

# Mathematics Teachers' Readiness to Integrate ICT in the Classroom

The Case of Elementary and Middle School Arab Teachers in Israel

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**Abstract**—ICT integration in mathematics education provides mathematics teachers with integrative teaching methods that motivate students learning, support their independent learning and active participation in the discovery of mathematics concepts and topics, and, as a result, helps them have deeper understanding of the mathematical ideas. So, the integration of ICT in the teaching and learning of mathematics, as a result of ICT educational affordances, helps students have better achievement in mathematics. These potentialities of the ICT make its integration in the mathematics classroom a promising practice, but the success of this practice is dependent on various factors, among which are the following: teachers' perceptions of their ability in ICT, teachers' attitudes towards ICT contribution to the mathematics teaching, teachers' attitudes towards ICT contribution to students' mathematics learning, teachers' emotions towards the use of ICT in the mathematics classroom, teachers' feelings of self-esteem and control in the presence of ICT in the mathematics classroom, and teachers' intentions to actually integrate ICT in their teaching. The current research came to verify the readiness of Arab teachers in elementary and middle schools in Israel regarding the integration of ICT in the classroom, and hence its interest in the six above constructs. The research used a questionnaire that included statements related to each one of the above constructs. This questionnaire was administered to 475 Arab teachers in elementary and middle schools in the North, Center and Haifa regions in Israel. The research findings show that more than seventy percent of the participating teachers have positive perceptions of their competence in technology and technology integration in their teaching. Further, they have positive attitudes towards the integration of ICT in teaching and learning and of their self-esteem in the presence of technology, in addition to positive emotions towards this integration. Thus the findings indicate that the teachers are ready for the integration of technology in their teaching, and this readiness is represented not only by the participating teachers' perceptions of and attitudes towards the integration of technology in teaching and learning, but also in their intention to do so.

**Index Terms**—ICT; teacher's ability; teachers' perceptions; teachers' emotions; teacher's intentions

## I. INTRODUCTION

New technologies in general and in particular new educational technologies make available for teachers advanced and user friendly tools to be used by the pupils

for deeper understanding of the subject matter. Further, these technologies "enable teachers to work collaboratively with students while the students themselves become more immersed in their own learning" ([1], p. 67). This educational situation is enabled due to the potentialities of the technological tools because they encourage students' active roles and independence, allow them to observe the investigation of scientific phenomena in various representations, and consequently develop deeper understanding of the studied subject. These qualities are supposed to encourage teachers in general and mathematics teachers in particular (because of the multiple mathematical representations that technological tools provide for mathematical concepts, procedures and topics) to use ICT in their teaching. This research examines various aspects of the ICT integration in teaching among mathematics teachers in elementary and middle Arab schools in Israel. These aspects include: teachers' perceptions of their ability in ICT, teachers' attitudes towards ICT contribution to the mathematics teaching, teachers' attitudes towards ICT contribution to students' mathematics learning, teachers' emotions towards the use of ICT in the mathematics classroom, teachers' feelings of self-esteem and control in the presence of ICT in the mathematics classroom, and teachers' intentions to actually integrate ICT in their teaching.

## II. LITERATURE REVIEW

At the beginning, research results will be presented regarding ICT contribution to teaching and learning in general, and then results related to teaching and learning mathematics in particular. Afterwards, the factors influencing teachers' integration of ICT in the classrooms will be described. These reviews will furnish our way towards looking at teachers' readiness to integrate ICT in the classroom, specifically when taking into account elementary and middle school Arab teachers in Israel.

### A. ICT contribution to teaching and learning:

Researches indicate positive influence of ICT use in various disciplines under specific conditions and contexts. Ref [2] describes the effect of ICT use on pupils' learning. Specifically, they found positive relation between the use of ICT and pupils achievements. Further, [3] found that ICT use support the development of Chemistry concepts like acids, base and pH concepts. Ref [4] studied the effect of computer games on elementary pupils' achievements and there motivation to learn geography, and found that pupils show in the game environment significantly higher

internal motives and lower external motives. Furthermore, the pupils were more independent in their participation in the game based activities and decreased their concentration on grades. Ref [5] used electronic simulations to teach velocity and acceleration concepts of bullet movement. They found that using simulations increases the pupils' achievements in the learned subject. They concluded that using electronic simulations could be an alternative teaching method which develops functional understanding of physical concepts.

### *B. ICT contribution to the teaching and learning of mathematics:*

Several researchers pointed at the contribution of ICT use in mathematics teaching and learning. The British Educational Communications and Technology Agency (Ref [6]) summarized the main benefits of this use as: It increases the collaboration among pupils and encourages communication and knowledge sharing; it enables quick and accurate feedback for the pupils which consequently leads for positive motivation; it allows the pupils to focus on strategies and interpretations of answers instead of wasting valuable time on unnecessary computations; and it supports constructive pedagogy, that is, the pupils use technology to discover mathematical ideas and deeply understand them. The National Council of Teachers of Mathematics (Ref [7]) points at technology as essential for the teaching and learning of mathematics because it affects the mathematics that the teacher teaches and the pupils learn, and it improves the pupils learning. The NCTM also declares that pupils who use technology learn more mathematics in depth. Both NCTM and Becta point at technology as enabling, as well as encouraging the pupils to concentrate on reflection, verification, decisions making and problem solving.

### *C. Factors influencing the integration of ICT in the classroom:*

Educational councils, such as the British Educational Communications and Technology Agency (Ref [8]), together with mathematics education researchers pointed at the factors that influence the ICT use in teaching and learning mathematics. These factors can be categorized as related to the school, the teacher, the technological tools, or the system ([9], [8]; [10]; [11]; [12]), where the factors related to the school and the teacher were mentioned by almost every author who treated the factors that influence the integration of ICT in the classroom, while the factors related to the technological tools and teachers' preparation programs were mentioned by some researchers. For example, [10] pointed at factors related to technological tools, the system, and teachers' preparation programs as influencing the integration of ICT in the classrooms.

Factors related to the school could be: the available technical support for the teacher; the quantity, quality and type of available guidance, the organization of equipment in the school, where this organization would better ensure maximum access for all users, and school resistance for change, such as necessary organizational change enabling successful ICT use in the school.

Factors related to the teacher could be: teacher's self-confidence regarding the use of technology, personal access level of the teacher for the ICT tools, availability of teacher's time to get to know closely and deeply the hardware and software needed to use ICT in the class-

room, as well as the availability of teacher's time to prepare learning materials suitable for the use of ICT in teaching. Another issue related to the teacher regarding ICT use in the classroom is associated with the resistance to change resulting from the non-willingness of teachers to change their teaching methods, and as a result their integration of ICT in the classroom is prevented or slowed. A different issue related to the teacher regarding ICT use in the classroom is the awareness or unawareness of the benefits of ICT use in teaching and learning. Further, teacher's attitude towards the ICT affects his/her use of ICT in the classroom and teacher's gender may affect the ICT use where male teachers use ICT in their teaching more than female ones.

Factors regarding ICT use in the classroom and related to tools could be: tools' operational technical problems, where they could decrease the use of the tools as personal tools, and, as a consequence, their general use in the classrooms. Moreover, these problems would lower the self-confidence of teachers and as a result decrease their use of ICT.

Factors regarding ICT use in the classroom and related to the system could be: teachers' training programs at colleges and universities, where ICT related training programs develop teachers' competences in computer use and affects positively their attitudes towards computers. These potentialities of teachers' training programs will be realized on condition that teachers are trained practically in personal and classroom uses of ICT tools; in particular, teachers ought to be trained to prepare varied learning materials appropriate for the integration of ICT in teaching and learning.

## III. RESEARCH RATIONALE AND GOALS

ICT integration in mathematics education would provide mathematics teachers with integrative teaching methods that motivate students learning, make them more active and independent, and, as a result, supports them to have deeper understanding of the mathematical ideas and topics. So, the integration of ICT in the teaching and learning of mathematics, as a result of ICT educational affordances, helps students have better attainment in mathematics. These potentialities of the ICT make its integration in the mathematics classroom a recommended practice, but this practice will have fruitful results only when specific conditions are met, as implied the above description of factors that influence ICT integration in the classroom. Specifically, ICT integration in the classroom will have positive results depending on the following factors: teachers' perceptions of their ability in ICT, teachers' attitudes towards ICT contribution to the mathematics teaching, teachers' attitudes towards ICT contribution to students' mathematics learning, teachers' emotions towards the use of ICT in the mathematics classroom, teachers' feelings of self-esteem and control in the presence of ICT in the mathematics classroom, and teachers' intentions to actually integrate ICT in their teaching. The current research came to verify these aspects of elementary and middle school Arab teachers in Israel, when the ministry of education plan is to implement ICT integration program in all elementary and middle schools in Israel. The results of the current research would give the teachers, principals, supervisors, curricular development teams in the ministry of education, etc. a general picture of the current status of various aspects of teachers' readiness to

integrate ICT in the classrooms among mathematics teachers in the Arab schools in Israel. This general picture would help the leading characters of mathematics education make changes in teaching and learning mathematics, especially, it would help them prepare appropriate workshops and programs for the professional development of mathematics teachers in ICT use in the classrooms.

#### IV. RESEARCH QUESTIONS

1. What are mathematics teachers' perceptions of their ability in ICT?
2. What are mathematics teachers' attitudes towards ICT contribution to the mathematics teaching?
3. What are mathematics teachers' attitudes towards ICT contribution to students' mathematics learning?
4. What are mathematics teachers' emotions towards the use of ICT in the mathematics classroom?
5. What are mathematics teachers' feelings of self-esteem and control in the presence of ICT in the mathematics classroom?
6. What are mathematics teachers' intentions to actually integrate ICT in their teaching?
7. What are the correlations of mathematics teachers' intentions to actually integrate ICT in their teaching with each of the following factors: perceptions of ability in ICT, attitudes towards ICT contribution to the mathematics teaching, attitudes towards ICT contribution to students' mathematics learning, emotions towards the use of ICT in the mathematics classroom, and feelings of self-esteem and control in the presence of ICT in the mathematics classroom?

#### V. RESEARCH METHODS

##### A. Research population and sample

The research population consisted of the mathematics Arab teachers in elementary and middle schools in the North, Center and Haifa regions in Israel. The sample included 475 elementary and middle school teachers from the three regions.

##### B. Research tools

Data collecting tools: A questionnaire was prepared by the researchers based on two questionnaires which are commonly used in the international research regarding teachers' attitudes towards using ICT in teaching. So, part of the statements in the final questionnaire was taken from questionnaires found in the references [13] and [14]. The questionnaire included three parts. The first part requested demographic data about the teachers, including: age, gender, academic degree, school location, classes taught by the teacher, and seniority. The second part included questions regarding the level of computerization in the school, as well as the teachers' ICT proficiency, and the readiness of the school to integrate ICT in mathematics teaching, as well as the actual integration. The third part included six tables of statements that the responding teacher was supposed to indicate to each one his/her extent of acceptance. The tables were related to the following categories: teachers' perceptions of their ability in ICT, teachers' attitudes towards ICT contribution to the mathematics teaching, teachers' attitudes towards ICT contribution to students' mathematics learning, teachers'

emotions towards the use of ICT in the mathematics classroom, teachers' feelings of self-esteem and control in the presence of ICT in the mathematics classroom, and teachers' intentions to actually integrate ICT in their teaching.

Data analysis tools: The distribution of the participating teachers' extent of acceptance regarding the statements in every category related to teachers' readiness to integrate the ICT in teaching and learning will be computed using the SPSS package. In addition, correlations between each of the following five categories and the category "teachers' intentions to actually integrate ICT in their teaching" were computed: (1) teachers' perceptions of their ability in ICT, (2) teachers' attitudes towards ICT contribution to the mathematics teaching, (3) teachers' attitudes towards ICT contribution to students' mathematics learning, (4) teachers' emotions towards the use of ICT in the mathematics classroom, and (5) teachers' feelings of self-esteem and control in the presence of ICT in the mathematics classroom.

#### VI. FINDINGS AND DISCUSSION

##### A. Teachers' perceptions of their ICT ability

TABLE I describes the distribution of the participating teachers' perceptions of their ability in ICT.

TABLE I points out three issues: (1) most of the teachers agree or strongly agree that they have the necessary efficiency (more than eighty percent) and skills (almost eighty percent) to use ICT in teaching mathematics, (2) almost two thirds of the participating teachers do not think that engaging with the ICT in teaching mathematics is so difficult, but at the same time almost one third of them think it is not easy; (3) more than three fourths of the participating teachers perceive themselves as able to

TABLE I. TEACHERS' PERCEPTIONS OF THEIR ICT ABILITY

Item	I strongly disagree	I disagree	I do not know	I agree	I strongly agree
I have the necessary efficiency to deal with ICT in teaching mathematics (N=472)	11	18	53	174	216
I have the necessary skills to use ICT in teaching mathematics (N=473)	12	34	62	188	177
Engaging with ICT is so difficult (N=474)	139	180	82	61	12
Engaging with ICT in teaching mathematics is not easy (N=474)	61	122	115	153	22
If I want, I can engage successfully with ICT at all levels (N=472)	1	18	82	235	136
I have the skills to use appropriate ICT tools in teaching different mathematical topics (N=472)	8	39	98	216	111

engage successfully with ICT at all levels, while almost seventy percent of them perceive themselves as having the skills to use appropriate ICT tools in teaching different mathematical topics. These results agree with [15] who found that teachers had the competencies required for successful technology integration. They also agree with [16] who reported that teachers regarded themselves as having the capabilities and skills to use different types of technologies in their teaching such as using different computer programs and integrating language labs to enhance teaching and learning. In addition, in order to utilize the positive perceptions of the teachers in their ability in ICT and in using it in their teaching, some procedures should be taken care of ([17]): (1) using computer labs as they give teachers the freedom and flexibility to prepare class materials required for the whole course, (2) providing teachers with appropriate professional development in the form of workshops on technology integration, (3) matching technology with curriculum goals so that technology integration enhances teaching and learning, and (4) giving enough freedom for teachers in the coverage and selection of materials to focus on quality rather than quantity.

TABLE II describes the distribution of the participating teachers' attitudes towards ICT contribution the mathematics teaching.

TABLE II shows that the participating teachers' general and specific attitudes towards the use of ICT in mathematics education are positive. For example, the participating teachers consider using ICT in mathematics teaching as influencing it positively (more than seventy percent of them think it speeds up the process of teaching and makes it easier, while almost eighty percent of them think it is important for a good teaching of mathematics). These findings agree with previous researches which found that teachers' or pre-service teachers' attitudes to using ICT in mathematics teaching is generally positive, for example [18] found that in-service EFL teachers possess positive attitudes towards the integration of computer technology in their instruction. At the same time, almost half of the participants consider using ICT in teaching mathematics as a factor which may hinder the completion of the learning material. This attitude could be explained by the teachers not being actual users of ICT in teaching, though they think their ability in ICT use in teaching is high. The lack of teachers' experience in ICT use could make them unable to perceive how the use of ICT could shorten the teaching time in the long run. This influence of the lack of use of ICT is supported by researches which studied such influence, for example [19] found significant differences that could be attributed to teachers' use of the interactive boards in primary school and teachers' perceptions of the contribution of the interactive boards for teaching and learning.

TABLE III describes the distribution of the participating teachers' attitudes towards ICT contribution to students' mathematics learning.

The participating teachers' attitudes, as can be seen from TABLE III, are also positive regarding the contribution of ICT to students' learning. Generally speaking, more than seventy percent of the participating teachers considered ICT use as assisting students' learning in various ways, and consequently it makes them understand the subject matter more by demonstrating the mathematical concepts. This ability to demonstrate the mathematical

TABLE II.  
TEACHERS' ATTITUDES TOWARDS THE CONTRIBUTION OF ICT TO MATHEMATICS TEACHING

Item	I strongly disagree	I disagree	I do not know	I agree	I strongly agree
I can get mathematical information from the internet more than from books (N=475)	12	46	134	170	113
Using ICT is important for good teaching of mathematics (N=467)	6	26	67	248	120
Using ICT in teaching mathematics speeds up the process of teaching (N=467)	9	33	95	241	89
The high level of ICT skills makes the mathematics teaching easier (N=466)	7	36	83	223	117
Using ICT in teaching mathematics hinders the completing of the learning materials (N=468)	17	89	143	159	60

TABLE III.  
TEACHERS' ATTITUDES TOWARDS ICT CONTRIBUTION TO STUDENTS' MATHEMATICS LEARNING

Item	I strongly disagree	I disagree	I do not know	I agree	I strongly agree
Using ICT makes the students understand more (N=472)	4	29	106	240	93
Using ICT in teaching mathematics enhances learning (N=469)	5	22	72	272	98
Using ICT in teaching mathematics is helpful for students (N=465)	9	20	79	248	109
Using ICT in teaching mathematics encourages students self-learning (N=468)	7	30	66	272	93
Using ICT in teaching mathematics demonstrates the mathematical concepts to students (N=469)	4	34	101	245	85

concepts also encourages students' self-learning. These positive attitudes imply that the participating teachers are aware of the positive influences that ICT can have on students' learning. These positive influences are also reported in the literature, for example researches pointed that using ICT in teaching and learning can assist students' learning in various ways ([20], [21]).

TABLE IV describes the distribution of the participating teachers' emotions towards the use of ICT in the mathematics classroom.

Generally speaking, the participating teachers, as can be seen from TABLE IV, had positive emotions towards the use of ICT in the mathematics classroom. More than eighty five percent of the participating teachers had positive relations towards the use of ICT in mathematics teaching, while almost twenty percent of the participating teachers or in most cases less, agree or strongly agree that the use of ICT in teaching causes them to feel negative emotions. Studying teachers' emotions associated with their practice is an important issue in order to study and improve the quality of their teaching ([22]). Here, studying teachers' emotions helps decide how to build on them in order to encourage teachers to use ICT in their actual teaching. So speaking, the participating teachers' positive emotions towards ICT use in the mathematics classroom indicated that they would use ICT in their actual teaching if appropriate conditions are fulfilled, like rich workshops and appropriate technological infrastructure. These workshops should include sessions on how to prepare appropriate lessons, so teachers would not feel that "engaging with ICT makes them feel tired and exhausted" (see the item in the above table). An alternative solution for trying to prevent teachers from feeling tired and exhausted can be done by the ministry of education by encouraging the writing of text books and activities appropriate for ICT use in the mathematics classroom.

TABLE V describes the distribution of the participating teachers' feelings of self-esteem and control in the presence of ICT in the mathematics classroom.

Generally speaking, TABLE V shows that the participating teachers' self-esteem (feeling of competence and achievement) and control in the mathematics classroom would be better in the presence of technology, though self-esteem would be further better. This could be explained by the previous findings, where the teachers expressed their appreciation of ICT use in the mathematics classroom. The previously described advantages of ICT use in the mathematics classroom, as represented in the previous findings, would make the work of the teacher more effective and improve their achievement, probably through improving their students' understanding and achievement. From the other side, the availability of appropriate tools would make the teacher feel in more control of his/her teaching. This influence of technology on self-esteem and feeling of control is described in detail in [23], but specifically regarding computer games: "Part of the attractiveness of computer games is based on having a feeling of control over a quasi-reality, being in the thick of the action, and the ability to raise self-esteem by achieving goals, power and success in the through-the-screen world" (p. 195). Here the goals achieved by the use of technology are primarily the teaching effectiveness represented by students' better understanding and achievement.

The same reasons are behind the participating teachers' intention to actually integrate ICT in their teaching, as TABLE VI shows.

The correlations between the constructs: teachers' perceptions of ICT ability, teachers' attitudes towards using the ICT in mathematics teaching, teachers' attitudes towards using the ICT in mathematics learning, teachers'

TABLE IV.  
TEACHERS' EMOTIONS TOWARDS ICT USE IN THE MATHEMATICS CLASSROOM

Item	I strongly disagree	I disagree	I do not know	I agree	I strongly agree
Interacting with ICT is pleasant (N=475)	6	15	38	209	207
Using ICT in teaching mathematics is pleasant (N=473)	5	9	49	247	163
Engaging with ICT makes me feel tired and exhausted (N=473)	63	170	136	88	16
Engaging with ICT makes me feel frustrated (N=473)	145	200	82	36	10
Engaging with ICT makes me feel angry (N=470)	98	190	113	52	17
Engaging with ICT scares me (N=470)	163	173	75	48	11

TABLE V.  
TEACHERS' SELF-ESTEEM AND CONTROL IN THE PRESENCE OF ICT IN THE MATHEMATICS CLASSROOM

Item	I strongly disagree	I disagree	I do not know	I agree	I strongly agree
If I engage with ICT I would feel a sense of competence in the classroom (N=473)	3	33	93	215	129
If I engage with ICT I would feel in control of my teaching (N=472)	11	70	164	173	54
If I engage with ICT I would feel a sense of achievement (N=469)	4	33	114	223	95
If I engage with ICT my work would be more effective (N=472)	7	25	94	237	109

TABLE VI.  
TEACHERS' INTENTION TO USE THE ICT IN THE MATHEMATICS CLASSROOM

Item	I strongly disagree	I disagree	I do not know	I agree	I strongly agree
I have the willingness to use ICT in teaching mathematics (N=471)	5	17	43	239	167
I have the intention to use ICT in teaching mathematics (N=473)	7	18	41	237	170
I plan to use ICT in teaching mathematics (N=470)	10	18	70	226	146

TABLE VII.  
CORRELATIONS WITH TEACHERS' INTENTION TO USE ICT IN THEIR  
ACTUAL TEACHING

		Teacher's intention to use ICT
<b>Perception of ICT ability</b>	Pearson Correlation	.559**
	Sig. (2-tailed)	.000
	N	469
<b>Attitudes towards using ICT in teaching</b>	Pearson Correlation	.462**
	Sig. (2-tailed)	.000
	N	465
<b>Attitudes towards using ICT in learning</b>	Pearson Correlation	.499**
	Sig. (2-tailed)	.000
	N	474
<b>Emotions towards using ICT in the mathematics classroom</b>	Pearson Correlation	.445**
	Sig. (2-tailed)	.000
	N	462
<b>Self-esteem in the presence of ICT in the classroom</b>	Pearson Correlation	.446**
	Sig. (2-tailed)	.000
	N	475

emotions towards using the ICT in the mathematics classroom, teachers' self-esteem in the mathematics classroom, and, from the other side, teachers' intention to use the ICT in their actual mathematics teaching, are shown in TABLE VII.

We see that all the constructs have moderate and significant correlations with teachers' intention to use ICT in their teaching. These significant correlations were explained above. Further, attitudes, emotions, and perceptions were shown to influence the actual behavior ([24]) and specifically of teachers ([25]).

## VII. CONCLUSIONS:

Ref [26] reported that the majority of the participating teachers realized the potential and importance of ICT for teaching and learning, although they lacked the necessary knowledge. The current research findings show that more than seventy percent of the participating teachers have positive perceptions of their competence in technology and technology integration in their teaching. Further, they have positive attitudes towards the integration of ICT in teaching and learning and of their self-esteem in the presence of technology, in addition to positive emotions towards this integration. Thus the findings indicate that the teachers are ready for the integration of technology in their teaching, and this readiness is represented not only by the participating teachers' perceptions of and attitudes towards the integration of technology in teaching and learning, but also in their intention to do so. Previous research indicates that teachers' integration of technology in their teaching should be accompanied by workshops that provide them with the suitable practical experiences and paradigms that help them understand their new role in the presence of technology, as well as the potentialities of

the great variety of the possible uses of new technologies for teaching and learning ([27]).

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