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Chapter

Learning and Teaching Mathematics with Online Social Networks: The Case of Facebook

Yaniv Biton and Ruti Segal

Abstract

We present here a study in which a digital-based communication platform is used for collaborative work in the learning and teaching processes. In this case, we focused on Facebook as the online social network to help motivate high-school students to become well prepared for their Bagrut (matriculation) exam in mathematics. To this end, the Center for Educational Technology (CET) established a "virtual review session" on Facebook before the exam in which 614 students and 16 teachers participated. We aimed to answer two questions: what learning and teaching opportunities can Facebook offer to prepare students for the mathematics matriculation exam? and how do students and teachers perceive learning processes via social networks? Our analysis was qualitative. The findings indicate that Facebook, for one, can offer excellent learning and teaching opportunities as a result of the interactions that evolve between the students themselves and between the students and teachers. For the students, this digital social platform helps promote peer evaluation, exposes them to a wide range of questions and solutions, and fosters the development of mathematical thinking and creativity. For the teachers, it helps expand their technological and pedagogical-mathematical knowledge.

Keywords: online social network, Facebook, peer evaluation, technological knowledge, pedagogical knowledge, TPACK, mathematics teaching

1. Introduction

Social media has changed the way we consume information, produce and share data, communicate, and think. The use of online social networks by students has grown dramatically in the last decade [1–5] and many studies have investigated the potential of social media to extend learning beyond the traditional classroom (see, e.g. [2, 6, 7]. This is also true in the field of mathematics, where social media has been found to facilitate learning [8] and where both teachers and students perceive learning via social media to be innovative and collaborative [9].

In this study, we investigated what opportunities for learning and teaching could be created using Facebook to help students prepare for the final secondary-school Bagrut (matriculation) exam in mathematics. We initiated a group on Facebook that included a four-day online review project launched by the Center for Educational Technology during which students presented problems with which they were having problems. We applied a qualitative research model to analyze the

instructional interaction between the teachers and students and to determine what learning opportunities were created. Later, we examined the viewpoints of students and teachers who took part in the study group.

2. Theoretical framework

2.1 Integrating online social networks in learning processes

The potential of online social media for improving collaborative learning among students has been widely reported. These environments facilitate different kinds of learning opportunities and collaboration between students and their peers, thus increasing opportunities for constructing knowledge [10–13]. It has been shown that integrating online social networking into the education experience enhances the students' learning experience, and those who partake in groups created on Facebook, for example, for educational purposes perform better than students who do not [14, 15]**.** The use of social platforms and social media groups tends to increase student involvement in discussions and out-of-class communication with their teachers and peers [16] and offers support and collaboration with more advanced peers during problem-solving, which can be of great value to struggling students [17]. Some studies emphasize the considerably favorable response that students gave and others showed that asynchronous online discussion helped promote student's self-organizational abilities [18]. It also creates opportunities for participants to reorganize their knowledge, communicate knowledge in various ways [**13]**, and promote students' self-assessments and reflections on their practice. Many students exhibit satisfaction learning in such technological environments [9] and for students with low self-esteem, the experience improves social integration and reduces learning barriers [19].

However, most of the research has focused on college and undergraduate students. Less is known about the potential of social networks to enhance learning among adolescents. Thus, the current study was designed to examine the impact social media might have on high-school students learning mathematical processes.

2.2 Teachers' technological and pedagogical content knowledge

The impact of digital technology on education in the 21st century calls on teachers to prepare for more dynamic teaching, the use of digital-based communication platforms, and collaborative work to enhance their students' critical and creative thinking and thus accelerate the learning processes required to prepare them for the challenges of life in the environment of a technological society [20]. Furthermore, teachers must become empowered professionals able to use and design technologically driven classroom environments for learning, teaching, and evaluation [21, 22].

Koehler and Mishra [22], based on Shulman [23], coined the term "TPACK" to refer to the amalgamation of the technological, pedagogical, and content knowledge, the three critical types of knowledge teachers must have. As their names imply, technological knowledge is full awareness of the various technologies available for teaching in the classroom environment, pedagogical knowledge means being skilled in the methods and instruction processes related to the teaching profession, and content knowledge is the familiarity and expertise the teacher has about the specific topic(s) being taught. Merging them together as TPACK implies that all these bodies of knowledge intersect at various levels of complexity and that teachers must have all these forms of knowledge to be able to successfully integrate

technologies into their teaching of any content area [24]. The model's complexity is reflected in merged components of knowledge. For example, TCK – technological content knowledge – which is knowledge about how technology can create different representations for a specific concept and demands that the teacher understands how using specific technologies can affect learners' skills and understanding of the relevant concepts and content; and TPK– technological pedagogical knowledge – which is familiarity with the range of technologies that can be integrated into teaching and understanding how their use can affect teaching methods. Thus, TPACK encompasses the intersection of the many types of knowledge that teachers require to integrate technologies into their teaching, no matter what the content area.

Clearly, the use of a social platform requires TPACK: the teacher must have the technological capacity to operate within the platform, the pedagogical skills to use it effectively, and (as goes without saying) the content knowledge they aim to impart to their students.

This premise formed the framework for this present study, whose aims were two-fold: to investigate the potential of the Facebook experience to influence and improve students' skills in high-level high school mathematics and to discern how mathematics teachers perceived their development of technological pedagogical content knowledge as a result of integrating the Facebook platform into their teaching. Specifically, to investigate the potential of Facebook as a digital-based communication platform tool to promote teaching and student learning, we formulated the following two research questions:

1. What learning and teaching opportunities are created when using the Facebook platform to enhance learning for the secondary school mathematics matriculation exam?

2. How do students and teachers perceive such a learning process?

3. Method

3.1 Procedure

The authors opened a Facebook forum group entitled "Facebook Marathon Mathematics Bagrut Workshop," which was an extensive, four-day (twelve hours per day) online support project designed specifically to help 12th-grade students preparing for the intermediate or advanced mathematics Israeli *bagrut* (matriculation) exams.

The Center for Educational Technology (CET) in cooperation with the mathematics inspectorate of the Ministry of Education issued a call for students around the country to participate in this "Facebook marathon." A total of 614 students from all over the country who were preparing for their mathematics matriculation exam responded. The students were divided into eight groups according to the level of exam (intermediate or advanced) they were intending to take.

In parallel, a call was issued for mathematics teachers who were interested in teaching over the Facebook platform. From the teachers who responded, 16 were chosen based on their experience in preparing students to sit for the matriculation exams and the recommendations of the mathematics inspectorate. We gave these teachers four hours of training during which they were taught the fundamentals of teaching in the Facebook setting and given technical instructions on how to respond on the forum. We supplied each teacher with all relevant textbook and presentations,

even if not the specific ones used in their class, so they would all be able to respond to any of the questions proposed. In addition, we provided the teachers with edited videos of teachers teaching a variety of topics from the curriculum that had been recorded in a recording studio at the CET.

The students were advised that during the marathon activity, they could raise questions about whatever topic they wished. They could post their questions by uploading photographs of the problems or providing details of the book, page, and exercise number.

The administrator of the forum ensured that each question offered was a separate thread on the forum. The teachers responded to the questions either by uploading a photo of the written solution or writing hints on how to reach it. Students were invited to comment or raise questions about that specific problem in that thread.

At the end of the four days, online questionnaires were sent to the participating students and teachers. A total of 109 students and 15 teachers submitted their questionnaires and they formed the group studied herein.

3.2 Participants

The actual participants in the study were the 15 teachers and 109 12th-grade students (98 Hebrew-speaking, 11 Arabic) who submitted the questionnaires. Of the students, 43 (40%) were preparing for the intermediate exam and 66 (60%) for the advanced.

3.3 Questionnaires

We composed two online questionnaires, one for students (see Appendix 1) and one for teachers (Appendix 2), each comprising open and closed questions. The questions in the student's questionnaire asked for details about personal background, level of examination (intermediate or advanced), and open questions regarding their reasons for joining the virtual review project and comments regarding their experience in the forum and ways in which they thought the experience could be improved. The questions in the teacher's questionnaire asked for details of their seniority and teaching experience (both traditional and online) and open questions in which they, too, were asked to write down their comments about teaching via Facebook, to describe any interactions they particularly thought worthy of mentioning (both favorable and not), their attitude toward the procedure, etc.

Each questionnaire also included closed questions: statements on a Likert scale from 1 (disagree) to 4 (strongly agree) regarding issues such as the use of technology, peer learning, willingness to continue learning/teaching similarly in the future, interactions, etc.

The validity of the questionnaire was established by a team of three scholars who are experts in mathematics education.

3.4 Interviews

We conducted a semi-structured interview based on Creswell [27] with two teachers chosen at random in order to deepen our insights regarding the response of the students and teachers to the questionnaires, as well as complete information regarding the interactions between the students themselves and between the students and teachers in the Facebook environment. The interviews were conducted online over Zoom and transcribed. The interviews were based on prepared

questions such as "What learning opportunities did you identify in the Facebook environment compared to the classroom environment?" and "Did the interaction with the students in the Facebook environment contribute to your teaching in the classroom environment?" but allowed for free discussion.

3.5 Data analysis

The data were collected and sorted based on a qualitative research paradigm [25] that employs open and axial coding processes to identify main and subcategories [26, 28]. The analysis process took place in three stages. First, the answers to the open-ended questions from the student and teacher questionnaires were analyzed using open coding analysis strategies [28]. Four themes emerged from this: statements relating to student–student interaction, statements relating to teacher-student interaction, statements relating to learning processes via Facebook, and statements relating to teaching processes via Facebook. Further to this analysis, we encoded the data [27] in each of the themes to identify secondary codes in order to gain deeper insight into the categories related to learning and teaching in the Facebook environment. These secondary codes were analyzed by three mathematics education experts to improve validity**.** Discussion continued until 100% agreement was achieved between the experts regarding the categorization of the data.

In the second stage, the interviews with the two teachers were analyzed to clarify the findings that emerged in the first stage, and the categories were classified accordingly. In the third stage, we searched for evidence in the Facebook correspondence to reinforce the findings from the analyses in the first and second stages, and define the final categories.

Reliability was ensured by triangulating the data obtained from the students and teachers and crosschecking the information acquired in the questionnaires and teacher interviews, along with retrospective observations of actual peer-to-peer and student-teacher participant behavior via Facebook.

4. Results

4.1 Using social networks for facilitating mathematics learning

Content analysis was made of the student-teacher interactions and peer-to-peer learning opportunities that arose.

An overall analysis of the posts revealed a total of five ways in which learning was facilitated. Two were student-oriented and included 1) evaluating peers' solutions and 2) exposure to peer's questions. The other three were teacher-oriented: 3) critical reading of teacher's solutions, 4) using teacher-provided scaffolding to arrive at the solution, and 5) asking the teacher content-related questions.

4.1.1 Evaluating peers' solutions

The Facebook platform was meant to furnish a type of review wherein the students posted their solutions to various mathematical problems, intending that the teacher would evaluate their work and point out any mistakes they had made either in calculations or in the method. Interestingly, we observed that while waiting for the teacher's response, other students would offer help in pinpointing the source of their peer's error(s). These students' attempts would then start a chain of responses until the teacher answered the question.

Figure 1 presents an example of a solution uploaded by one student (A). This is followed by an excerpt from the forum where another student (B) offered help before the teacher had a chance to respond.[1]

B: I think you made a mistake with the angle QAC. Shouldn't it be 90 minus half alpha?

A: Yes, you are right. And that changes them all to 90 minus half alpha … So it's the same proof, I simply need to change the alpha to half alpha … right?

B: Yes, you got it, great.☺ Also, I think that generally, you cannot say that AC = AB is given. Right?

A: I meant BR = RC

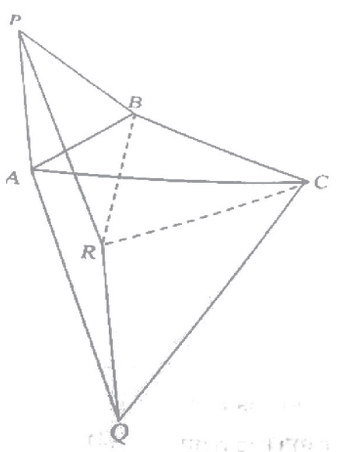
A: I've got too many mistakes☹.

B: Aaah. Now it all makes sense! It's not so bad. It's a mini mistake!

We noticed, in fact, that throughout the sessions on the forum, students had considerable success in taking the teacher's role and providing explanations, an observation strengthened by the students' answers to the questionnaire at the end of the review session. In fact, 72% (N = 104) stated in the questionnaires that they had learned from responses given by their peers.

4.1.2 Exposure to peers' questions

Throughout the review session, students were exposed to questions raised by other students and tried to answer these questions themselves. Exposure to peers' questions expanded the available pool of exercises and presented additional



Triangles APB, ACQ, BCR are similar isosceles triangles whose bases are the sides of triangle ABC. Prove: ∡ACB = ∡QCR

AB = AC given
PA = PB given
AQ = QC given
∡AQC = α
⇒ ∡QAC = ∡QCA = 90 − α
⇒ ∡BRC = α similar triangles so angles are equal
⇒ ∡RBC = 90 − α = ∡BCR
∡RCA = β
⇒ ∡QCR = 90 − α − β subtracting angles
⇒ ∡ACB = 90 − α − β " "
⇒ ∡QCR = ∡ACB

Figure 1.
A geometric problem with a student's solution as uploaded on the forum.

[1] Note: The text of the students' dialog was originally published in: Biton Y, Hershkovitz S, Hoch M. Learning with Facebook: Preparing for the Mathematics Bagrut—A Case Study. Proceedings of the 38th Conference of the International Group for the Psychology of Mathematics Education and the 36th Conference of the North American Chapter of the Psychology of Mathematics Education; Vancouver, Canada, July 2014.

mathematical problems that were often challenging and difficult. This finding is supported by student responses in the questionnaires where 78% reported that they learned by observing questions raised by other students.

Following is an example of a dialog that developed from a student's question (S) and how other students (A and N) helped out. Student "S" refers to the following problem (of which only the relevant sections are replicated here).

A sequence of $2n + 1$ numbers satisfies the following conditions:

$a_1 = 10$, $an + 1 = 5an$.

a. Express in terms of n the sum of the terms in the even-numbered places.

b. The last term in the sequence is 3,906,250.

Calculate:

1. the sum of the terms in the even-numbered places

2. the sum of the terms in the odd-numbered places

3. the term in the middle of the sequence

The student posted the following:

S: What am I not understanding here? I need help with a general understanding of this problem. It's clear to me that the sequence is geometric and that q is 5 … . The general term, according to the given information, should be $a_n = 10 \cdot 5^{2n+1-1}$ which means that a_2 is 6,250. It's clear that's incorrect because it should be 50, but I would be happy for an explanation of what I am not understanding here, and for the solution. Thanks.

We can see that S recognizes that the sequence is geometric and knows the formula for the general term in a geometric sequence $a_n = a_1 \cdot q^{n-1}$. However, he substitutes $2n + 1$ for n in the formula thus finding the last term instead of the general term.

A replies to S, and the following dialog takes place:

A: The general term in a geometric sequence is $a_n = a_1 \cdot q^{n-1}$ and so $a_2 = 10 \cdot 5^1 = 50$.

S: Right, but here the last term is in place 2n + 1.

A: That does not change anything buddy.

S: I'm pretty sure it does because in section b you have to use the general term $a_n = 10 \cdot 5^{2n}$.

A: That formula is for every geometric sequence. The number of terms does not matter for this formula, only for the sum formula.

S: I'm pretty sure you are wrong. Let us wait for one of the tutors to answer.

A is determined to help S and tries to fine-tune the mathematical language he uses in his explanation. S appears doubtful but is grateful for A's efforts.

A: Okay, but there you are looking at the sum of terms. You asked what's a_2?

S: Let us wait for an answer. I want to be sure. But, thanks, pal.

A: I think I understand what your problem is … … The n-1 in the power of q is not according to the number of terms in the sequence but the place of the term in the sequence.

A: And if you want to find the value of a_2 you need to do $q^{(2-1)}$

At the end of the discussion, N joins in as follows:

N: In my opinion, if you substitute 2 in the first formula given $a_{n+1} = 5a_n$ you get $a_2 = a_1 \cdot 5$, that is $10 \cdot 5 = 50$.

S: Right, that's clear, but I'm trying to understand why the formula for the general term, and it's correct, does not give me $a_2 = 50$.

We can see from this exchange that N had been following the discussion and now enters in to suggest a different strategy. S accepts this answer as correct but still wants to understand where his mistake lies. At this stage N understands S's request and formulates his question clearly and in a mathematically correct form as follows:

N: Why not? It works out terrific … If I understood you correctly you meant the formula for the general term $a_n = a_1 \cdot q^{n-1}$ where you substituted 2n + 1 for n. If so, I can help.

S: Yes. That's what I meant.

N: Terrific. So $a_{2n+1} = a_1 \cdot q^{2n+1-1}$ and that's equal to $a_{2n+1} = a_1 \cdot q^{2n}$ and then if you want a_2 your n will have to be 1/2 and then $a_2 = a_1 \cdot q^{2*1/2}$ and that works out $a_2 = a_1 \cdot q^1$ and that's exactly right if you substitute the givens and you do get $a_2 = 50$. I hope you understood me.

N has shown S how the correct answer can be obtained using his method. S now understands and clarifies his mistake in his own words:

S: Wow thanks a lot!! All the time I read the general term to be a_n instead of a_{2n+1}. Thank you. I was getting stressed out.

N: Hey – my pleasure. Just glad I was able to help.

From an analysis of the above dialog, we can observe the learning opportunities that occurred among the students, particularly observing their peer's misconceptions (in this case, the connection between the general term of the sequence and the number you need to replace for *n* to find a particular term of the sequence). The combination of giving explanations and asking questions, alongside the perseverance and motivation of S to understand the source of his error and the desire of his peers (A and N) to help him, enhanced the mathematical discourse and enriched the students' understanding of the topic.

4.1.3 Critical reading of teachers' solutions

The most significant learning opportunities that occurred during the online forum sessions were the chances to read, analyze, and understand the teachers' solutions on the forum. In some of the posts it is evident that after inspecting the teachers' solution, the students returned to their own to compare the two methods.

As an interesting aside, at the end of this post, an error was found in the book thanks to one student's "stubbornness," which we show below.

S: Thanks [for your explanation]. But somehow in the answer, there is 3/4 instead of 3 root 3 divided by 2. And according to the volume of the prism that you [the teacher] found, I got the correct *t* but the maximum volume is different. Maybe there is a mistake in the exercise? Can you please send me the rest of the solution? Because I did not get the same answer … .

4.1.4 Coping with scaffolding (no crutches!)

In most cases, the teachers did not simply provide a solution to the problem for the students. Instead, they tried to direct the student to a different (more correct) approach to the problem to allow them to make their own progress. In fact, 87% of the students claimed that the teachers' tips helped them arrive at a solution on their own.

In the excerpt below, we see how one teacher gave a hint to lead to the solution and the student's satisfied response that it did help solve the problem.

T: I think you should try to finish this on your own. If you do not succeed, let me know and I'll post the solution. But here is a tip: the lateral area is the sum of the areas of the rectangular faces without the bases.

S: Thank you very much! I tried that and now I got it right! ☺.

4.1.5 Asking questions

Throughout the review sessions and in addition to their posting problems as photos or text, the students also asked concrete questions on particular parts of a solution and expressed any doubts that arose during a solution. The advantage here is that in contrast to questions asked face-to-face, asking questions on-line requires another skill – the ability to formulate a concise question *in writing* with enough clarity to allow the teacher to provide the necessary help to solve the problem.

The following excerpt shows a student's questions *after* a solution to a problem was posted by the teacher. It shows a search for a logical explanation or proof, indicating that the student read the solution critically.

S: It's not clear to me how you can deduce from the sketch of the graph alone that there is no maxima or minima? Who says there is not one before the asymptote? And how can you tell without a table if the function is increasing or decreasing from the asymptote? Thanks!!

4.2 Teachers' and students' perceptions of the potential of the social network to enhance learning

Analysis of the data showed that students' and teachers' perceptions regarding the use of Facebook in preparing for the exam were mostly positive. In general, the student participants' responses indicate great satisfaction. 75% (N = 81) of the 109 students who completed the questionnaire stated that it was easy for them to ask

Outcome based on category	Student testimony	Teacher testimony
Motivation for learning	I'm glad I got the chance to learn for the exam via the Facebook forum. It helped me not give up like I usually do, but to solve exercises that I could not solve on my own. Being able to ask the teacher for solutions really helped me.	I liked the fact that the students asked relevant questions and did not give up until they understood.
Peer learning	The forum was a very good idea. We could learn from other students' questions and answers.	A student posted a question and I noticed that students started to help him in the forum. They really helped him solve some parts of it on his own.
Technology utilization	I would recommend improving the method of posting pictures on Facebook.	The idea of photographing the problem or the solution and posting is brilliant! It's very cost-effective in terms of time and resources. It's very useful for presenting the solution.
Supportive learning climate	I would be very happy to get this kind of help throughout the year. It is above and beyond what a student needs to succeed. Thank you so much for all the help.	The students' appreciation was heart-warming.

Table 1.
Some example of students' and teachers' responses to the questionnaire about utilizing Facebook in preparing for the mathematics matriculation exam.

questions and receive replies through Facebook, 79% stated that they would like to use Facebook this way for learning other subjects too, and 87% stated that they would like to continue learning similarly throughout the year. With respect to the teachers, all but one (93%, N = 14) stated that the environment encourages meaningful learning, that the project justified the investment of resources, and that they would be interested in opening similar learning environments for their students during the year. There was 100% agreement on their willingness to continue similarly next year.

Table 1 presents some examples of students' and teachers' responses to the open questions, categorized into "motivation for learning," "peer learning," "technology utilization," and "supportive learning climate."

Some criticism of the technology was heard from both students and teachers, particularly with respect to the clarity of the pictures uploaded to the forum. Also, teachers raised the need for extra staff to help manage the responses where necessary.

5. Discussion and conclusions

The findings indicate that students showed great satisfaction with the opportunity given them to study for the mathematics matriculation exam through the medium of Facebook. The Facebook forum encouraged different kinds of learning opportunities and promoted interaction between teachers and students and between the students themselves [10–13] to formulate answers for problematic questions by allowing them a user-friendly platform to ask questions, learn from peers, be exposed to different methods of problem-solving, and critically read the solutions given by the teachers. The environment seemed to motivate them to deal with questions their peers found difficult and make an effort to help. They were also exposed to questions from different textbooks and to solution methods that differed from what they may have received from their own teachers. These learning opportunities carry extra value and seem to be important in the learning process leading up to the matriculation exam. In fact, they would certainly be valuable for any learning situation, not just before an exam and not just for mathematics.

The findings showing the students' positive opinions of learning in the Facebook environment strengthen the findings of earlier studies about learning on social networks [9]. The fact that all the teachers declared their intention to adopt a similar environment in the future – both when teaching during the school year and when preparing their students for matriculation – also indicates their great satisfaction with the Facebook environment.

Responses from the teachers indicate that they felt they expanded their TPK by identifying the added value of learning and teaching through Facebook and that it served as a viable tool for accelerating social interaction, thus encouraging active learning among students. This was evident to them whether a student raised a question and examined the range of solution strategies offered to them or whether a student read the solutions to problems raised by other students and compared the different ways that that problem could be solved.

Another addition to the teachers' TPK was that they were introduced – or became more familiar - with an important technology that promotes student–student or student-teacher interaction that is quite different from that of the traditional classroom environment. The teachers indicated that it was one that they felt they would like to continue to integrate into their teaching as they saw Facebook as an environment that not only benefitted social interaction but also social interaction for the purpose of learning. In other words, they now identified the social network

as a means of not only accelerating pedagogical goals and their students' learning process, but a way of sharing knowledge and encouraging critical thinking. It allowed them to identify difficulties and misconceptions that students can have and created an optimal climate for conducting an ongoing dialog with their students that motivates them to build knowledge. They also indicated that the experience increased their understanding of how Facebook, as a social platform, can affect their teaching methods and expand their TPK in the context of the intelligent use of technology.

Our findings suggest that a good recommendation would be to include the use of this and other social media in teacher education programs within the TPACK model. In other words, to introduce teachers to the technological learning environments that are available to them and their students that can invite student-student interaction so that they can assist each other in solving complex tasks, thereby enhancing their perspective of the numerous ways available to solve a specific problem, expand their mathematical knowledge, and increase their chances of success.

The results encourage further research into these and other aspects related to teaching with the aid of social media platforms by testing them on larger groups of teachers and students, for longer periods, and on different social networking environments. Such studies would likely lead to more extensive peer-to-peer learning – not only among students but also among the teachers themselves. For example, teachers might discuss how to characterize students' questions and the like. Continued research demonstrating the usefulness of such platforms might also provide educational policymakers with an understanding of the value of investing in similar projects in the future.

In conclusion, the value of the forum was threefold: it exposed students to broader content and various teaching approaches to explain that content that differed from what they were familiar with from their own classroom; it gave students the opportunity to discuss problem-solving issues with other students who were not their immediate peers, leading to a broad array of learning opportunities and a chance to "play teacher" and help their peers; and it allowed teachers to observe a wide variety of student responses, thereby allowing them to identify additional difficulties that might be encountered by students and incorporate such insights into their own classroom.

A. Appendix 1 – Students questionnaire

Part I: Closed questions.

Following your experience in the Facebook math marathon, to what extent do you agree or disagree with each of the following statements?

(1- disagree, 2- agree to an extent, 3- agree, 4- completely agree).

a.	I learned from other students' questions too.	1 2 3 4
b.	I learned from solutions received by other students.	1 2 3 4
c.	I would have loved to have a marathon-style group on Facebook throughout the year	1 2 3 4
d.	The responses I got by the teachers encouraged me to continue practicing.	1 2 3 4
e.	It was easy for me to notice an error I made after I got the solution from the marathon team.	1 2 3 4
f.	It was important for me to see different teachers' approaches to solving exercises.	1 2 3 4
g.	I learned from responses I got from other students.	1 2 3 4
h.	The tips given by the marathon teachers contributed to my learning.	1 2 3 4

i.	I would rather meet a math teacher face to face to ask questions.	1 2 3 4
j.	Using Facebook during the marathon distracted me from concentrating on learning.	1 2 3 4
k.	It would be worthwhile using the social network platform in other subjects.	1 2 3 4
l.	The Facebook marathon and private lessons serve me the same way.	1 2 3 4
m.	It was easy for me to send questions as I sent them in the Facebook group.	1 2 3 4

Part II — Open questions

1. Did you encounter any technical difficulties entering the group?

2. What would you recommend to improve this activity?

3. What things would you not change in this activity?

B. Appendix 2 – Teachers questionnaire

Part I — Closed Questions

1. Which groups did you accompany in the Facebook marathon? (choose one)

   Intermediate, advanced.

2. What previous experience do you have using a computer in instruction: school site, social network, computer software, not at all, other _____

Following your experience in the Facebook math marathon, to what extent do you agree with each of the following:
(1- disagree, 2- agree to an extent, 3- agree, 4- completely agree).

a.	The use of a social network such as this Facebook marathon allows significant learning for students.	1 2 3 4
b.	The use of a social network such as this Facebook marathon justifies the investment of resources.	1 2 3 4
c.	I would recommend holding such a Facebook marathon in future years.	1 2 3 4
d.	Technologically, it's easy for me to reply to students' questions via the social network as is done in the current marathon.	1 2 3 4
e.	Mathematically, it was easy for me to reply to students' questions. Via the social network as is done in the current marathon.	1 2 3 4
f.	I learned from the questions that the students raised on Facebook.	1 2 3 4
g.	I learned from other teachers' answers during the marathon.	1 2 3 4
h.	I would be happy to participate in similar marathons in the future.	1 2 3 4
i.	A Facebook marathon can be a good opportunity for teachers to learn from other teachers' approaches to solving problems.	1 2 3 4
j.	The Facebook marathon helped me learn about what questions students ask at the last minute before the exam.	1 2 3 4
k.	I enjoyed the interactions with the students on Facebook.	1 2 3 4
l.	Students contributed a lot to the workshop.	1 2 3 4

m.	I would be happy for this kind of marathon to be conducted throughout the year.	1 2 3 4
n.	A Facebook marathon and a private lesson may serve the same purpose.	1 2 3 4
o.	I would be happy to conduct a similar Facebook marathon during the year with my own students.	1 2 3 4
p.	Pupils raised high-level questions during marathon.	1 2 3 4
q.	Teaching on the social network, as I did in this Facebook marathon, has been a significant experience for me.	1 2 3 4
r.	The marathon on Facebook encouraged interaction between the teachers who participated in this project.	1 2 3 4

Part II — Open Questions

1. Name two things to improve a future Facebook marathon.

2. Name two things that you would not change in a future Facebook marathon.

3. Describe two interactions you remember favorably from the marathon.

4. What are your feelings on teaching through the social network following your current experience in the marathon.

5. Can you characterize the kind of questions that students bring up at the last minute before the exam? Can you list their properties?

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