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Teachers' Views on the Social Networks Used by Mathematicians

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Abstract: Many teachers work on social networks out of school. They participate via this social networking in maths forums where they exchange views on various maths issues with their students and other maths teachers (ή colleagues). The purpose of this research paper is the assessment of the afore-mentioned social networks taking into account the opinions held by maths teachers aggregated using a method similar to the SWOT technique, i.e. by completing electronic questionnaires distributed via email. The participants' answers were then grouped based on criteria defined by the researcher. The relative weight of each criterion was determined at a later point in the survey. Teachers should decide if some criteria were more important than others and give a higher arithmetic value to them. The conclusions drawn is that the above-mentioned procedure is really useful since it can pose analytical questions-after having researched new suggestions and initiatives- that will shed light to aspects of the external and internal environment.

Keywords: Social Networks, Strong Points and Weak Points, Senior High School (Lyceum)

1. Introduction

Mathematics is taught in Greek primary and secondary education. Primary education lasts for 6 years and is followed by Junior High School (Gymnasium). Junior High School in Greece is a compulsory school which lasts for three years, after which pupils may attend Senior High School (Lyceum) General or Professional, or can attend various trade schools for professional training. Senior High School is not compulsory in Greece. However mathematics is everywhere and Maths is considered one of the most important lessons in Greek schools. Maths is taught everywhere by maths teachers who are university graduates except for in primary schools where maths is taught by graduates of the University Schools of Education.

Many of these teachers work on social networks out of school. Through them they participate in maths forums where they exchange views on various maths issues with their students and other maths teachers. At the same time the Covid epidemic has made it imperative for both teachers and students to use the internet. Moreover, teaching requires children not to be left out of the learning process for as long as the epidemic lasts. The question remains as to how to improve the quality of teaching practices so as to meet the needs and expectations of both teachers and learners.

In this paper we try to assess these social networks, taking into account the opinions of maths teachers aggregated using a method similar to the SWOT technique. We use something simple that helps us to understand strengths and weaknesses along with finding the opportunities and threats a teacher might face by using social networks. The acronym SWOT stands for Strength, Weakness, Opportunities and Threats. Teachers can analyze and identify the negative and positive internal and external factors that are important to a situation, decision or any proposal by using this tool. It also provides strong baseline of the information that is wanted to create the vision for a future and easily analyze a problem.

Therefore, the article is organized for the achievement of two objectives:

Firstly, it discusses strengths, weaknesses, opportunities and threats that impact evaluation social networks in maths

education.

Secondly, it is good if the teachers make groupings of the strengths and opportunities, weaknesses and threats.

The article closes with considerations about present and future of impact evaluation of management of the social networks.

2. Theoretical Context

The design of the courses, the roles that the teachers play, the help they receive from the rest of the community and also the practices and learning processes used play an important part in the success of e-learning [2].

The question remains, however, as to how to raise the quality to meet the needs and expectations of learners; thus, collaborative peer learning and the assessment of it within the online learning environment are the crucial patterns of quality that foster the reconstruction of knowledge with the support of peers, social interaction, and interconnections [3-5]. Educational staff are a very important element of the success of learning through the internet. Within the framework of quality standards and improvements of higher education institutions, e-learning practices now have a significant role in fostering a competitive advantage and service differentiation in order to meet and satisfy the expectations and needs of diversified learners [6].

As Chen and Tsai [7] say, the collaborative learning environment enriches peer support, thus enhancing the critical element of friendship in order to foster the learning and skills development of learners in an online context. Furthermore, peer learning and evaluation become parts of the learning process which increase negotiation, teamwork, reconstruction of knowledge and sharing.

Much is made of the value of peer-feedback and collaborative knowledge building especially the different populations spanning different regions of Greece, where it is not practical or even possible for teachers to provide feedback to large groups of learners. There is evidence that learners' perceptions of peer-feedback and willingness to engage with it improves with growing experience of peer-feedback. However, peer-feedback can be rather cumbersome to orchestrate without adequate preparation and training. It is advisable in such settings to provide participants with training and assistance, so that they can provide meaningful feedback to their peers. This can include the provision of rubrics that learners can use to provide feedback, models of feedback to emulate, and examples of best, as well as poor practices [1].

3. The Methodology Used

As far as the research we carried out is concerned, in an effort to codify teacher's viewpoints the principles of content analysis have been largely followed. In this context as few questions as possible were asked and a gradual withdrawal was attempted on the part of the researcher during the flow of interviews, enabling the subjects to be the narrators. The aim was for the respondents to be free to classify important and material events themselves. A combination of interview types was followed during the course of the survey, according to its needs. There were points at which mixed questions were used, and others in which the role of the "guide" was played by the course of the discussion. But to a large extent the questions approached the form of the "in-depth interview." These elements were classified, as we said above, using a system similar to the SWOT analysis. This is a tool for designing strategies which is used in the internal and exterior environment of a business.

According to Husni Thamrin, H. and Pamungkas Endang Wahyu [8] learning the current condition of strength, weakness, opportunities, and threats (SWOT) can help a study program in a university in making a decision. For the middle term, it can also help in building strategic planning. However, conducting SWOT analysis is usually an expensive and time consuming activity. We have been doing research to provide a software application that may facilitate study program stake-holders in conducting SWOT analysis more quickly and easily. In a SWOT analysis the Strengths and Weaknesses of an organization or even an area are studied as well as what Opportunities and Threats there may be. [8]

A SWOT analysis is a structured assessment method which evaluates the strengths (S), weaknesses (W), opportunities (O) and threats (T) involved in a process or a structure in the most general sense of these terms. A SWOT analysis involves specifying the objectives of the process or structure, identifying the internal and external influences with regard to the degree of achievement of these objectives and, finally the core element, characterizing the strengths, weaknesses, opportunities and threats of the process or structure under scrutiny. In general, a SWOT analysis can help developing the assessed entities for further rounds of improved goal achievement, and it usually has an exploratory dimension bringing to the fore aspects which have not been noticed by other means of analysis. This exploratory force originates from the requirement to identify and distinguish explicitly the four different categorization dimensions of processes or structures [9].

However, a SWOT analysis cannot replace more in-depth research and analysis and its execution becomes complicated if factors are uncertain or two-sided with respect to the four factor types of strengths, weaknesses, opportunities and threats; particularly, the boundaries between classes are often fluent, ambiguous or fuzzy. Further limitations are that a SWOT analysis may not prioritize issues; may not be empirically validated; may use unclear and ambiguous words and phrases; may not provide solutions or offer alternative decisions; may generate too many ideas but not help to choose which one is the best;

Many things from the application of this analysis give data that is not needed [10]. The framework should invite decision makers to be more systematic and coherent than those ask for the assessment so that the information may be concentrated and filtered out by the user according to needs and

requirements. It would also be a good thing for there to be a methodology chosen to be a before and after comparison and ex-post analysis with their respective sub-specifications of assessment by participants, analysis of documents and data, counterfactual self-estimation and causal social mechanisms. In this stage the participating students and teachers are asked to exchange ideas and opinions. This can be done in the classroom during the maths lesson, or could even take place in online discussions, for example in chats. It is good if SWOT analysis is conducted in various meetings to exploit the benefits of the discussion in workshop sessions. The directors cultivate an atmosphere that allows free expression and exchange of information, leaving participants to express their opinions without criticism.

The Strengths and Weaknesses concern the internal environment of the social network as they result from the internal resource that it possesses (e.g. properties and characteristics, technical know-how) which can also be found today in the social networks. Conversely the Opportunities and Threats reflect variables in the external environment and have to do with the evolution of science, as well as the needs of the students and also of the teachers who exchange views with the help of these social networks, which need to be identified, adapted, or even adapted them to their own use where such a thing is possible (e.g. entry of new competitors, changes in the legal environment, creation and/or emergence of new mathematical problems, analytical programmes, materials etc.

Generally, when applying the analysis, an attempt is made to answer the question of how the process can be qualitatively improved.

4. Process

Mathematics teachers were enrolled in this study, 34 of whom were working in Senior High School (Lyceum) and 23 in Junior High School (Gymnasium). The teachers were approached personally to request them to participate in this study. The telephone was mainly used to give information about where the study was to be conducted, then Messenger, Skype etc. This was carried out after searching for pages that had mathematics issues content, blocks and mathematical forums. We also examined pages on Facebook etc. that had maths content. This research was carried out in the second semester of 2019 with what was posted there. We also invited teachers to participate who, even if they didn't maintain pages on social websites with maths content, submitted opinions to these and interacted with students and other teachers. So, the basic criterion for teacher participation in the study was interaction with students or colleagues on mathematics topics on social websites of over 15 times a month at different times.

A questionnaire was developed based on which the teachers were asked about the importance of the 4 criteria for the S.W.O.T. analysis. The questions covered the theoretical definitions and descriptions of the S.W.O.T. analysis (Table 1). After the questionnaire was completed, the researcher with another group of 3 people who worked in a school and communicated almost daily with other mathematicians, commented on the readability of the questions and their relevance or irrelevance to mathematics in social networks.

Table 1. *Γενικά ερωτήματα με βάση την μεθοδολογία SWOT.*

Strengths:	What are the advantages? What is the most competitive social network? Why would students and teachers use it?
Weaknesses:	What can be improved? What should be avoided? What factors are considered to be the inherent weaknesses of the social networks?
Opportunities	What opportunities exist at this time for spreading mathematical literacy through social networks? What are the interesting points? What can be considered as opportunities:
Threats	If there are threats that could in any way damage the reputation or honour of teachers and their students? If, instead of positive results in mathematics learning, there are negative results and if so, what are they?

Before analyzing the results of the questionnaire, the reliability of the criterion scales was determined. The Cronbach's a scores of all scales, which were found to be moderately to highly reliable (range 0.59– 0.82). To increase scale reliability, one question with a low item-total correlation value was removed from the transparency scale. To explore whether the criterion scales were one dimensional, a factor analysis was conducted on each scale. All scales proved to be one dimensional except for cognitive complexity.

As was expected, this scale was composed of two distinct subscales. A factor analysis with varimax rotation showed two factors, with an Eigen value 3.34 and weightings ranging from 0.399 to 0.766 on the usability of social networks in mathematical literacy, in the management and discussion of mathematical ideas and an and Eigen value 1.06 and weightings ranging from 0.559 to 0.701 for thinking processes and for the deepening of mathematical thinking. The first factor consists of all questions regarding thinking level and the second factor includes the questions about assessing thinking processes.

5. Procedure

The questionnaires, which were in an electronic form, were distributed by e-mail. Because teachers often neglected to respond, one contact person was appointed at each school, usually the head of the department. So the teachers received an e-mail from her or him with the request to fill out the electronic questionnaire on the Internet and the contact person informed them of the progress of the study at regular intervals.

One researcher with a team of 3 persons participated in the study. Thus the answers given by the teachers were gathered by the researcher and his team (of 3). The participants' answers were then grouped as in the following tables (Tables 2, 3, 4 and 5):

Table 2. *Strengths.*

Correspondingly for social networks in Mathematics education:
D1. A good environment. Everyone interacts with the maths teachers and students from the comfort and security of his/her own home.
D2. The teachers act purely voluntarily. They interact with each other and other colleagues and also with students.
D3. Building community spirit among students
D4. Overcoming isolation and geographical distance
D5. Enhanced communication between students and educators
D6. Early intervention and almost real-time feedback or support from educator
D7. Improved relationship between educators and students
D8. Better understanding of students' needs. Development of support mechanisms
D9. Improved learning
D10. Collaborative learning
D11. The teachers identify the specific needs of the students and adapt their teaching appropriately to the needs of each student since this is one of the objectives of social networks Koutselini, 2008).
D12. The use of modern tools in the learning process and competition of even better work.
D14. Collaboration with many teachers and students for the exchange of various opinions, ways and methods of solving problems, etc.

Table 3. *Weaknesses.*

Here we study the weak points of social networks
A1. Work load issues of educators so that they have to put social networks second
A2. Work load issues of students so that they have to put the social networks second
A3. Limitations in the quality of interaction
A4. Selective or disruptive interaction among students
A5. Limited socializing
A6. Lack of trust in peer feedback
A7. Uncertainties of ownership and assessment
A8. Poor assessment of collaborative activities
A9. Ownership issues of content in public or collaborative spaces
A10. The use of experimental learning is difficult or non-existent. (Laboratory, natural environment, etc).
A11. Difficulty in acquiring balanced emotional development due to distance and no physical contact.
A12. The teaching staff are not all sufficiently educated in their subject and in new Technologies. Thus a limited age group use it – usually up to the age of 55. Its use is greater in maths teachers that in teachers of other subjects.. Training in these fields could help their involvement with social networks.
A13. Teachers do not realise and are not able to exploit the cultural specificity of student potential.
A14. They do not support students with special educational needs and do not provide them with learning incentives as appropriate

Table 4. *Opportunities for the social networks maintained by math's teachers [11].*

E1. Improving the quality of teaching through social networks in relation to the international community (international networks).
E2. Better use of teaching time where students are searching for solutions in the social networks
E3. Use of various techniques to create evaluation procedures for conducting systematic assessment.
E4. Cultivation of respect towards the diversity, linguistic, cultural and religious pluralism that has come to exist n Greek society in recent years.
E5. Positive attitude and action on environmental issues, since many mathematical problems use issues in the students' own environment to engage them
E6. Exchange of views with other schools abroad to help students, through collaboration, to approach the different ways of working in Europe and internationally.
E7. Constructive collaboration with parents and other social partners

Table 5. *Threats.*

X1. Competition with other social networks.
X2. Difficult to ensure reliability of the service
X3. Resources may be misappropriated or may even disappear Consequences of illegitimate use
X4. Publishing of illegitimate content by students may affect the institution's credibility
X5. Protect the student space and their interaction from outside interventions
X6. Protect the anonymity of students
X7. Are there intellectual property issues?

Teachers also express queries regarding:

To what extent does content-specific visualization influence social networks

(a) the group-to-individual transfer and

(b) the intra-didactic divergence of learning partners in the group-to-individual transfer?

The group responses were again sent back to the teachers (Tables 2, 3, 4 and 5) and then they were asked how they could make the most of the existing Strengths and Opportunities so as to reduce the Weaknesses and Threats as much as possible.

The questions raised were:

1. To what extent can processes on the social networks of maths education construction be supported by Strengths and Opportunities to minimize negative elements such as threats to the social networks?
2. To what extent can the social networks improve learning?

New Data analysis

Below we follow a methodology proposed by Nicolaou, Korfiatis, Evagorou, and Constantinou [12]. Data analysis was based on a combination of qualitative and quantitative method. The teachers bear in mind the grouped responses, end up as follows.

Specifically:

The content of teachers' reports and their responses to the pre- and post-intervention tests were analyzed by the author and classified in categories representing the different elements of an optimization decision-making strategy, as they were described in the 'learning and applying decision-making procedures' section:

Use of all criteria to reach an answer: the teachers should construct a list of their own criteria according to which they will make their decision. The criteria were developed by the researcher to evaluate and were classified by researchers in three categories

1) The social network impact of each solution.
2) Effectiveness in solving maths problems, and questions they give rise to in the students, development of collaboration etc.

Ranking of alternative solutions on a common scale of measurement:

Consideration of the relative weight of each criterion. Teachers should decide if some criteria were more important than others and give to them higher arithmetic values.

Sum of the scores for each solution.

Additionally, two generic skills of comprehension and reasoning were evaluated through the analysis of reports and tests, namely:

Understanding the content and the context of the disadvantages – threats in the maths education social networks and the criteria.

Providing an explanation for the steps followed and the solution chosen: Teachers should provide detailed explanations, which would accompany their final decision.

The development of solutions to address the disadvantages of social networks recorded the following categories. In total, each reporter test was graded with a score between 0 and 10 depending on the number of aspects implemented successfully at each task (examples of the implementation of the evaluation scheme for grading students' reports and tests are given in the 'results' section – for similar approaches of content analysing, coding, classifying and evaluating responses to decision-making tasks. Inconsistencies were resolved through discussion between the authors [12].

The researcher then grouped the responses. These groupings had to do with the strengths and weaknesses of an intervention and how, through these, or by following some other road we can lessen the weaknesses and threats. Table 6 describes the reduction of weak points and threats in the second phase after the researcher returned the answers to the teachers. There were cases where some teachers used only the Strengths in their second response [13].

Chi-square tests were contacted between the teachers' first decision and their second decision (in order to search for significant differences). The average score for each group of items was calculated for each teacher before and after the intervention, in order to investigate changes in their opinion about the better functioning of the school unit.

Table 6. *Σύνολα Strengths Opportunities Threats and Weaknesses κατά τις δύο φάσεις.*

	Strengths	**Opportunities**	**Threats**	**Weaknesses**
1st Phase Answers	14	14	7	7
2nd Phase Answers	23	16	3	2

Poor reputation of some teachers with deficiencies in the cognitive field, poor use of social networks and lack of pedagogical knowledge can be offset by the selected multimedia material, as well as the freedom of students and teachers to choose other social networks. So through dialogue the teachers should change their attitudes, be interested in learning and adapting their behavior to pedagogical standards, this time using social networks.

Table 7. *Researcher's grouping of students' responses for reducing Threats Weaknesses.*

Teacher	**Group number of final proposals**	**Number of people in the group who gave similar answers**	**Evaluation response of the researcher on a scale of 10**	**Mixing connectio ns of the Strengths and Opportunities With Threats and Weaknesses**			
				Strengths	**Opportunities**	**Threats**	**Weaknesses**
1	Group 1	4	7.74 (SD:.067)	☐		☐	
2	Group 2	6	6.56 (SD:.65)	☐			☐
3	Group 3	7	8.21 (SD:.89)		☐	☐	
4	Group 4	4	7.45 (SD:.67)		☐		☐
5	Group 5	5	8.67 (SD:.56)	☐	☐	☐	
6	Group 6	15	6.76 (SD:.62)	☐	☐		☐
7	Group 7	11	7.77 (SD:.53)		☐	☐	☐
8	Group 8	5	6.01 (SD:.82)	☐	☐	☐	☐

In other words in the second phase they asked for an increase the value given by their teachers by reducing extra-curricular assistance in informal form by providing more and better assistance and making better use of their time by dealing with other activities.

Therefore in table 7 it seems that the post-response test content revealed that the teacher understood the context of both criteria, used both of them to reach a verdict, then

ranked the alternative solutions on an arithmetic scale of measurement, considered the relative weight of each criterion and added the scores for each solution in order to reach an answer. Finally, the teacher provided a proposal.

In the same table (table 7) the third column shows the number of people who used the SAME mixture of strong points and opportunities offered by social networks in mathematical education.

A paired-samples t-test comparing students' performance on the pre- and post-intervention tests, indicated a statistically significant difference [$t(1,8)=4.500$, $p< .001$].

6. Conclusions

The SWOT and Balanced Scorecard analysis can also be very important tools also for the social networks that are concerned with mathematics. Through them the Strengths and Weaknesses can be identified and exploited. Often the discovery of weak points can lead to their correction. This created better psychology in the teachers and students as they will be involved in making decisions for "their own" social web page.

It would be good to have a framework for developing knowledge with more autonomy, greater use of electronic means, more cooperation with classmates and with other schools, as well as refusing anything that might complicate evolution in learning.

The availability of different types of exercise solution, and the forms of learning offered by the social networks is good. Moreover, teachers have someone to discuss things with who has about the same level of knowledge. Teachers get used to coming into contact with other teachers sometimes even from different subjects.

Another positive factor for social networks is that the teacher, along with other teachers and students wants to and is able to continue as a researcher, e.g., he/she is able to formulate new research problems, is able to work in new research groups and continue to publish, has her/his own network of international contacts,

has knowledge of her/his own about important organizations in her domain, conferences and journals and has been active also in this connection in various ways.

Creation of a friendly environment with good communication with the students. In this environment there should be as few confrontations as possible between students and teachers.

Reflective learning

Independent learning and problem solving skills.

Development of online communication skills.

This can enhance and compensate in part for the weakness and difficulty of acquiring a balanced emotional development due to unnatural presentation.

Another positive factor is the fact that at a global level young people have a very good relationship with the new technologies. They are happy to use the internet. As a consequencemany students have been attracted to this type of atypical education. At the moment they use social networks to solve maths problems with other students or even find answers to simple queries, very often in the form of games. The Threats and Risks that will occur can be determined. It would be good, however, to have confidence among the participants. The questions raised through the analysis and SWOT, particularly those referring to Weak Points and Threats, may cause unpleasant feelings. So the members of the group should have open communication and a good close relationship so that the Weak Points and Possible Threats can be discussed openly and objectively, and have the capacity for change. It would also be good for there to be in the groups (teachers' associations) individuals with different experiences.

Besides formal knowledge, one aim of the course is that the participants on social networks can be trained to use each other as a network for support and source of inspiration in their future searches. On each question it was possible to give comments. Some of those who answered gave very few comments. This may depend on the fact that they are mostly satisfied or that they are at the beginning of using the social networks for study or for the exchange of mathematical ideas. Others complement the answers on many of the questions with their own comments. It is interesting to learn about these experiences and reflections. We surmise that it is possible that the lack of anonymity could have hindered some teachers from commenting more.

7. Discussion

This study extends our knowledge about peer assessment in mathematical issues related to e-learning.

According to Altınay [14] the collaborative online peer learning process in higher education practice is essential for enhancing critical reflection and self-assessment. The development of human potential within an interactive process can be examined within the realm of the online collaborative learning process, in which motivation, social interaction, teamwork and learning experience form the patterns for the fostering of the knowledge creation process investigated in this study [15]. Social negotiation and multiple perspectives through dialogue increase critical thinking, confidence, self-evaluation, and control. This practice supports the ability to think critically, to take responsibility for one's own learning and to gain multiple perspectives through collective interactions within the peer learning environment.

The operation of e-learning throughout this pandemic has shown that such research should continue in order to gather more extensive data on the experiences of both teachers and students, so that:

1. New methods, teaching practices and new knowledge are proposed.
2. The use of social networks for mathematical issues can be improved and become more competitive in relation to live education.
3. All the participants must understand the choices and directions that are considered to be the threats involved during the use of social networks in the teaching of mathematics and the exchange of views between teachers.

4. Both students and teachers feel more comfortable in making proposals, so the teacher can make important changes in a plan that depends on the possibilities and priorities defined by the strengths and weaknesses of students, and can establish how these can be covered.

However, the limitations of the collaborative learning environment should be considered, as well as how they should be addressed by developing organisational and paedagogical models that improve online learning practice and provide information on the value of these practices as well as their limitations.

Also parts of the system still need to improve. First, more experts are required to get more comprehensive opinion and reduce a biased analysis result. Second, sentiment analysis method need to be modified to get better accuracy in classifying the sentiment of user answer. This study is a good start in exploring the possibility to build automatic SWOT analysis system in the domain of secondary Education [9].

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