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EMERGING 2018

Forward

The Tenth International Conference on Emerging Networks and Systems Intelligence (EMERGING 2018), held between November 18, 2018 and November 22, 2018 in Athens, Greece, constituted a stage to present and evaluate the advances in emerging solutions for next-generation architectures, devices, and communications protocols. Particular focus was aimed at optimization, quality, discovery, protection, and user profile requirements supported by special approaches such as network coding, configurable protocols, context-aware optimization, ambient systems, anomaly discovery, and adaptive mechanisms.

Next-generation large distributed networks and systems require substantial reconsideration of exiting 'de facto' approaches and mechanisms to sustain an increasing demand on speed, scale, bandwidth, topology and flow changes, user complex behavior, security threats, and service and user ubiquity. As a result, growing research and industrial forces are focusing on new approaches for advanced communications considering new devices and protocols, advanced discovery mechanisms, and programmability techniques to express, measure and control the service quality, security, environmental and user requirements.

The conference had the following tracks:

- Technology and networking trends
- Quality and optimization

We take here the opportunity to warmly thank all the members of the EMERGING 2018 technical program committee, as well as all the reviewers. The creation of such a high quality conference program would not have been possible without their involvement. We also kindly thank all the authors that dedicated much of their time and effort to contribute to EMERGING 2018. We truly believe that, thanks to all these efforts, the final conference program consisted of top quality contributions.

We also gratefully thank the members of the EMERGING 2018 organizing committee for their help in handling the logistics and for their work that made this professional meeting a success.

We hope that EMERGING 2018 was a successful international forum for the exchange of ideas and results between academia and industry and to promote further progress in the field of emerging networks and systems intelligence. We also hope that Athens, Greece, provided a pleasant environment during the conference and everyone saved some time to enjoy the historic charm of the city.

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The Efficacy of Using GeoGebra in Teaching Eighth Grade Mathematics

The Case of Two Nabatieh Area (Lebanon) Schools

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Abstract—**The objective of this study is to investigate the effect of the use of the GeoGebra program and the educational aids on the achievement of both types of direct and deferred learning in mathematics in the parallelogram and circle unit for the eighth grade students. The study also compared the results of the students who studied the parallelogram and circle units of the eighth grade in the traditional method and those who studied using the GeoGebra program and teaching aids, in order to find out if there are statistically significant differences in favor of the use of the GeoGebra program in teaching. The study showed that the use of GeoGebra has led to an increase in the level of students' achievement in mathematics, in light of the studies that confirm the low level of achievement in the subject of geometry, especially the parallelogram and the circle units when taught in traditional methods. The study also showed that the use of specialized software contributes to the consolidation of concepts, facts and generalizations in the long-term memory of the learner.**

Keywords-GeoGebra; efficacy; mathematics; Lebanon.

I. INTRODUCTION

The educational process aims to educate the members of society according to its values, principles and philosophy. The process of education is essentially a process of communication, whose components are the sender or teacher, the receiver or the student, the message or the mathematical content, the means or the tool or variables used to convey the message to the learners, and finally, the feedback or action that the learner produces to reflect his/her acceptance and understanding of the message [1].

Mathematics is one of the most difficult subjects learned by students, because of its abstract nature. At the same time, mathematics is becoming increasingly important as it is the language of science. In order for a greater proportion of learners to understand different mathematics subjects and acquire mathematical skills, reducing their level of abstraction makes them attractive and understandable. Educational tools, in their different and varied forms, offer mankind this great service that makes mathematics more realistic and close to everyday life [2].

Most students believe that mathematics is not important in their lives, and this led to the formation of negative tendencies towards the study of the subject, in addition to the lack of teachers' use of teaching aids in teaching mathematical concepts [3]. Students at a global level suffer from difficulties in learning abstract concepts. The most important of these is the emphasis on descriptive aspects and formal proof without attention to new mathematical processes such as geometrical sense and the use of technology in teaching geometry [4].

The middle schools in Nabatiyeh governorate lack the use of technology-based teaching aids and computer software in teaching mathematics, especially geometry topics. Mathematics concepts, in general, and in the mathematics of the eighth grade – specifically the units of the parallelogram and the circle – in particular, are showing more confusion, because of the emphasis on the abstract side of teaching, without trying to engage educational tools and computer software to simplify the students' understanding of these concepts and instill them in their minds. Such obstacles can only be overcome through educational means and appropriate computer software designed to achieve the objectives of education.

Based on the recommendations of educational studies related to this subject, and due to the lack of studies and research on the use of GeoGebra and teaching aids in the teaching of mathematics in grade eight, the study investigated the effectiveness of such a teaching aid on the direct and deferred achievement of students in mathematics, probed by a specific student sample and specific topics: the parallelogram unit and the circle unit.

This paper is organized into four sections as follows: Section 2 contains the literature review of the study. Section 3 investigates the methodology of the study. Section 4 discusses the findings and analyzes the data. We conclude the paper in Section 5.

II. LITERATURE REVIEW

The call for the use of teaching aids in education began long time ago, and this is manifested through the role of educators in advocating the use of educational means. Plato considers that the role of the teacher is not based on the imposition of science on students through external pressure, but rather directing the latter with the discussion and the

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questions he mentions. The Platonian educational system has a significant educational status and emphasizes that its use in the educational process achieves the educational goals envisaged. Roso has demanded that the child's access to reasonable things be via the means of concrete things, which is known as experiential learning [3].

A. Reasons for low student achievement in mathematics

Sbeitan reported that the world-renowned educational scientist Kline highlighted in his famous book (Why Johnny Cannot Add) his criticism of the traditional curriculum in mathematics and the drawbacks that lead to low achievement of students in mathematics. The most important points are [5]:

- Focusing on automation training and memorization, since the goal of the traditional curriculum was to teach arithmetic skills and the memorization of rules and theories and providing them through training and repetition without focusing on understanding and application.
- The emergence of concepts, facts and processes separate from each other.
- Lack of consideration of accuracy and clarity of expression, and lack of mathematical precision to be provided in curricula and textbooks.
- Inclusion of traditional curricula and books of some useless topics that had lost its importance and value.
- Avoidance of curricula, books and traditional books of mentioning the mathematical proof except in geometry.
- Lack of curriculum and textbooks to the element of motivation and suspense.
- Lack of books and curricula to keep abreast of modern developments that meet the requirements of the times and the needs of individuals and society.
- The use of old methods that proved ineffective in the teaching of mathematics, and the reluctance to use alternative methods.
- Poor professional preparation of the teacher, so the weakness of the teacher professionally is reflected on the low level and achievement of the students in mathematics.

B. Features and characteristics of the GeoGebra software

GeoGebra [6] is a program based on the scientific standards of mathematics and the curricula adopted by most Ministries of Education around the world, not a substitute for them. Markus Hohenwarter developed the program along with an international team of programmers (University of Florida, Atlantic). It is designed in a way that enables the student to develop a deep understanding of mathematical theories and realities through practical application, and the discovery of concepts himself. It is a collection of tools that contribute to the achievement of the student's mathematical skills, and includes all the aids necessary to make the learning process easy and interesting, as the student builds on his previous learning [7][8].

The themes common to GeoGebra and the Lebanese curriculum are:

1- Plane and space Geometry plan
2- Statistics
3- Algebra
4- Coordinate systems
5- Lines in the coordinate plane
6- Functions
7- Polynomials.

III. METHODOLOGY

A. Design of the study

The study is classified as descriptive quazi-analytical and experimental approach. A commercially available statistical package (SPSS, version 21 [9]) was used to analyze the data.

B. Participants

The study sample consists of 34 students. The sample is divided into two groups: the first group (A) consists of the eighth grade students in one public school and the second group (B) consists of the eighth grade students in another public school, plus some 41 instructors of mathematics in the schools of Nabatiyeh area. The researcher chose the sample in a deliberate manner, so that the sample of the study is in schools equipped with the means and tools necessary for the study, such as educational tools, display screen and computer laboratory that are well equipped and appropriate.

C. Instrument

The researcher used the training material of the Circle Unit and the Parallelogram Unit, the GeoGebra application, a computer and a projector, tests of comprehension – both direct and delayed – and a teachers' survey.

D. Experiments

The researcher used the training material of the Circle Unit and the Parallelogram Unit, the GeoGebra application, a computer and a projector, tests of comprehension – both direct and delayed – and a teachers' survey.

IV. RESULTS AND DISCUSSION

The current study aims to identify the effectiveness of the use of the GeoGebra program in the direct and deferred educational achievement of the eighth grade students in Nabatieh Governorate, the extent of the use of the GeoGebra program, and the compatibility of the curriculum and the approved textbook with the use of the program and teaching aids. To achieve this goal, the researcher prepared educational tools and the use of the GeoGebra software, where two groups of students were taught. The first one studied the material using the GeoGebra program and the

TABLE I. THE RESULTS OF THE DIRECT TEST ON THE PARALLELOGRAM UNIT

Section (A) – GeoGebra		**Section (B) – Traditional Method**	
Mean	***Standard Deviation***	***Mean***	***Standard Deviation***
12.88	3.71	10.00	3.98

second studied the same material in the traditional way. Then the first group studied the rest of the experimental material using the traditional method, and the second group studied the same lesson using GeoGebra. Two tests (direct and deferred) about the lessons that were explained to the students were administered. After collecting the data and processing it statistically using a commercially-available program, the following results were drawn:

TABLE II. A COMPARISON BETWEEN THE DIFFERENT TEACHING VARIABLES OF THE LESSON ON THE PARALLELOGRAM UNIT

Variable	Section (A) - GeoGebra	Section (B) – Traditional Method
Nb of hours of explanation	2	3
Nb of hours of lesson preparation	3	1
% of students who identified the lesson properties during explanation	73	<10
% of students who passed the test of learning outcomes	81.25	55
Drawing competency	Weak	Good
Teaching method	Active and stimulating, for the student is a partner in the teaching-learning process	Slow and dull, for the teacher is the focus of the process, rather than the student

The results of the direct test of the two groups, after explaining the parallelogram unit in Section (A) using the GeoGebra and explaining the same lesson in Section (B) using the traditional method, are shown in Table I.

Table II shows that the use of the GeoGebra program is more activating and stimulating for the students than the traditional method. This was demonstrated by the interaction of the students with the teacher during the explanation. The percentage of students who discovered the characteristics of the lesson was 73% compared with less than 10 percent when using the traditional method. Learning using the GeoGebra program takes less time to communicate the concept and objectives that the student is supposed to learn than in the traditional way.

After the same direct evaluation of the two sections, the success rate in Section A was 13 out of 16 (81.25 %), compared with Section B (10 out of 18, or 55 %). This shows that the result of the students' achievement in Section (A), in which the lesson was explained by the use of the GeoGebra program, is better than the result of the students' achievement in Section B, in which the lesson was explained using the traditional method.

TABLE III. THE RESULTS OF THE DIRECT TEST ON THE CIRCLE UNIT

Section (A) – Traditional Method		Section (B) – GeoGebra	
Mean	***Standard Deviation***	***Mean***	***Standard Deviation***
9.66	4.11	11.74	3.52

In contrast, the amount of time it takes to prepare a lesson with the use of the GeoGebra program is more than the amount of time it takes to prepare the lesson without it. The preparation of the lesson in Section (A) took three hours versus one hour to prepare the lesson in Section B.

The observations during the experiment also revealed a weakness in the skill of manual drawing of the students who learned using the GeoGebra program (Section A), compared with the students who learned without using the GeoGebra program (Section B).

The results of the direct tests of the two sections, after explaining the circle unit in Section (B) using GeoGebra, and explain the same lesson in Section (A) in the traditional way, are shown in Table III.

The results shown in Table IV prove that the use of the GeoGebra program is more activating and stimulating for the students than the traditional method. This was demonstrated by the students' interaction with the teacher. The percentage of students who discovered the characteristics of the lesson was 65% (15 % when using the traditional method), as well as learning using the program GeoGebra takes less time to communicate the concept and objectives intended to provide the student of education in the traditional way, where lesson took one lesson with the use of the program GeoGebra compared to two hours using the traditional method.

TABLE IV. A COMPARISON BETWEEN THE DIFFERENT TEACHING VARIABLES OF THE LESSON ON THE CIRCLE UNIT

Variable	Section (A) - Traditional Method	Section (B) – GeoGebra
Nb of hours of explanation	2	1
Nb of hours of lesson preparation	1	2
% of students who identified the lesson properties during explanation	15	65
% of students who passed the test of learning outcomes	56.25	72.22
Drawing competency	Good	Weak
Teaching method	Slow and dull, for the teacher is the focus of the process, rather than the student	Active and stimulating, for the student is a partner in the teaching-learning process

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After the same direct evaluation of the two sections, the success rate in Section (A) was 9 out of 16 (56.25 %), compared to Section (B) 13 out of 18 (72.22 %).

This shows that the result of the students' achievement in Section (B) in which the lesson was explained by using the GeoGebra program is better than that of the students in Section A, in which the lesson was explained using the traditional method.

In contrast, the amount of time it takes to prepare a lesson with the use of the GeoGebra program is more than the amount of time it takes to prepare the lesson without it. The preparation of the lesson in Section A took one hour, compared to two hours to prepare the lesson in Section B.

Two weeks after the completion of the either unit explanation, another test was carried out to assess the level of achievement of the two sections in order to compare the results of this test with the results of the direct test conducted immediately upon completion of the unit explanation. This is to determine whether education using the GeoGebra program has a positive effect on deferred comprehension. The experiment clearly proved (data not shown) the marked superiority of the marks obtained by the students who studied the material using GeoGebra, over their peers who studied the same material – either unit – by the traditional method. The mean of deferred parallelogram test was 12.98, even higher than the average of the direct test of 12.88. The increase of 0.115 indicates – however modest – that teaching using the GeoGebra program has a positive effect on deferred learning.

V. CONCLUSION

The paper sheds light on the use of a specific computer application as a teaching aid in mathematics, in order to ameliorate the students' understanding of the parallelogram and circle units, taught in grade eight in the Lebanese curriculum. There was a clear difference in the learning statistics between the students who studied the units of the circle and the parallelogram using the GeoGebra program and the students who studied the same units using the traditional method, both on the scale of direct and deferred testing, in favor of the GeoGebra. This indicated that the use of technology made it easier on the students to grasp otherwise hard concepts. This was manifested by the test results based on the learning outcomes.

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Adaptive Probabilistic Search in Complex Dynamic Networks

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***Abstract*—Probabilistic flooding search is a fundamental technique for a wide range of complex systems. However, search over these systems is quite challenging due to their dynamic and complex nature, which results from the interactions between participants. Here, we propose A2PF, an adaptive probabilistic search scheme, which is capable of adjusting its operation in dynamic network environments. It works in a distributed manner and each participating node exploits past query messages to reveal hidden attributes of the network topology (e.g., other nodes' degrees). Based on such estimates, and with a partial knowledge about the topology of its neighborhood, a node decides how to efficiently forward incoming query messages to other nodes. In order to quantitatively evaluate and confirm the performance of A2PF, we conduct detailed experiments in various network topologies.**

Keywords–Complex networks; dynamic networks; probabilistic flooding; search.

I. INTRODUCTION

Search is a common and well known operation in numerous domains, including physical, biological, economic, communication social and peer-to-peer (p2p) systems [1]–[4]. The process of search unfolds when a node generates a question (or a query message); the message is transmitted, traversing the network until it gets answered or some termination condition is met. The query is about locating resources (e.g., data, services, information or other types of computational resources [5]) or target nodes.

The development of search strategies has a rich history [6]. It has become the subject of a substantial amount of research and as a result, quite a few schemes have been proposed. Flooding and its variants are traditionally used for search in real-world networks as information regarding target nodes or resource placement is inherently limited. Because flooding can indeed flood the network with messages, its extent is usually limited by a Time-To-Live (TTL) parameter. TTL is actually the maximum number of hops a query message is allowed to travel. One of the major drawbacks of flooding is the large number of produced messages which overload the network quickly [7].

Probabilistic search, which is the subject of this paper, is a class of dynamic search strategies which try to alleviate the deficiencies of flooding. In this type of search, each node propagates the query message with a given probability, termed *forwarding probability*. One of the major goals of probabilistic flooding strategies is to determine the forwarding probabilities so as to make the decision whether to further propagate a message or not, as efficient as possible. This decision may encode a property of the network or an estimation of some of the system characteristics, e.g., approximate knowledge of node distances or resource popularity.

Actual networks are usually formed by nodes and links between them that change over time [8]. The problem of performing search efficiently in such settings is vastly more difficult than in static networks. The search procedure now faces new restrictions and challenges as it has to deal with temporal links and *churn*. Churn [9] refers to the continuous process of node arrival and departure in/from the system.

In this paper, we propose a new search method which is applicable to dynamic networks. It is rooted in a previous proposal [10] but exploits local information about the generalized neighborhood of a node, which is collected from past queries that have been submitted by other nodes in the system. The main contributions of this work are the following:

- We propose Adaptive Advanced Probabilistic Search (*A2PF*), a novel adaptive search scheme which is capable of adjusting its operation parameters in dynamic networks.
- We implement a local mechanism that "learns" topological properties of the network from passing messages.
- We provide experimental evidence on dynamic networks, which show that A2PF is able of achieving superior performance in comparison to other probabilistic flooding protocols.

The rest of this paper is organized as follows. After discussing related works, Section II gives the system model and introduces our heuristic for unveiling characteristics of the network topology. The proposed A2PF strategy is then presented in Section III. Section IV presents experimental results and, finally, Section V concludes this work.

A. Related Work

Typically, researchers study the problem of search in networks which are modeled as static (non-evolving) graphs. Plain flooding propagates the query messages with forwarding probability equal to 1 and makes no use of knowledge about the structure of the network or any other of its properties. In modified BFS (mBFS) [11], a node propagates the query message only to a subset of its neighbors with a fixed forwarding probability. Adaptive Resource-based Probabilistic Search (ARPS) [12] varies the forwarding probabilities according to resource popularity and node degree distribution. Advanced Probabilistic Flooding (APF) [10] adjusts the forwarding probability according to the distance from the query initiator and the popularity of the requested resource.

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However, the above approaches are not designed for many real-world cases, where the state of nodes and links change over time. Studies on structured and unstructured peer-to-peer (p2p) systems [9] [13] [14] try to understand the user behavior and examine the impact of churn on the network and its processes. Other works [15]–[17] study the limitations of distributed computations, such as counting, aggregation, summing or averaging in dynamic networks, using random walkers, gossip protocols or other probabilistic forwarding techniques.

Using simulation, Furness and Kolberg [18] investigate the impact of churn on the success rate of "blind" search techniques in structured p2p systems. Augustine et al [19], assuming limited churn and efficient storage, propose randomized distributed algorithms that guarantee the data retrieval with high probability even under high adversarial churn.

Finally, the works in [20]–[23] examine the completion time of the flooding mechanism on dynamic graphs, which are modeled as a fixed set of nodes with links whose birth and death is modeled after a Markovian process. These approaches do not capture other important network events, such as node arrivals and/or departures.

II. System Model and Methodology

Let $G_\tau = (V_\tau, E_\tau)$ be a graph that is defined by its node set $V_\tau = \{v_1, ..., v_N\}$ and edge set $E_\tau = \{(v_i, v_j) | v_i, v_j \in V_\tau\}$, representing our dynamic network at time τ. Here, we focus on the classical Erdős-Rényi (ER) network and on scale-free networks. The ER network is formed on N nodes and each pair of nodes is connected by an edge with some given probability p. In scale-free networks, the node degrees follow a power-law distribution.

Each node u in the network has a certain lifetime that is defined at node creation time. At a particular time τ, this node is *active* if it participates or *inactive* if it has left the system. Similarly, each neighbor v of an active node u can be either active or inactive. The state of each neighbor is modeled as an on/off process $Y_v(\tau)$ [24], where

$$Y_v(\tau) = \begin{cases} 1 & \text{neighbor } v \text{ is active at time } \tau, \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

At time τ, the degree of node u, can be calculated as

$$d(\tau) = \sum_{v \in \mathcal{N}(u)} Y_v(\tau)$$

where $\mathcal{N}(u)$ is the immediate neighborhood of u (i.e., the set of all nodes that have a connection with u).

Flooding search starts at a randomly picked node u. The node sends the query message to all its neighbors, and then the neighbors which do not know about the asked resource forward the message to their own neighbors, repeating the process until the whole network or a certain part of it has been reached. Intuitively, the flooding search process discovers new nodes in rounds. In step/round 1, it reaches the neighbors of u, in step 2 it reaches the neighbors of its neighbors, and so on. Each query message embeds a step (or hop) counter, which is incremented by 1 when the message gets forwarded to the next node, so that the process can be limited to some maximum allowed distance (TTL).

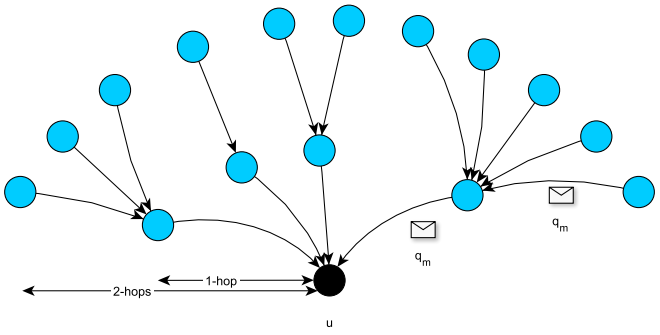

Figure 1. The flooding shape as it is viewed by node u. It is the result of information collected from incoming query messages q_m.

A. Average Degree at Distance t

As we discussed above, a node u with degree $d(\tau)$ knows that there exist $\sum_{v \in \mathcal{N}(u)} Y_v(\tau)$ nodes at distance 1. Suppose that the average number of nodes in distance t from a node u is n_t. During the flooding process, these nodes will be receiving the query message at exactly the t-th step. If we symbolize the set of these nodes by $\mathcal{N}_t(u)$, then the average degree of nodes at distance t from a node u is given by:

$$\overline{d}_t(\tau) = \sum_{v \in \mathcal{N}_t(u)} Y_v(\tau)$$

We are interested in determining n_t and $\overline{d}_t(\tau)$. However, in complex networks with arbitrary degree distributions, deriving analytically these quantities for distance $t > 1$ is not always precise or indeed possible [2] [25] [26]. In addition, such approaches are based on the assumption that the network is static. To overcome this problem, we propose a heuristic technique.

Consider an active node u which, during its lifetime, poses and receives query messages. Every node in the network is assumed to never re-forward any message that it forwarded in the past. In effect, each node implements a local log/monitor at each connection in order to limit retransmissions of the same message on that edge. Due to the nature of flooding-based schemes and the utilization of local monitor mechanisms, first-time message receptions occur through shortest paths. Thus, a node can learn its distance from the querying node simply by checking the hop counter in the message. Consider node u as illustrated in Figure 1. From incoming query messages, node u can learn the distances to other nodes in the network. This leads us to the following idea: it may be possible to discover additional network parameters through the information stored in query messages. For example, if querying nodes include their degree within the message, node u could also estimate the average degree of nodes at any distance t, simply by averaging up all the incoming degree information from messages with hop counter equal to t. This key insight allows node u to uncover structural information about the network topology.

Consequently, we enforce the following rules for all the nodes in the network:

- Every querying node u includes its degree into the query messages (q_m) it poses in network.
- Every node v which receives a query message q_m for the first time, at step t of the search process, stores

the embedded degree information in order to estimate the average degree of nodes at distance t.

B. Estimating the Average Degree at Distance t

Each node exploits observations from incoming query messages coming from a certain distance t, in order to estimate the average degree of nodes at this distance. This estimation can be simply the arithmetic mean of the k most recent observations (node degrees). Such an estimate assumes that all values are equally important. However, the degrees of nodes change over time due to the dynamic evolution of the network; in addition some of those k values may not be relevant any more because the corresponding nodes departed and are no longer active.

To obtain a better estimate, we resort to a *weighted* mean where we give more emphasis to recent values and progressively forget the past ones. For a participating node, let $\hat{d}_t$ represent the estimate of the average node degree at distance t. For each subsequent received value, the new estimation is calculated as a linear combination of the current one and the new incoming value, as follows:

$$\hat{d}_t(\text{new}) = (1 - w) \times \hat{d}_t(\text{current}) + w \times value$$

where $value$ is the newly received information about node degree at distance t, and w is the weight factor, $0 \leq w \leq 1$. Initially, when the first messages from distance t arrives, we set $\hat{d}_t = value$. The weight factor is a design parameter and determines how quickly the past values are forgotten. Its value should be tuned according to the characteristics of the network and the generated queries; for example, under a high churn rate and relatively infrequent queries, a value of $w > 0.5$ might be more appropriate so as to quickly "learn" the new node degrees.

III. Advanced Adaptive Probabilistic Search (A2PF)

Suppose that a node u poses a query message to the network using a flooding-based strategy. We can visualize the search space as extending in concentric circles, with node u at the center and the nodes on the circle of radius t being nodes lying t hops away from u. For example, the nodes in the first cycle ($t = 1$) are u's immediate neighbors; the second circle ($t = 2$) contains the immediate neighbors of u's neighbors, etc. When a node receives a query, it does not know if the query has been answered on another search path. Here, we exploit the main idea behind the original APF strategy [10], which chooses to propagate a query message only if the query has not been answered yet (with high probability). To do this, we need to know the number of nodes that have received the query up to that point, so as to estimate if the query is already answered or not.

Let n_t be the number of nodes that have received the query exactly at step t, and let N_t be the number of all visited nodes up to and including step t; clearly $N_t = \sum_{i=0}^{t} n_t$. According to APF, which assumes static networks, the number of nodes that have received the query at step $t+1$ can be calculated as follows:

$$n_{t+1} = (\overline{d}_t - 1) n_t \left(1 - \frac{N_t}{N}\right) \tag{2}$$

where $\overline{d}_t$ is the average node degree in distance t from u. A node that receives the query at step t, may then decide to forward it with probability $(1 - (N_t/N))^{qN}$, where q is a measure of the popularity of the required resource.

Notice, however, that it was implied that $\overline{d}_t$ is either known or can be (imprecisely) substituted by the average degree of the whole network. While the actual details are given in Section IV, Figure 2 can serve as an early illustration of how the average node degree varies according to the distance, as viewed by a node. In networks with power-law degree distributions, the average degree decreases abruptly after the first few hops. This means that the average node degree may be quite large during the first steps of the search process, converging to the network average degree in the following steps. Clearly, we need the knowledge of the average degree at distance t from a node so as to obtain an accurate estimation of the network coverage and guide the search process.

In dynamic networks, the number of nodes varies over time according to the churn characteristics while links between nodes may come and go. Let $N(\tau)$ be the number of nodes of network at time τ. Based on (2) we can express the number of nodes that have received the query at step $t+1$ in a dynamic network as follows:

$$n_{t+1} = (\overline{d}_t(\tau) - 1) n_t \left(1 - \frac{N_t}{N(\tau)}\right).$$

Similarly to the static case, the term $\overline{d}_t(\tau)$ is crucial for the successful calculation of n_{t+1}, especially for particular families of networks, such as scale-free ones. In the proposed A2PF strategy we use the estimator presented in Section II-B to approximate $\overline{d}_t(\tau)$:

$$n_{t+1} = (\hat{d}_t(\tau) - 1) n_t \left(1 - \frac{N_t}{N(\tau)}\right). \tag{3}$$

The forwarding probability is then given by

$$p_f(t) = \left(1 - \frac{N_t}{N(\tau)}\right)^{qN(\tau)}.$$

IV. Simulation

We use the *Armonia* simulation framework [27] to evaluate and compare our approach with other flooding-based strategies. Armonia offers a multitude of parametrized topologies, while also allowing the generation of additional ones. Armonia offers complete control over resource allocation and placement. Finally, it implements a large number of search protocols but also provides facilities for user-defined ones.

For our purposes here, we conduct our study on synthetic networks, focusing on classical Erdős-Rényi (ER) random graphs and Barabási (BA) power-law graphs. The networks can be static or dynamic. Initially, the network has N nodes; this number can vary in dynamic networks during simulation time. The nodes provide resources (with each resource having a number of replicas), which are uniformly distributed over the network. In dynamic networks, a node participates in the system for a certain time period, called the node *lifetime*, which is the elapsed time from its first appearance in the system until its departure. The lifetime of each node is defined at creation time by a Weibull distribution [13] with parameters a and b. New nodes join the network according to a Poisson distribution with arrival rate λ. A total of 1,000 queries are submitted to the system; we collect the measurements and average the results.

Before proceeding with the comparative study, we first present the average degree as a function of distance t in real-world datasets, obtained from the Stanford Network Analysis

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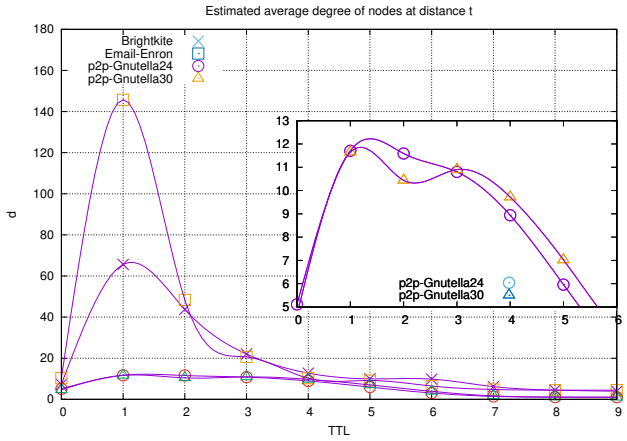

Figure 2. The overall average degree of nodes in distance t, measured in datasets from real networks.

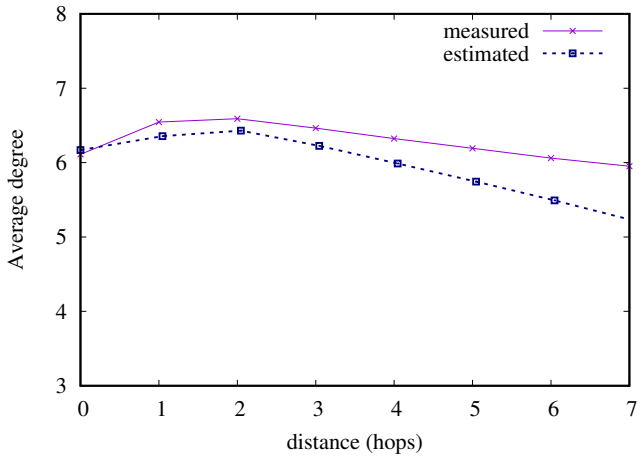

Figure 3. The overall average estimation of node degrees per hop distance vs the actually measured ones in a dynamic ER network of 1,000 nodes.

Platform [28]. Figure 2 shows the overall average degree per hop distance for the following traces: two gnutella network snapshots with 26,518 nodes and 36,682 nodes, captured at 2002, a trace of the email-Enron network with 36,518 nodes and a trace from the Brightkite social network with 58,228 nodes. We observe that the average degree 1 hop away is quite larger than the average network degree. This proves that knowledge of the average node degree in the network cannot serve as a good approximation of the node degree at arbitrary hop distances.

Next, we apply our heuristic estimator in a dynamic ER network with 1,000 nodes. The node lifetime is determined by a Weibull distribution with parameters $a = 7,200$ sec and $b = 4$ and the arrival rate is $\lambda = 2$. Nodes submit queries and collect statistics about other nodes' degrees. The estimator weight factor was empirically set to $w = 0.1$ to favor past estimations. Figure 3 shows the arithmetic mean of averages, over all nodes as estimated by our heuristic ("estimated" curve) while the other curve ("measured") shows the actual averages as a function of distance t for the same network. While the two curves do not coincide, the estimator proves to follow effectively the measured curve, even if the weight factor was not fine-tuned.

For our comparative study, we consider four flooding-based search policies, namely plain flooding (flood), mBFS [11], ARPS [12] and our proposed A2PF. All strategies are constrained by a TTL hop limit. Also, they are assumed to maintain a local monitor mechanism in order to avoid the re-forwarding of an already sent message. For the mBFS and ARPS strategies, the forwarding probabilities (p_f) follow the corresponding authors' guidelines. In particular, in mBFS the query is forwarded to 50% of a node's neighbors ($p_f = 0.5$), while in ARPS the value of p_f depends on resource popularity. For plain flooding $p_f = 1$. The forwarding probabilities of A2PF involve a different calculation in each node, using the estimations in Section III. We assume that the basic structural properties of the network do not change drastically over time, so that $N(\tau) \simeq N$, approximately balancing arrivals and departures.

The comparison is based on the performance of these search strategies on different networks. We assess the performance based on three metrics:

- The *probability of success*, which measures the probability that a query can locate the desired resource, given the TTL hop limit. A query is considered successful if it discovers at least one replica of the resource in question.
- The total number of *messages* that are transmitted, before the resource is located.
- The number of *duplicate messages*. A message is considered duplicate, or redundant, if it is received by the same node more than once (and thus does not contribute to the success of the search). It serves as a measure of the how efficiently a policy utilizes the network resources.

We present three different experiments. The corresponding simulation parameters are summarized in Table I.

The first ER model is generated with 30,000 nodes and high churn (45%). Resource popularity is the same for all resources and equal to $q = 0.0006$. Figure 4 shows the results (success rate on the left and number of duplicate messages on the right) obtained by simulating the four search strategies. While all strategies manage to locate at least one resource in the first few hops, only A2PF produces negligible duplicate messages. One of the key benefits of A2PF is its adaptive behavior on network changes.

Next, we use the model of Barabási-Albert [29] and generate a scale-free network with no churn. In scale-free networks, the node degrees can vary significantly with respect to the average network degree. In practice, this impacts heavily the search process. In this experiment we test the behavior of our approach on such networks. This particular network starts with three connected nodes. Each new incoming node is connected to two existing nodes ($m = 2$). New nodes prefer to link with nodes with more neighbors. The total number of nodes on the network is 30,000. Resource popularity is uniform and equal to $q = 0.0016$.

Figure 5 illustrates the simulation results. We observe that flooding is successful after 2 hops, ARPS and A2PF need 1 more hop, while mBFS needs a further 1 hop. At the same time, we observe an exponential growth of duplicate messages in the case of plain flooding and ARPS. In contrast, mBFS

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TABLE I. SIMULATION NETWORK TYPES AND PARAMETERS

$\overline{d}$	*network*	*nodes*	q	*Flooding*	*mBFS*	*ARPS*
6	dynamic ER	30,000	0.0006	$p_f = 1$	$p_f = 0.5$	$p_f = 0.9$
4	BA	30,000	0.0016	$p_f = 1$	$p_f = 0.5$	$p_f = 0.8$
4	dynamic BA	20,000	0.005	$p_f = 1$	$p_f = 0.5$	$p_f = 0.7$

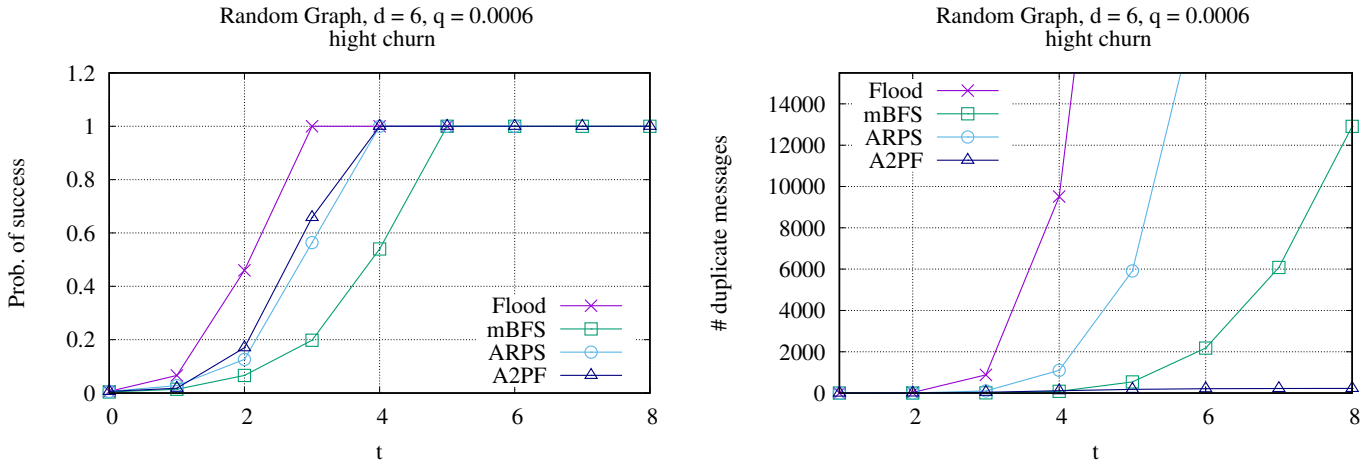

Figure 4. Success rate (left) and duplicate messages (right) in a dynamic ER network with 30,000 nodes, $\overline{d} = 6$ and $q = 0.0006$. The churn rate is churn 45%.

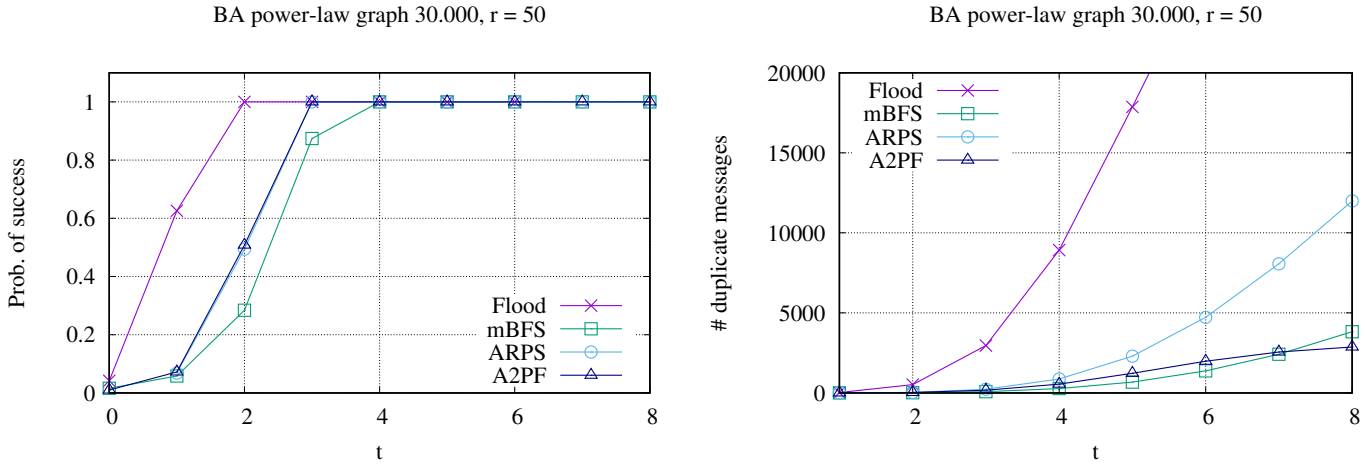

Figure 5. Success rate (left) and duplicate messages (right) in a BA power-law network with 30,000 nodes and $m = 2$, $q = 0.0016$.

and, especially, A2PF, manage to keep such messages in quite limited quantities.

Finally, we consider the search performance of the four strategies on a dynamic BA network with 20,000 nodes under high churn (45%). The experimental results are given in Figure 6. Flooding has the best success rate as a function of hop distance. At the same time, it pays the price of the largest number of redundant messages. ARPS and A2PF have similar success rates while A2PF produces the fewest number of messages among all strategies. mBFS does not seem to be very effective in this case.

All the above experiments indicate the consistent superiority of A2PF over the other three strategies (flooding, ARPS, mBFS) regarding the success rate and the number of redundant messages. The employment of the heuristic estimator is responsible for the success of A2PF, giving it the ability to moderate the redundant traffic.

V. CONCLUSION

In this work, we propose the A2PF, an adaptive probabilistic search strategy, which exploits knowledge collected from received queries at each node. A2PF is based on APF and embeds a new heuristic mechanism. The heuristic mechanism assists nodes in estimating the average degree of nodes $t \geq 2$ hops away from them. The estimations guide a node to make a knowledgeable decision whether to further propagate a query message or not. Our experimental results confirm that A2PF is fast and efficient.

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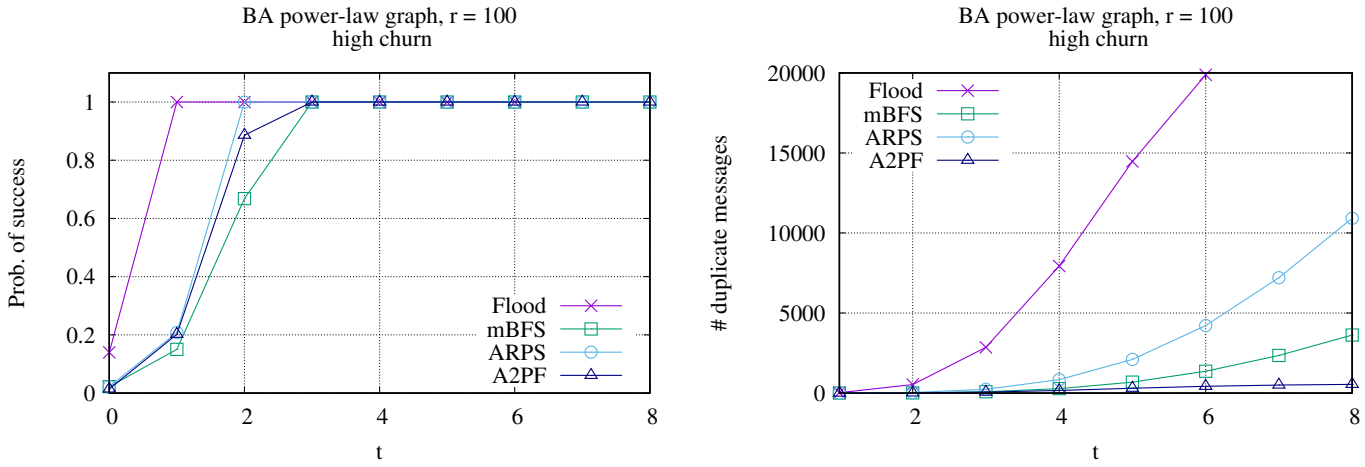

Figure 6. Success rate (left) and duplicate messages (right) in a BA power-law network with 20,000 nodes, $m = 2$ and $q = 0.005$. The churn rate is 45%.

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Perception of English Teachers towards the Use of Technology in Class

The Case of Nabatieh Area (Lebanon) Schools

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***Abstract*—This study investigates the perception of English teachers about the use of technology in their classes in Nabatieh – South Lebanon – schools. Descriptive qualitative and quantitative methodology, which includes a questionnaire and interview questions, is used to answer the research questions. Data is collected from English teachers and coordinators from Nabatieh district schools – both public and private – and a university, the Lebanese International University (LIU). The findings revealed that technology is used more in Nabatieh private schools, English teachers at Nabatieh schools are well-equipped with technology, technology use enhances the students' performance and attention in class, and that technology is frequently used in teaching English in classes.**

Keywords-attitude; perception; technology; Lebanon.

I. INTRODUCTION

Technology provides various options to make teaching more interesting and productive when it comes to improvements. Today, technology is being used as part of new, updated methods in teaching to serve students with auditory and visuals aids [1]. As the English language is becoming increasingly used globally, it is being learned and spoken by many individuals every day. Technology-mediated language learning seems to be most successful when the technology is continuously integrated into the overall activity and where it is used as a tool in curriculum. Technology is continuously being used for many skills and activities of language teaching [2].

This paper is organized into four sections, as follows: Section 2 contains the literature review of the study. Section 3 investigates the methodology of the study upon discussing the design of study, participants, instruments, findings, and data analysis. The results and their discussion are presented in Section 4. We conclude this paper in Section 5.

II. LITERATURE REVIEW

A. The impact of technology integration

The impact of integrating Information and Communication Technology (ICT) in education has been explored by many researchers in various contexts and settings. There was a common result in most of the studies, which showed the effectiveness of technology use in education and how it helps in creating teaching methods and developing students' knowledge. Technology provides learners access to high amount of data that the teacher has no control on. However, teachers in schools are being more active in implementing new thoughts while their attitude and beliefs may support improvements in education. Technology gives students the opportunity to learn in the most updated ways. Using technology in language classes, like English language, is changing the way we learn. The Internet gives access to new vocabulary, mostly because the users lead the language to specific ways. The positive results of technology integration in education have persuaded many countries to include the use of technology in their programs in order to develop workforces that are skilled and educated in technology, as well as being able to meet with international challenges [3].

B. The barriers to the effective use of technology in education

Lack of professional development is one of the barriers, where in many schools, teachers do not feel ready to learn technology and integrate it while teaching in class, whereas students know how to use technology for educational purposes. Another barrier is resistance to change; in this case, some teachers prefer to stick to the old methods of teaching. Using technology in class can be very demanding at first because students need some assistance [4]. Also, the lack of innovation can be considered another barrier where teachers need to be creative when using technology tools in classes. For some teachers, it is easy to learn, while others take some time to learn technology tools in their teaching [5]. Access to technology is the most obvious barrier, where some schools lack access to technological equipment that can be used as auditory and visual aids [6].

C. Training educators to integrate technology in classrooms

Teachers need to comprehend the latest approaches for applying technology in class in order to have effective technology enhanced instructional strategies. How a teacher feels about applying technology in class impacts how it is used in classrooms and how it affects students' learning. It is important to include teacher training in schools a keep teachers informed about new technology programs and tools

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so that teachers will be ready to use it with their students and make teaching and learning an easy and fun process [3].

D. *Analysis on necessity of application of multimedia technology to English teaching*

There are many reasons to apply multimedia technology to English teaching. One of the reasons is that it cultivates students' interest to study [7]. Another reason is that multimedia technology promotes students' communication capacity [2]. Also, it is used to widen students' knowledge to gain insightful understanding to Western culture [7]. In addition, multimedia technology helps improve the effect of teaching [2]. Moreover, it improves the interaction between students and teachers. Multimedia technology also creates a context for teaching languages [7]. Finally, multimedia technology provides flexibility for the course content [2].

III. METHODOLOGY

A. *Design of the study*

The study is classified as descriptive qualitative and quantitative, since the results will be described and analyzed statistically to get information about research questions and hypothesis. Commercially available statistical packages are used to analyze the data.

B. *Participants*

The participants that will be helping in collecting data for the research are English teachers and English coordinators from various schools – both public and private – and a university in Nabatieh district.

C. *Instrument*

In this research, the techniques or instruments to be used are a questionnaire that the English teachers will fill in and an interview that will be done with the English coordinators. The questionnaire is made up of 24 questions built using Google Forms and the interview includes 8 questions. We got the ethical approval from the University Institutional Review Board (IRB), as well as the permission from the Ministry of education to be able to apply these two instruments in the schools

IV. RESULTS AND DISCUSSION

The teachers who replied to the survey were 46; 34 teachers from Nabatieh, 2 from Bekaa, 1, Mount Lebanon, and 10 from South Lebanon. English teachers were females more that they were males, and the age distribution is given in Fig. 1. The teachers that replied to the survey are public school teachers more than they are private teachers. Most of the English teachers have Master's degree (60.9%), BA (34.8%) and the others are distributed to other educational levels. Their educational experience is depicted in Fig.2, and their distribution by cycle is in Fig. 3.

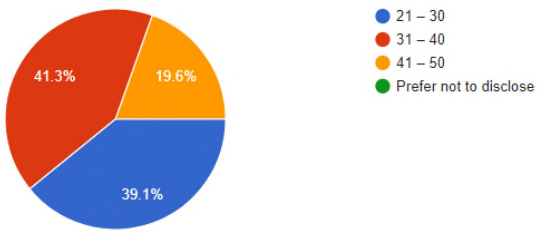

Figure 1. Age group of the responding English teachers.

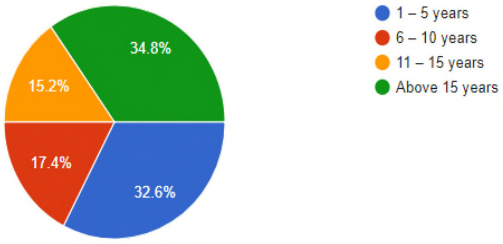

Figure 2. Teaching experience of the responding English teachers.

Most of the teachers use computer applications in their class, and most of the English teachers have received training sessions. The majority of the schools consider ICT training as not obligatory. Also, most of the schools do not have an ICT coordinator, and most the schools do not reward teachers for using ICT in class.

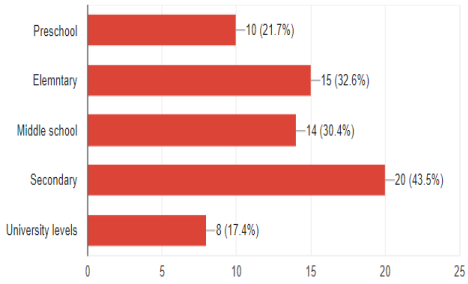

Figure 3. The distribution per cycle of the responding English teachers.

The data show that most of the school's computers are located in the computer laboratory, while others are distributed in other places in the schools and very few schools do not have computers. Not only do most of the English teachers use ICT in their class (Fig. 4), some because they choose to do so and some because of curriculum requirements, the majority of these teachers believe that their knowledge of content, pedagogy and technology is enough to use ICT in class. Most of the teachers agree that ICT has a positive impact on the learning process, and many teachers agree that ICT allows students to be attracted more to the lesson explanation, and agree that ICT helps students in academic performance.

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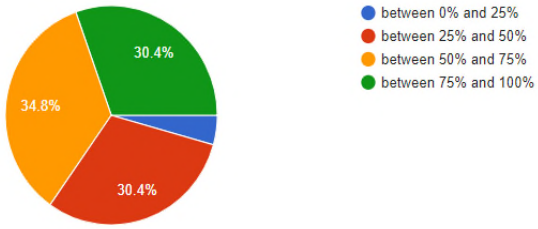

Figure 4. The frequency of using technology in the classes of the responding English teachers.

The findings showed that the more teaching experience the teachers have, the easier the use of ICT in their class. The teachers who use ICT more in class are in private schools, holding Master's degrees, and aged between 21 and 40. Most of the teachers who believe they are very good in integrating ICT in class, have received ICT training sessions.

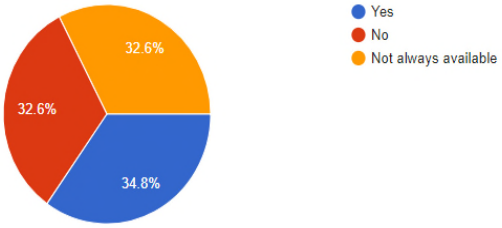

Figure 5. The presence of proper staff for ICT equipment in the classes of the responding English teachers.

The teachers that said they do not have computers in their schools are of public schools, while in private schools, the teachers have access to computers and technological help (Fig. 5). It was also shown that, in these private schools, ICT is obligatory in the curriculum. The teachers who received ICT training sessions consider they are well-knowledgeable in the subject matter, are willing to integrate ICT in class

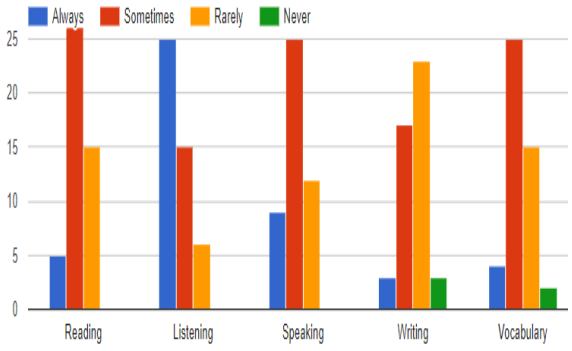

Figure 6. The use of ICT in the various English skills in the classes of the responding English teachers.

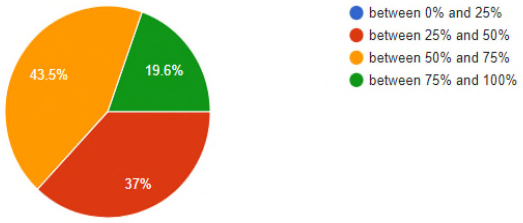

Figure 7. The willingness to use ICT in the classes of the responding English teachers.

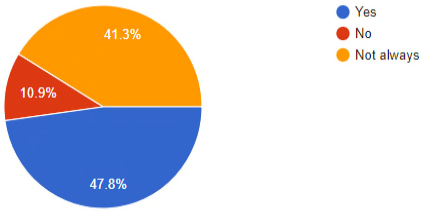

Figure 8. The ease of use of ICT in the classes of the responding English teachers.

(Fig. 6 and Fig. 7), and use ICT more frequently in teaching English (Fig. 8).

In correlation, the results revealed (data not shown) that the teachers, both holding higher degrees and of younger ages, are the ones advocating the use of ICT in the classrooms. While the years of experience did not play as important a role as did the level of training on ICT, it was evident that the resistance to change concept is a driving force in halting the introduction of ICT in some schools.

V. CONCLUSION

Using technology in classrooms is important for both teachers and students. The results have shown that technology is used in private schools more than in public schools. Also, it is shown that some schools need to be aware of the use of technology where training should be provided and technology equipment included.

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Extent of the Commitment to Corporate Social Responsibility (CSR) in Private Schools of Beirut (Lebanon)

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Abstract—**Corporate Social Responsibility (CSR) is an approach that focuses on the beneficence of not only the shareholder, but also the stakeholder. There is also a keen focus on resolving environmental and social problems that arise in the corporation. This is a newly emerging concept in Lebanon, especially in the field of education. This study investigates one of the CSR policies and the implementation of its practices in private schools of Beirut. To achieve this purpose, a sample of three private schools of different socioeconomic status were chosen to conduct a four-part questionnaire that covers four major aspects of CSR practices, which are philanthropic, legal, ethical and environmental. The teachers and administrative personnel of each school filled the data asked by the questionnaire. Descriptive statistics were implemented to check the extent of commitment of CSR practices exhibited towards teachers, students, parents and the natural environment. Analysis of Variance (ANOVA) tests were performed to check the effect of school socioeconomic status and location on CSR activities. Results showed that CSR targeting employees, parents and students are taken into consideration and applied in the chosen schools. In addition, results showed discrepancies in applying practices of CSR targeting the society and natural environment among the three schools based on school location and status. As a conclusion, the commitment to CSR practices seems to be still in its emerging phase in most schools in Beirut, and this necessitates more efforts to ensure a continuous improvement of CSR implementation in education. More ideas about the topic need to be extensively researched in Lebanon as well to ameliorate CSR in Lebanese educational policies and practices.**

Keywords-CSR; education; Lebanon.

I. INTRODUCTION

Being socially responsible adds value to organizations. With social responsibility comes a level of self-monitoring which guarantees an organization's sustainable development and maintains its public image, including its internal and external relations [1]. Lebanon's past performance regarding the implementation of CSR was mixed, with the country still facing development challenges, including poverty reduction and environmental sustainability. According to the United Nation's Voluntary Review in 2018, it is stated that "the situation was highly exacerbated by the impact and spill-overs of the Syria crisis. While Lebanon has shown exceptional solidarity by temporarily hosting 1.5 million displaced from Syria, this has come at a high cost, compounding pre-existing development challenges, and stretching Lebanon beyond its limits." [2].

However, promising progress still emerges as the Voluntary National Report on CSR in Lebanon states that out of 17 Sustainable Development Goals (SDGs), it is covering 7-8 of these goals, which is a promising number. Moreover, for each SDG, there are indicators [2]. Supporting this notion is the report of the Global Compact Network of Lebanon (GCNL) that shows that 167 companies in Lebanon have currently adopted one of the principles, and this is according to the United Nations Global Compact Organization's recent report in 2018. Some of these companies comprise the academic sector. Example of a school that adopts the principles of CSR is the International School of Choueifet, and such example extends to universities such as the American University of Beirut (AUB), the Lebanese American University (LAU), the Beirut Arab University (BAU), the Lebanese International University (LIU), and Notre Dame University (NDU) [2]. This serves to show that the educational sector is implementing CSR principles in Lebanon and they are taking accreditation (e.g., the New England Association of Schools and Colleges [NEASC]), which stems from previous awareness. Hence, the role of CSR in Lebanon is important and emerging in the educational sector. This is because the accreditation of these institutions seek to attain is partly linked to whether or not they comply with CSR policies and practices. The national economic and social council forces them to adopt these policies and practices as a group; however, the scope and degree of implementation differs according to considerations of the region and country.

This paper aims to underscore the origins of CSR and the effect of its implementation in educational institutions, namely Lebanese schools. It also aims to analyze and evaluate the extent of commitment of CSR practices in a representative sample of private schools in the Beirut area. More importantly, the main objective of this study is to show the relationship between CSR and the ability of private schools to achieve high organizational performance.

The rest of this paper is organized as follows. Section 2 gives a background of the topic. Section 3 describes the methodology used in the study. Section 4 addresses the key

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findings. Section V discusses the results. We conclude the paper in Section 6.

II. LITERATURE REVIEW

A. Definition

CSR is widespread in the business world. Corporations produce an annual report concerning their activities, whether or not these activities are considered to be socially responsible [3]. The European Commission states that this concept is active when the enterprises take into consideration the social and environmental issues in their business, in addition to staying in contact with their stakeholders [4]. Caroll defines it as, "a multidimensional construct, encompassing a company's efforts to fulfill multiple responsibilities – economic, legal, philanthropic [and] ethical" [5].

B. CSR Policies vs. Practices

CSR policies are the norms a certain organization chooses to follow that can be taken from different accrediting institutions or guidelines approaches, such as NEASC, and the Association to Advance Collegiate Schools of Business (AACSB). Practices, however, are how we work on one of these policies and choose some of their indicated components to implement them. For example, by taking one of the Sustainable Development Goals and adhering to its indicators, that is when we can say that an organization or an educational entity is practicing CSR [6].

C. Previous Studies

To study CSR implementation effectively, one has to demonstrate case studies of countries where CSR is being implemented. One of the important Lebanese studies done on policy analysis of CSR in Lebanese private university asked on the balanced school card tool, which is based on four initial indicators. The four indicators that were used and analyzed were the following: customer perspective, financial perspective, learning, growth, and internal business process perspective. This study was also compiled at the very end into a book score aimed at conveying the results to other universities so overall recommendations aimed at enhancing the level of Universities to reach the international levels are scribed. This aim helped define the process of this study and its aim as well [7].

D. CSR and the Scoreboard

David Norton and Robert Kaplan introduced the concept of the scoreboard in 1992. In their Harvard Business Review article, they stated that if a company needed to improve its intangible assets, i.e. nonphysical or perceived assets, they would need to use a tool in order to measure those assets. This is through the Balanced Scorecard approach. "The value from intangible assets is indirect" [8]. With the Balanced Scoreboard approach, a corporation should invest to prepare its employees for developments in service quality, which would satisfy customers, eventually gain for the corporation its customers' loyalty, and thus, produce more revenues and margins [8].

In order for an organization to measure its performance from several aspects, it follows the strategic performance scorecard system where it uses "strategic planning, management, and the measurement system" [9]. People working at the corporation apply this strategy from within, and then communicate it to interested stakeholders.

To accomplish sustainability, an organization must follow the following strategy [9]:

1. From a financial viewpoint, it means for the organization to remain in business and provide the right return for the investors.
2. From a customer and stakeholder viewpoint, it means for the organization to provide value and satisfaction for sustainability- conscious consumers.
3. From a process viewpoint, it means handling materials, energy, and waste following an eco-efficient method.
4. From an organizational capacity viewpoint, it means working for a culture that honors sustainability, which is shown in the daily choices employees make.

A good CSR approach falls in the category of organization capacity performance. As an objective, it should improve the culture and information technology. It should measure the employee culture score and IT maturity score. As an initiative, it should grow a life cycle assessment system and start sustainability training. To build this scorecard system effectively, a nine-step framework is adopted and applied in the following order: assessment, strategy, objectives, strategy map, measures and targets, strategic initiatives, automation, cascading, and finally evaluation.

In order to apply the principles of Balanced Scorecard, a company should go on a journey where there are motivations along the road and a few bumps as well. However, this approach results with "self-inquiry" and "in-depth analysis" and self-criticism which is "at the heart of all successful strategic planning and performance management systems" [9]. This is what private schools should adopt in order to successfully follow the CSR approach and work for the benefit of the institution itself along with that of the learners.

III. RESEARCH METHODOLOGY

A. Data Collection Technique

We have adopted the quantitative approach. The aim is to examine the validity of the proposed research hypotheses on a large sample of subjects. The quantitative approach requires collecting data. The data collection tool for the present research is the questionnaire. Indeed, a questionnaire was elaborated especially for the needs of this research and inspired from various previous studies [10]-[14], which tackled similar topics. Consulting previous studies for the preparation of the questionnaire was helpful in setting up the components of the selected variables. In practice, the questionnaire comprises nine main variables of different types, as indicated in Table 1.

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TABLE I. THE MAIN VARIABLES OF THE STUDY

Variable Name and Type	
Variable name	Variable type
Age	Control variable
Gender	Control variable
Educational level	Control variable
Job position	Control variable
Work experience	Control variable
Tenure with current employer	Control variable
Annual income level	Control variable
CSR activities	Dependent variable for H1 Independent variable for H2
Employee engagement	Dependent variable for H2

B. Data Analysis

The Balanced Scorecard approach was adopted, which is a method utilized in a similar study [7]. The Balanced Scorecard approach balances internal and external factors that include profit and nonprofit aspects. The research questions of the study were developed and to answer them, a questionnaire was designed. Based on that, a clear set of questions for the questionnaire were derived underneath the categories of the balanced approach; hence, an assessment of CSR in these three sample schools was analyzed. In order to ensure a scalable assessment across all three schools, the four prominent aspects were taken into consideration, which are: philanthropic legal, ethical and environmental. Descriptive statistics were implemented to check the extent of commitment of CSR practices the sample schools exhibited towards teachers, students, parents and the natural environment. ANOVA tests were performed to check the effect of school socioeconomic status and location on CSR activities.

IV. RESULTS

The dimension of CSR targeting employees revealed that 70% of the employees surveyed answered that their school encouraged them to participate in volunteer activities in a proper and correct way, 73% answered that in their school, the administrative decisions regarding the staff were fair and equitable, 70% answered that their school administration was primarily concerned with the needs of its employees, 65% said that their school applied flexible policies to provide a balance between work and personal life of the employees, 70% indicated that their school supported staff who desire professional development, and 93% answered that their school policies encouraged the employees to develop their skills and professions in a proper and correct way.

The dimension of CSR targeting students and their parents showed that 88% of the surveyed staff said that their school protects the rights of their students and their parents according to the law, 93% said that the school provided the students and their parents with accurate and complete information about its programs, and 96% said that the satisfaction of students and their parents was of great importance for the school in a proper and correct way.

On the dimension of CSR targeting society and natural environment, 81% of the employees surveyed said that their school contributed to the projects and campaigns that promote the well-being of the society, 67% answered that the school employed special programs to reduce their negative impact, 72% said that their school aimed to protect and improve the quality of the general natural environment, 78% said that the school was making investments to create a better life for future generations, while 81% answered that their school aimed to achieve sustainable development that took into account future generations, in a proper and correct way.

Finally, the results on the dimension of CSR targeting employee engagement revealed that 92% of the employees surveyed knew what was expected from them, 89% had the required equipment and materials to do their job properly, 77% said that at work there was a chance to do more and better on daily bases, 43% received appreciation and praise for doing a good job during the last 7 days, 73% said that the supervisor or another person at work took care of them, 77% said that someone at work encouraged their development, 74% said that their opinions were taken into consideration at work, 83% said that the mission of their organization made them feel that their job was important, 83% said that their colleagues were committed in achieving quality work, 77% had a very close friend at work, 52% said that someone at work talked to them about the progress they had achieved during the last 6 months, and 68% had opportunities to learn and develop during the last year in a proper and correct way.

V. DISCUSSION

This study is engaging with an educational institute and using a single source or a more limited version of sources than the ones expected making it single goal focused and related to this study.

As noticed in the results above of CSR targeting employees, most of the answers were above neutral, which indicates that the CSR targeting employees are being taken into consideration in the chosen schools in different levels. On the other hand, it is noticed that some of these CSR are absent in some cases. This will help indicate the difference in dealing with CSR seriously in the targeted schools.

The absence of negative results of CSR targeting students and their parents is obvious in the results above. This is a clear indicator that despite the category or the area

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of the school, the CSR targeting the students and their parents is being taken into consideration and is being applied.

In terms of schools categories and areas, there were substantial findings that gave rise to essential concepts. The results indicate that the CSR targeting society and natural environment are not applied equally at the three schools. After connecting these results to the school's categories and area, we will be able to indicate if the negative results are from a specific school while the positive ones are distributed on the other schools. If so, the negative-results school condition can be considered as an indicator to navigate or accept the null hypothesis.

VI. CONCLUSIONS

The general outcome of our statistics proves that, despite the difference in the level of application of CSR at Beirut schools, it is still applied throughout schools in Beirut area.

The outcomes of the first section regarding CSR targeting employees show that CSR increases in high-paying schools, but it is only slightly affected by the geographic area. This indicates that the school category plays a role in CSR targeting employees; the higher the category (highly paid school), the more CSR targeting employees exist.

The outcome of the second section regarding CSR targeting students and their parents does not show a big difference between low, medium, and high-paying schools and it shows no difference at all between Beirut Areas 1 and 2, which indicates that neither the school category nor the school area plays a role affecting CSR targeting students and their parents.

The outcomes of the third section regarding CSR targeting society and natural environment reflect a big difference between high-paying schools and low and medium paying schools, where it is clear that the high-paying schools are much more aware of applying these CSRs than the low and medium categories. We can also notice that the area plays a role in CSR targeting society and natural environment, since these CSRs also rise in Beirut Area 2 while weak in Beirut Area 1.

Thus, the total CSR activities indicate that schools in Beirut are committed to CSR practices at different levels. These levels increase in high-paying schools while they decrease in low and medium paying schools. In addition, CSR initiatives rise significantly in high-paying schools, and this is applicable on different target audiences: employees, students and their parents, society and the environment. This proves that adhering to CSR practices is directly related to a school's performance.

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