp allows participation without fear of embarrassment from making errors.	S	55.3	32.3	12.5
	T	37.5	58.3	4.2
I managed to understand/explain the material in the WhatsApp environment at the same level as in a regular class.	S	59.9	35.5	13.8
	T	54.5	45.5	0.0
I managed to follow the lesson during the WhatsApp discourse/I managed to track the students’ progress.	S	48.7	37.5	13.8
	T	70.8	29.2	0.0

Note. S: Student & T: Teacher

**Table 3.** Advantages of using WhatsApp in learning and teaching mathematics according to students and teachers (ranked in descending order according to the teachers)

	Students		Teachers	
	F (n)	P (S)	F (n)	P (T)
Availability for teachers and students	65	43	21	88
Accessibility/distribution & quick response/simplicity/convenience	40	26	20	84
Peer learning/dialogue, encouraging discourse	16	11	15	62
Support from a teacher/personal attention from a caring teacher who can efficiently explain	25	16	7	29
Different/good learning experience	-	-	5	21
Anonymity	-	-	4	17
Mutual help	59	39	-	-
Immediacy	40	26	-	-
Possibility to return to the contents at any time	31	20	-	-
Exposure to a variety of solution methods	21	14	-	-
Group size	-	-	18	12

Note. N = 152 for students; N = 24 for teachers; F: Frequency (n); P (S): Percentage (%) of students; & P (T): Percentage (%) of teachers

best/worst advantages/disadvantages, as can be seen in **Table 3**, where we list statements that at least four teachers and/or 16 students mentioned.

Note that both teachers and students cited “availability for teachers and students” as the foremost advantage of the *Bagroup* project, although there is a large difference regarding the percentage of each who noted this. Other factors show different levels of importance for each group, and some factors are entirely absent from one or the other.

Notably, while students rated anonymity highly in quantitative items (M = 3.73), none used the word “anonymity” in their open-ended responses. Instead,

they described its effects: “I can ask things I’d never ask in class”; “No one knows who I am, so I’m not embarrassed”, and “it’s easier when you’re just another person in the group.” In contrast, 17% of teachers explicitly discussed anonymity’s importance: “the anonymity encourages students to ask questions without fear of judgment.”

### Qualitative and Quantitative Data Combined

To better understand the differences in how teachers and students appreciated the program, **Table 4** presents and compares the actual statements given for the various advantages in order of prioritization for the teachers.

**Table 4.** Comparison of statements regarding aspects mentioned in open-ended questions

Aspect	Students		Teachers	
	Sample statements	P (%)	Sample statements	P (%)
Availability	[It’s the] ability to be in class anywhere.	43	The app is always available for students to receive help beyond class time, even at unusual hours.	88
	WhatsApp is very popular among teenagers, so making it a mathematical learning tool is fitting. This makes learning mathematics accessible at any given moment.			
	The answers given by the other students are always available.		Students have access to all the explanations and materials that their peers have shared.	
	You can ask questions wherever you are.			

**Table 4 (Continued).** Comparison of statements regarding aspects mentioned in open-ended questions

Aspect	Students		Teachers	
	Sample statements	P (%)	Sample statements	P (%)
Accessibility / fast response/ simplicity/ convenience	<p>The phone is always with you.</p> <p>You can participate in lessons even while traveling. You don't necessarily have to be at home.</p> <p>You can study at any time you want, send questions that students will see and answer.</p> <p>Using WhatsApp is very convenient because there are various options to upload any type of information such as voice recordings, written messages, photos or videos, and more.</p>	26	<p>Accessibility to students allows teaching them anywhere and anytime.</p> <p>... even on weekends and holidays.</p>	84
Peer learning/ dialogue that encourages discourse (termed "mutual help" by the students)	<p>Students in the group help each other solve exercises, which is excellent.</p> <p>There's always someone to help you, even outside school hours.</p> <p>You can ask a question, and other group members answer it.</p> <p>When I answer other students, it also helps me practice and exposes me to other problems.</p>	39	<p>There is identification with group members.</p> <p>The group is active all the time, so there is always discourse between students regarding every question.</p> <p>The group includes many peers, enabling brainstorming by everyone, thus exposing new and elegant problem-solving methods.</p>	62
Anonymity		0	<p>The anonymity encourages the students to ask questions without fear of judgment from either the teacher or other students.</p> <p>The students feel more comfortable asking basic questions that they might feel embarrassed about asking in a classroom situation.</p> <p>Students participate without worrying what others will think, because the others don't know who they are.</p>	17
Immediacy	<p>You can get an immediate response, thus having the opportunity to reduce learning gaps.</p> <p>We can get a quick response to every question. This reduces frustration and motivates you to practice more.</p>	26		0
Support from teacher/ personal attention from teacher/ good explanations from teacher	<p>The teacher took special notice of me and made a point of asking me if I understood. This made me feel outstanding and motivated me to continue.</p> <p>The teacher gave explanations that helped me understand the topic of probability, which I found very difficult.</p> <p>The teacher took a personal interest in me to asked if I needed more help. This really increased my motivation to try.</p> <p>When you see that a teacher really cares about you, you want to invest more of yourself to succeed.</p>	16	<p>At the beginning, some of the students tried to contact me privately because they were embarrassed to ask their questions in the group.</p> <p>The students knew that the teacher is here for them and wouldn't leave them "dangling" without an answer to their question.</p> <p>In the <i>Bagroup</i>, the students are exposed to explanations that might differ from what their class teacher gave.</p> <p>This helps some of them to better understand the topic.</p> <p>In the <i>Bagroup</i> I am more empathetic and patient, even when a student asks a very basic question.</p>	29

**Table 4 (Continued).** Comparison of statements regarding aspects mentioned in open-ended questions

Aspect	Students		Teachers	
	Sample statements	P (%)	Sample statements	P (%)
Possibility to return to the contents at any time	You can view lessons and explanations anytime.	20	You choose if and when to participate.	0
	Questions and answers are available all the time.			
	You can save messages and read them when convenient.			

**Table 5.** Integration of quantitative and qualitative findings by conceptual model components

Model component	Quantitative finding	Qualitative theme (teachers)	Qualitative theme (students)
Platform features	Anonymity	M = 3.73	“Reduces judgment fear”
	24/7 access	M = 3.72	“Always available” (88%)
SEL processes	Emotional safety	55.3% high agreement	“Safe environment”
	Self-management	M = 3.46	“Track progress”
Outcomes	Reduced anxiety	$\chi^2$ significant	“Students are more confident”
			“Less stress”

Note that the teachers focused more on pedagogical possibilities and availability, while students emphasized practical benefits and peer support opportunities.

### Chi-square analysis

A chi-square analysis revealed significant disparities in how teachers and students perceived three key aspects of WhatsApp-based mathematics learning.

Teachers showed substantially higher recognition of the benefits of **availability** compared to students (88% vs. 43%,  $\chi^2 = 18.29$ ,  $p < .000$ ), suggesting that teachers may place greater value on the extended teaching opportunities the platform provides.

A similar difference was also noticeable with respect to the benefits of **accessibility** (84% vs. 26%,  $\chi^2 = 11.66$ ,  $p < .001$ ), with teachers emphasizing the pedagogical advantages and students focusing on convenience aspects.

Finally, teachers emphasized the aspect of **peer learning** more than students (62% vs. 39%,  $\chi^2 = 25.83$ ,  $p < .000$ ). Here, we included statements in which students used different terminology, such as “mutual help”. These statistical differences highlight important gaps between teacher and student perspectives on WhatsApp’s educational utility, suggesting potential areas for alignment in implementation strategies and expectations.

**Table 5** shows the integration of quantitative and qualitative findings by conceptual model components.

## DISCUSSION

This study examined how anonymous WhatsApp-based mathematics learning supports students’ social-emotional needs by comparing teachers’ and students’ perspectives. Our findings contribute to understanding how digital platforms can support SEL in mathematics education, while revealing critical perception gaps that have important theoretical and practical implications.

### Divergent Conceptualizations of Platform Affordances

#### The availability-accessibility-immediacy triad

Teachers valued availability (88%) and accessibility (84%) significantly more than students (43% and 26%), viewing these as pedagogical opportunities for extended teaching. Students, however, uniquely emphasized immediacy (26%), a dimension absent from teachers’ responses. This tripartite distinction extends previous work (Durgungoz & Durgungoz, 2022; Engelbrecht et al., 2020) by demonstrating that: availability (24/7 access) may provide emotional security through guaranteed support, accessibility (multiple engagement pathways) reduces participation barriers, and immediacy (rapid response) prevents frustration accumulation. This finding suggests reconceptualizing digital support not merely as extended traditional support, but as a qualitatively different intervention that prevents rather than remedies frustration.

#### Peer learning vs. mutual help

The linguistic divergence between teachers’ “peer learning” (62%) and students’ “mutual help” (39%) reveals fundamentally different conceptualizations of collaborative support. Teachers frame peer interaction through pedagogical lenses, emphasizing knowledge construction and diverse problem-solving exposure. Responding students in our sample experienced it as survival solidarity, practical assistance in managing academic demands.

This extends Nida et al.’s (2020) findings by suggesting that effective peer support operates simultaneously at multiple levels: pedagogical (as teachers perceive) and practical (as students experience). The *Bagroup’s* success may stem from supporting both dimensions without requiring explicit acknowledgment of either.

## The Paradox of Invisible Support Structures

### *Anonymity as unconscious scaffolding*

The striking disconnect between students' high anonymity ratings ( $M = 3.73$ ) and their failure to name it explicitly reveals an intriguing phenomenon. As shown in our results, responding students described experiencing the benefits of anonymity, without using the word itself. This suggests that for engaged participants, anonymity may function as what we term 'invisible scaffolding', essential support that operates below explicit awareness. This finding extends Kizel's (2017) work on safe digital spaces by demonstrating that effective SEL support may not require conscious recognition. The *Bagroup's* nationwide scale ensured true anonymity (unlike classroom WhatsApp groups), potentially creating conditions where emotional safety became an environmental rather than a negotiated condition. However, we acknowledge this interpretation applies only to our sample.

Furthermore, our findings challenge the assumption that anonymity inevitably leads to toxic online behavior (Suler, 2004). The virtual absence of hostile interactions despite complete anonymity suggests that careful structural design, distributed group composition, and explicit behavioral contracts can harness anonymity's benefits for reducing mathematics anxiety while preventing its potential harm. This aligns with Postmes et al.'s (1998) argument that context and norms, rather than anonymity itself, determine behavioral outcomes in digital environments.

### *Written discourse and learning management*

The stark disagreement about written discourse (teachers 70.8% vs. students 28.3%) reveals competing affordances of text-based mathematics communication. Teachers value the permanent record for progress tracking and reflection, while students struggle with mathematical notation constraints. This finding aligns with Robinson et al. (2015) and Yilmazsoy et al. (2020) regarding the challenges of text-based mathematical expression. However, this challenge may inadvertently support SEL by forcing students to articulate confusion precisely, developing metacognitive awareness. Future implementations should explore multimodal solutions that preserve teachers' tracking needs while reducing students' expression barriers.

One final aspect that showed a large gap between teachers and students concerns the effectiveness of learning management and monitoring progress, with over 70% of teachers strongly agreeing that WhatsApp allows them to effectively track student progress. However, only about half of the students felt they were able to follow the lessons effectively. This gap aligns with the findings of Kaliyadan et al. (2016), who investigated the challenges involved in monitoring

student progress, and also supports the observations of Borba et al. (2016) about the perspectives of different stakeholders on learning management.

## Theoretical Implications

### *Extending the CASEL framework for digital contexts*

Our findings suggest that CASEL's (2020) SEL framework requires adaptation for anonymous digital environments. Traditional SEL models assume face-to-face interaction where emotional support emerges through interpersonal relationships. The *Bagroup* experience of our respondents suggests that SEL can potentially be structurally embedded through platform design, anonymity is designed to support emotional safety, scale guarantees peer support, and synchronicity enables self-management.

This structural embedding of SEL represents a paradigm shift from relational to environmental support, suggesting new pathways for addressing mathematics anxiety in students who struggle with traditional interpersonal support seeking.

### *Reconceptualizing the ZPD*

The *Bagroup's* 100-student groups create what we term as "collective ZPD", where scaffolding emerges from someone within the group who can provide appropriate support. Unlike traditional ZPD with identified more-capable peers, the "collective ZPD" operates through crowd-sourced scaffolding where help-seekers remain anonymous while help-providers gain recognition. This extends Vygotsky's (1978) framework by demonstrating how digital scale can restructure fundamental learning dynamics, creating conditions where help-seeking becomes normalized through statistical inevitability rather than interpersonal negotiation.

### *Framework for implementing protected anonymity in digital education*

The *Bagroup's* success in preventing negative anonymous behaviors while maintaining SEL benefits offers a replicable model for large-scale digital learning initiatives:

1. **Structural anonymity:** Limiting same-school representation prevents offline relationship dynamics from infiltrating online spaces
2. **Explicit contracting:** Pre-participation agreements establish behavioral expectations and consequences
3. **Swift enforcement:** Immediate removal for violations maintains group norms and psychological safety.

These design principles demonstrate that anonymity's documented risks (Biton & Segal, 2025;

Segal & Biton, 2025; Suler, 2004;) can be effectively managed without sacrificing its benefits for emotional safety and participation equality.

Finally, the model, while developed for mathematics education, may offer insights into other subjects where emotional barriers impede learning. However, the confluence of mathematics anxiety, notation challenges, and the need for immediate error correction makes the SEL-digital integration especially critical in mathematics contexts.

### Limitations and Future Directions

While the results of this study indicated that both teachers and students appreciated the *Bagroup* format, the study sample size may hinder the actual understanding of the overall impressions. With respect to the teachers, more than half responded, so the results may furnish a reliable indication of teachers' feelings. However, only a small percentage of students responded to the questionnaire, compromising the validity of the results and suggesting a need for larger-scale validation whereby all the participants are motivated and/or required to give feedback about the program.

Future research might examine the long-term impact of the *Bagroup* project on student achievement, including objective SEL measures beyond self-report, and examine optimal group sizes for balancing anonymity with community.

In addition, future research might explore how the model presented in **Figure 1** adapts across disciplines, identifying which components remain universal and which require subject-specific modifications. For instance, language learning might benefit similarly from anonymity (reducing pronunciation embarrassment), while science subjects might leverage peer explanations of abstract concepts.

### CONCLUSION

Our findings suggest that for engaged participants, large-scale anonymous WhatsApp groups may create unique conditions for supporting mathematics students' social-emotional needs through fundamentally different lenses. Most significantly, the findings reveal that some of the most powerful SEL supports may operate below conscious awareness, challenging traditional approaches that emphasize explicit emotional skill development. As education increasingly incorporates digital platforms, understanding these complex dynamics becomes essential for designing interventions that support both learning and well-being.

This study provides insights into how engaged participants in WhatsApp-based mathematics learning perceive SEL support, based on responses from 152 students (of approximately 4,000 participants) and 24 teachers who chose to share their experiences. While

these perspectives offer a valuable understanding of potential benefits, we cannot claim these findings represent all participants' experiences. The voluntary response sample likely overrepresents engaged and satisfied users.

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