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Articles

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The current issue is the third of the eighth volume of the *Athens Journal of Education (AJE), published by the Education Unit of ATINER.*

Gregory T. Papanikos
President
ATINER

Athens Institute for Education and Research

A World Association of Academics and Researchers

23rd Annual International Conference on Education
17-20 May 2021, Athens, Greece

The Education Unit of ATINER organizes its **23rd Annual International Conference on Education, 17-20 May 2021, Athens, Greece** sponsored by the Athens Journal of Education. The aim of the conference is to bring together scholars and students of education and other related disciplines. You may participate as stream leader, presenter of one paper, chair a session or observer. Papers (in English) from all areas of education are welcome. Please submit a proposal using the form available (https://www.atiner.gr/2021/FORM-EDU.doc).

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Important Dates

- Abstract Submission: **5 April 2021**
- Acceptance of Abstract: 4 Weeks after Submission
- Submission of Paper: **19 April 2021**

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The Social Program Emphasizes the Educational Aspect of the Academic Meetings of Atiner.

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- Athens Sightseeing: Old and New-An Educational Urban Walk
- Social Dinner
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Important Dates

- Abstract Submission: **8 March 2021**
- Acceptance of Abstract: 4 Weeks after Submission
- Submission of Paper: **7 June 2021**

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- **Dr. David Philip Wick**, Director, Arts, Humanities and Education Division, ATINER & Professor of History, Gordon College, USA.
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- **Dr. George Priovolos**, Director, Center for Small and Medium-Sized Enterprises (CSME) & Professor, Iona College, USA.

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The Effect of Mathematics Teachers' Self-Efficacy and Leadership Styles on Students' Mathematical Achievement and Attitudes

By Tevfik Küçükalioğlu[*] & Güler Tuluk[†]

The aim of this study was to examine the effect of middle school mathematics teachers' self-efficacy and leadership styles on middle school students' mathematical achievements and attitude towards mathematics. In this study, the general survey method was employed and the research population was consisted of a total of 917, 5th grade students, 472 girls and 455 boys, picked across 10 middle schools in a central district of a province located in North-West Anatolia. In order to gather scientific data, scales such as Mathematics Attitude Scale, Teacher's Self-Efficacy Scale, and Mathematics Achievement Test were used. Teacher characteristics were divided into two categories which consist of two and three sub-categories respectively; autocratic and semi-democratic based on the Leadership Style Scale. And low, moderate, high level according to teachers' scores in the Self-Efficacy Scale. The data obtained were analysed in accordance with the objectives by means of frequency, percentage, arithmetic mean, standard deviation, t test, one-way variance analysis (Ancova). The significance level in statistical analyses was set at $p<0.05$. Consequently, whether the teachers displayed low or high leadership styles had no significant effect on the students' mathematical achievement and their attitude towards the subject. Teachers' self-efficacy for classroom management sub-scale was found to have an effect on the mathematical achievement of students. The self-efficacy level of teachers for student engagement does not have a significant effect on students' mathematical achievement. However, it was found that teachers' self-efficacy for instructional behaviour, classroom management and student management affected students' attitude towards mathematics.

Keywords: Mathematical achievement, attitude towards mathematics, Teachers' Self-Efficacy, Leadership Styles of Teachers.

Introduction

Mathematics is one of the most important subjects students have to learn at school. Mathematics is a human activity, so the student must be a part of it. Instead of memorizing some rules, students can learn mathematics in a social environment by constructing mathematical concepts and relations themselves. Mathematics includes quantity, structure, space, and change. While the place of mathematics in this changing world has moved out of itself today and affects school mathematics, this effect has also expanded in school mathematics, from science and technology to society and culture, and into daily life with personal health and finance.

Apart from biological trends and knowledge structures, mathematics competence also depends on sociocultural influences (Cobb, 1994). One does not pass the mathematics knowledge passively from the environment just like other

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forms of knowledge; constructs the teacher as a result of interactions with classmates and other individuals.

Closing the long existing achievement gap between students of high and low achievement in mathematics classes has been vital for the member countries of EU, as well as Turkey (Eurydice, 2011). This existing need for mathematics knowledge and its usage has brought about other variables such as self-efficacy, self-regulation, demeanour etc., as a result of the advancements in learning theories (Schunk, 2009).

It is also an important component of attitude towards mathematics in mathematics teaching studies. Attitude; It refers to a tendency that is attributed to a person and regularly creates his emotions, thoughts and behaviors related to an object (Kağıtçıbaşı, 1979).

Students' attitudes towards mathematics are very important in mathematics education. Studies (Bloom, 1995) show that about a quarter of the differences between an individual's learning come from affective features. Developing a positive attitude towards mathematics is one of the most important goals of mathematics education (Reyes, 1984). Ministry of National Education (MEB, 2013) Course in Elementary Mathematics Program is also located in Turkey this purpose.

Self-efficacy is the belief in one's own capacity to bring Learning and behavior to the required levels (Bandura, 1977a, 1977b, 1986, 1993, 1997). Self-efficacy is what one thinks is sufficient to do; is very different from knowing what to do. It is the evaluation of individuals' self-efficacy, skills and capacities and turning them into behavior. Self-efficacy has an important place in gaining self (Bandura, 1997, 2001). Self-efficacy also includes teachers (Pajares, 1996; Tschannen- Moran, Woolfolk Hoy, & Hoy, 1998).

High self-efficacy ensures motivation continues. When individuals reach their goals, they also tend to achieve more goals (Schunk, 1989). Self-efficacy greatly affects effort and commitment (Bandura & Cervone, 1983, 1986; Schunk, 1995). Individuals with high self-efficacy spend more effort when faced with difficulty and become more dependent on the challenge when they have the necessary skills.

Social Cognitive Theory and Humanistic Learning Theories have changed the understanding of being a mathematics teacher in Turkey schools'. MEB (2009) programs and the place of the teacher, who assumed the role of knowledge transfer expert; a. Teaching and learning, b. Observing, controlling and improving teaching, c. Continuing its education and professional development, d. Working together to succeed, e. He has evolved to change as a teacher who thinks deeply.

Being a mathematics teacher, one can say that self-efficacy perceptions affect the purpose and the nature of the function that teachers desire to fulfil. The behaviour of one such individual exerts influence on a classroom, having an effect on the students' satisfaction, motivation and performance.

Furthermore, the subject-matter knowledge, pedagogical content knowledge, ability, talent and the personality characteristics of a mathematics teacher have a direct impact on students. The main role of the mathematics teacher is to make the subject easier to comprehend. Students are both responsible and active when learning mathematics. The self-efficacy of the teacher is a variable in trying to

maintain the efficiency in terms of input and output during this process. Thus, the effects that this variable has on achievement and attitude should be further scrutinized.

Under these circumstances, we should not only look for the students' thoughts, beliefs, attitudes and roles of their values, but also the factors that determine the effect of their teachers in these roles. Consequently, self-efficacy perceptions and leadership styles of mathematics teachers in Turkey are points that are worth stressing at this point.

In this study, the aim was to investigate the effect of teacher characteristics on fifth grade students' attitudes towards mathematics and mathematical achievement and answers to the following questions were sought.

1. Does the mathematical achievement of fifth grade students in middle school differ according to the leadership styles of mathematics teachers?
2. Does the attitude of fifth grade middle school students towards mathematics differ according to the leadership styles of mathematics teachers?
3. Does the mathematical achievement of fifth grade students in middle school differ according to the self-efficacy of mathematics teachers?
    i. Is there a significant difference between teachers' self-efficacy for student engagement and students' mathematical achievement?
    ii. Is there a significant difference between teachers' self-efficacy for instructional strategies and mathematical achievement of students?
    iii. Is there a significant difference between teachers' self-efficacy for classroom management and mathematical achievement of students?
4. Does the attitude of fifth grade middle school students towards mathematics change based on the self-efficacy of the mathematics teachers?
    i. Is there a significant difference between teachers' self-efficacy for student engagement and students' attitude towards mathematics?
    ii. Is there a significant difference between teachers' self-efficacy for instructional strategies and students' attitude towards mathematics?
    iii. Is there a significant difference between teachers' self-efficacy for classroom management and students' mathematical success?

Literature Review

Studies generally show the effects of students' self-efficacy beliefs on their academic achievement and performance (Denise & O'Neil, 1997; Malpass, O'Neil, & Hocevar, 1996), and teachers'/prospective teachers' self-efficacy for teaching/ learning. It also shows the effects of beliefs (Andersen, Evans, & Serensen, 2003; Huinker & Madison, 1997) and gender difference on self-efficacy towards learning/ teaching and computers (Aşkar & Umay, 2001). In some studies, it has been emphasized that the development of self-efficacy in the individual will increase the performance of the individual (Stajkovic & Luthans, 1998; Tuckman & Sexton, 1990). At the same time, it is emphasized that self-efficacy belief can be directly developed in the studies (Eden & Aviram, 1993; Bandura, 1986).

In many studies, it has been determined that teachers with high self-efficacy beliefs show more effort in teaching, are more willing in the learning-teaching process, are more successful in the selection of methods and techniques, and in summary, in implementing the curriculum (Friedman & Kass, 2002; Tschannen-Moren & Woolfolk, 2001).

Gibson and Dembo (1984) state that a teacher with a high self-efficacy belief is more willing in the classroom, uses time by planning better and works longer.

Methodology

In the general survey model, in a universe consisting of many elements, the whole universe or a group of samples or samples to be taken from it is scanned in order to make a general judgment about the universe (Karasar, 2007). There is never an effort to alter or affect the research subject.

Research Population

The population of the study was consisted of fifth grade students and their teachers in 2013-2014 academic year, which were picked across 10 different middle schools within the borders of a province located in North-West Anatolia.

Of the 917 students participating in the research, 51.4% (472) were female and 48.6% (445) were male. The data were collected from fifth grade middle school students and their mathematics teachers in nine schools.

Survey Scales

Within the scope of this study, four different scales, namely; "Mathematics Achievement Test" (MAT), "Teachers' Efficacy Beliefs System-Self Form" as adopted by Baloğlu and Karadağ (2008) and its reliability re-tested by Tuluk (2015), "Mathematics Attitude Scale" (MAS) developed by Nazlıçiçek and Erktin (2002), and "Teacher Leadership Style Scale" developed by Deniz and Hasançebioğlu were used. The mathematics achievement test (MAT) was developed by the researchers (Cronbach-Alfa, 0.84).

Application of Data-Collecting Instruments and Analysis

Prior to the survey, the administration of the schools and the mathematics teachers taking part in the survey were consulted and necessary appointments were taken. Mathematics Achievement Pretest and Mathematics Pretest Attitude Scale were applied in two different forms: First, as pretests in the second term of 2013-2014, pre-test between 10-15 February, 2014 academic year and as posttests between 26-30 May, 2014. Twenty mathematics teachers in their respective

schools took part in the Teacher Leadership Style Scale and Teacher Self-Efficacy Survey between 2-7 June 2014. The data collected were analysed via the statistic program SPSS 19.0 on a computer (significance level set at <.05)

Findings/Results

Research Questions

The Pearson Correlation Analysis results regarding the question, "Is there a correlation between the mathematical success of students and their attitude towards mathematics?" are shown on Table 1.

Table 1. Correlation Analysis Results

Test Pair	**r**	**p**
MAchPreT (Achievement Pretest) –MAttPreS (Attitude	0.383	<0.001
MAchPostT (Achievement Posttest)-MAttPostS (Attitude	0.385	<0.001

Analysis of the results on Mathematical Achievement Pretest and Mathematics Attitude Pretest showed that there was a moderate relationship between the values found after the analysis (r=0.383. p<0.001). The same correlation proved to be correct in the case of Mathematical Achievement Posttest and Mathematics Attitude Posttest scores (r=0.385. p<0.001).

1. Findings on the sub-research question, "Does the mathematical achievement of fifth grade students in middle school differ according to the leadership styles of mathematics teachers?"

The first sub-research question of the study was described as the following: "Is there a significant relationship between the pretest and the corrected posttest scores of the mathematical achievement test of students that have teachers who display autocratic or semi-democratic teacher leadership styles?"

An ANCOVA test was performed on the Mathematical Achievement posttest scores of students, whose mathematics teachers displayed autocratic or semi-democratic leadership styles. Posttest scores of two student groups prior to test are given in Table 2.

Table 2. The Results of the ANCOVA Test on the Changes in Mathematics Achievement Test Scores According to Teachers' Leadership Style

Source	**Type III Sum of**	**SD**	**Mean**	**F**	**P**
Corrected Model	22538,202[a]	2	11269.101	418.355	.000
Intercept	2039.305	1	2039.305	75.707	.000
TEST1	22510.494	1	22510.494	835.681	.000
Leadership	59.372	1	59.372	2.204	.138

Error	24620.156	914	26.937		
Total	295115.000	917			
Corrected Total	47158.358	916			

Based on the results of the ANCOVA test given in Table 2, there is no significant difference between the pretest scores and the corrected posttest average scores of students in different groups (F (914;1)= 2.204. p>0.05). Thus, it is possible to say that the leadership styles of the teachers have no impact on the mathematical achievement of students.

Table 3. The Results of the ANCOVA Test on the Changes in Mathematics Attitude Scale Scores According to Teachers' Leadership Style

Source	Type III Sum of Squares	sd	Mean Square	F	P
Corrected Model	30727.592[a]	2	15363.796	156.471	.000
Intercept	21012.403	1	21012.403	213.999	.000
ATTITUDE1	30611.420	1	30611.420	311.760	.000
Management Style	233.703	1	233.703	2.380	.123
Error	89744.861	914	98.189		
Total	5185868.000	917			
Corrected Total	120472.454	916			

a. R Squared = .255 (Adjusted R Squared = .253)

Based on the results of the ANCOVA test given in Table 3, there is no significant difference between the pretest scores and the corrected posttest average scores of students in different groups (F (914;1)= 2,380, p>0.05). Consequently, it can be concluded that teachers' leadership styles do not affect the students' attitude towards mathematics.

2. Findings on the sub-research questions, "Does the mathematical achievement of fifth grade students in middle school differ according to the self-efficacy of mathematics teachers?"

Table 4. The Results of the ANCOVA Test on the Changes in Mathematics Attitude Scale Scores According to High and Low Self-Efficacy Levels of the Teachers

Source	**Type III Sum of Squares**	**sd**	**Mean Square**	**F**	**P**
Corrected Model	22724.577[a]	2	11362.289	425.032	.000
Intercept	2200.718	1	2200.718	82.323	.000

TEST1	21916.608	1	21916.608	819.840	.000
Self-Efficacy	245.746	1	245.746	9.193	.002
Error	24433.781	914	26.733		
Total	295115.000	917			
Corrected Total	47158.358	916			

a. R Squared = .482 (Adjusted R Squared = .481)

As per the results of the ANCOVA test given in Table 4, there is a significant difference between the pretest scores and the corrected posttest average scores of students in different groups ($F(914;1) = 9.193$, $p<0.02$).

Further ANCOVA tests were conducted on each sub-research question to find out whether this situation was the result of the self-efficacy score or the outcome of a sub-research question regarding self-efficacy in particular.

i. Findings on the sub-research question regarding Mathematical Achievement and Teachers' Self-Efficacy for Instructional Strategies

Table 5. The Results of the ANCOVA Test on the Changes in Mathematics Achievement Test Scores According to Teachers' Self-Efficacy for Instructional Strategies

Source	**Type III Sum of Squares**	**sd**	**Mean Square**	**F**	**P**
Corrected Model	22577.258[a]	2	11288.629	419.746	.000
Intercept	2150.242	1	2150.242	79.953	.000
TEST1	22236.443	1	22236.443	826.819	.000
Self-Efficacy for Instructional strategies	98.427	1	98.427	3.660	.056
Error	24581.100	914	26.894		
Total	295115.000	917			
Corrected Total	47158.358	916			

a. R Squared = .479 (Adjusted R Squared = .478)

In accordance with the ANCOVA test results given in Table 5, there is no significant difference between the pretest scores and the corrected posttest average scores of students in different groups ($F(914;1) = 3.660$, $p>0.05$). Hence, it is possible to say that the teachers' self-efficacy level in instructional strategies does not affect the academic achievement of students in mathematics.

ii. Findings on the sub-research question regarding Mathematical Achievement and Teachers' Self-Efficacy for Classroom Management

Table 6. The Results of the ANCOVA Test on the Changes in Mathematics Achievement Test Scores According to Teachers' Self-Efficacy for Classroom Management

Source	**Type III Sum of Squares**	**sd**	**Mean Square**	**F**	**P**
Corrected Model	22869.582a	2	11434.791	430.297	.000
Intercept	2146.817	1	2146.817	80.786	.000
TEST1	22171.582	1	22171.582	834.329	.000
Self-Efficacy for Classroom Management	390.751	1	390.751	14.704	.000
Error	24288.776	914	26.574		
Total	295115.000	917			
Corrected Total	47158,358	916			

a. R Squared = .485 (Adjusted R Squared = .484)

Based on the results of the ANCOVA test given in Table 6, there is a significant difference between the pretest scores and the corrected posttest average scores of students in different groups ($F(914;1)=14.704$, $p<0.01$). As per the findings, we can conclude that the self-efficacy level of teachers in classroom management has an effect on students' academic achievement in mathematics.

iii. Findings on the sub-research question regarding Teachers' Self-Efficacy for Student Engagement in Mathematical Achievement

Table 7. The Results of the ANCOVA Test on the Changes in Mathematics Attitude Scale Scores according to Teachers' Self-Efficacy for Student Engagement

Source	**Type III Sum of Squares**	**sd**	**Mean Square**	**F**	**P**
Corrected Model	22554.731a	2	11277.365	418.943	.000
Intercept	2226.030	1	2226.030	82.695	.000
TEST1	22550.989	1	22550.989	837.747	.000
Self-Efficacy for Student Engagement	75.900	1	75.900	2.820	.093
Error	24603.627	914	26.919		
Total	295115.000	917			
Corrected Total	47158.358	916			

a. R Squared = .478 (Adjusted R Squared = .477)

In accordance with the ANCOVA test results given in Table 7, there is no significant difference between the pretest scores and the corrected posttest average scores of students in different groups (F (914;1) = 2.820, p>0.05). In tandem with the abovementioned findings, it is reasonable to say that teachers' self-efficacy for student engagement had no significant effect on students' mathematical achievement.

3. Findings on the sub-research questions, "Does the attitude of fifth grade students towards mathematics in middle school differ according to the self-efficacy of mathematics teachers?"

Table 8. The Results of the ANCOVA Test on the Changes in Mathematics Attitude Scale Scores based on High and Low Self-Efficacy of the Teachers

Source	**Type III Sum of Squares**	**sd**	**Mean Square**	**F**	**P**
Corrected Model	33596.720a	2	16798.360	176.732	.000
Intercept	20542.452	1	20542.452	216.123	.000
Attitude	30046.236	1	30046.236	316.110	.000
Self-Efficacy	3102.830	1	3102.830	32.644	.000
Error	86875.734	914	95.050		
Total	5185868.000	917			
Corrected Total	120472.454	916			

a. R Squared = .279 (Adjusted R Squared = .277)

Based on the results of the ANCOVA test given in Table 8, there is a significant difference between the pretest scores and the corrected posttest average scores of students in different groups (F (914;1)= 32.644, p < 0.01). Consequently, it can be concluded that teachers' self-efficacy has an effect on students' attitude towards mathematics.

Further ANCOVA tests were conducted on each sub-research question to find out whether this situation was the result of the self-efficacy score or the outcome of a sub-research question regarding self-efficacy in particular.

i. Findings on the sub-research question regarding Attitude towards Mathematics and Teachers' Self-Efficacy for Instructional strategies

Table 9. The Results of the ANCOVA Test on the Changes in Mathematics Attitude Scale Scores based on Teachers' Self-Efficacy for Instructional Strategies

Source	**Type III Sum of**	**sd**	**Mean Square**	**F**	**P**
Corrected Model	33864.654a	2	16932.327	178.692	.000
Intercept	19942.698	1	19942.698	210.462	.000
ATTITUDE1	30472.964	1	30472.964	321.591	.000
Instructional	3370.765	1	3370.765	35.573	.000

Error	86607.799	914	94.757		
Total	5185868.000	917			
Corrected Total	120472.454	916			

a. R Squared = .281 (Adjusted R Squared = .280)

Based on the results of the ANCOVA test given in Table 9, there is a significant difference between the pre-test scores and the corrected post-test average scores of students in different groups (F (914;1)=35.573, p<0.01). Thus, it is possible to say that the teachers' self-efficacy level have an effect on the students' attitude towards mathematics.

ii. Findings on the sub-research question regarding Students' Attitude Towards Mathematics and Teachers' Self-Efficacy for Classroom Management

Table 10. The Results of the ANCOVA Test on the Changes in Mathematics Attitude Scale Test Scores based on Teachers' Self-Efficacy for Classroom Management

Source	**Type III Sum of**	**sd**	**Mean Square**	**F**	**P**
Corrected Model	31760.217a	2	15880.108	163.612	.000
Intercept	20386.473	1	20386.473	210.041	.000
ATTITUDE 1	30591.827	1	30591.827	315.187	.000
Self-Efficacy for Classroom Management	1266.327	1	1266.327	13.047	.000
Error	88712.237	914	97.059		
Total	5185868.000	917			
Corrected Total	120472.454	916			

a. R Squared = .264 (Adjusted R Squared = .262)

In accordance with the ANCOVA test results given in Table 10, there is a significant difference between the pre-test scores and the corrected post-test average scores of students in different groups (F (914;1)=13.047 p<0.05). Within the light of these findings, it can be concluded that teachers' self-efficacy level in classroom management plays a significant role in students' attitude towards mathematics.

iii. Findings on the Sub-Research Question Regarding Teachers' Self-Efficacy for Student Engagement in Students' Attitude Towards Mathematics

Table 11. The Results of the ANCOVA Test on the Changes in Students' Mathematics Attitude Scale Scores based on Teachers' Self-Efficacy for Students Management

Source	**Type III Sum of**	**sd**	**Mean Square**	**F**	**P**
Corrected Model	33624.274a	2	16812.137	176.933	.000
Intercept	20473.687	1	20473.687	215.467	.000
ATTITUDE1	30846.973	1	30846.973	324.637	.000
Self-Efficacy for Student Engagement	3130.385	1	3130.385	32.945	.000
Error	86848.179	914	95.020		
Total	5185868.000	917			
Corrected Total	120472.454	916			

a. R Squared = .279 (Adjusted R Squared = .278)

As per the results of the ANCOVA test given in Table 11, there is a significant difference between the pre-test scores and the corrected post-test average scores of students in different groups ($F(914;1)=32.945$. $p<0.01$). In consideration of this fact, one can say that teacher's self-efficacy for student engagement affects students' attitude towards mathematics.

Conclusion

Following the above mentioned tests, it was found that the leadership style of middle school mathematics teachers has no effect on students' achievements and their attitude towards mathematics. Furthermore, this is in line with Somar's (2009) findings, which concluded that the leadership style of high school mathematics teachers did not have a significant effect on students' achievement in mathematics.

Based on the findings of this study, it is possible to claim that middle school mathematics teachers' management style has no impact on students' attitude towards mathematics, which yet again conforms to the findings of Somar (2009) on the relationship between the leadership style of high school mathematics teachers and students' achievement in mathematics.

Teacher self-efficacy can be broadly described as teachers' thoughts about their own capacity with respect to teaching. Perception of teachers with high self-efficacy affects their activities, efforts and work with students (Ashton, 1985; Ashton & Webb, 1986). Accordingly, it was discovered that teachers' self-efficacy had an impact on students' mathematical achievement. Self-efficacy is particularly related to school learning and similar achievement activities. Researchers have found the effects of self-efficacy on preference, effort, commitment and success of students (Pajares & Miller 1994; Pajares, 1996, 1997; Schunk & Pajares, 2002).

Furthermore, mathematics teachers with high self-efficacy were observed to have a positive effect on students' mathematical achievement. Therefore, self-efficacy of mathematics teachers seems to be the determining factor in their way of teaching and behaviour in class.

i. It was observed that teachers' self-efficacy levels for instructional behaviour did not prove to be a factor in students' mathematical achievement.

ii. It was determined that teachers' self-efficacy for classroom management affected students' mathematical achievement. According to Bandura (1995), teachers that display low self-efficacy have the tendency to create an environment that has an adverse effect on students' mathematical achievement. Bandura (1982) also suggests that, even in a situation where individuals know what they are supposed to do, they are set on the course of failure as a result of low self-efficacy levels.

A mathematics teacher fulfils many functions during the teaching process. While building on students' prior knowledge, the teacher provides the learners with scaffolding, which is a must for students to make of mathematics (Van De Walle, Karp, Bay-Williams, 1998). The classroom environment enables students to establish a connection between what they already know and what they are being taught. In accordance with the findings in this study, it can be claimed that teachers with high self-efficacy are able to create a positive classroom environment. iii. The study showed that teachers' self-efficacy for student engagement did not play a significant role in students' mathematical achievement.

Pajares and Miller (1994) argue that self-efficacy level of teachers is critically important while teaching children with learning disabilities. In addition to that, Ashton and Webb (1986 as cited in Gresham, 2003), state that teachers' self-efficacy perception differs based on the activity; if a teacher feels comfortable with teaching via the direct instruction teaching strategies, he or she is unlikely to employ peer teaching method even if they had prior training in this regard (as cited in Gresham, 2003).

The 2009 mathematics curriculum published by the Ministry National Education İn Turkey is based on the assumption that every individual is capable of learning mathematics. Ashton and Webb (1986) discovered that students are prone to believe in their tendency to learn and that teachers have developed themselves in a way that would ensure students' faith in themselves. These teachers not only offer students a hospitable and encouraging learning environment, but they also sustain the belief that students will behave themselves accordingly, if they are treated equally and coherently. The Mathematics curriculum (MEB, 2009; 2013) is indeed on these principles and standards. High levels of self-efficacy will prevent the discrimination of students as successful or unsuccessful.

Findings in this study suggest that teachers' self-efficacy affecs students' attitude towards mathematics.

This effect was further scrutinized to see whether it was the result of the self-efficacy score or the outcome of a sub-research question regarding self-efficacy in particular. Students transfer ideas in social learning environments to their own psychological upbringing. Internalisation of knowledge can be said to play a role

in the individual's attitude. Steinkamp (1982) suggested that the basic variables determining achievement in mathematics are math attitudes

i. In the present study, it was found that teachers' self-efficacy for instructional behaviour had a significant effect on students' attitude towards mathematics.
ii. It was found out that teachers' self-efficacy for classroom management had a significant effect on students' attitude towards mathematics.
iii. It was found out that teachers' self-efficacy for student engagement had a significant effect on students' attitude towards mathematics.

Implementation of effective instructional practices in mathematics has been linked to teacher efficacy (Enon, 1995), and highly efficacious teachers are more effective mathematics teachers than teachers with a lower sense of efficacy (Swars, 2005).

Attitudes toward mathematics play a crucial role not only in mathematics education but also in other areas, for example preservice teachers' education (Bursal & Pozanski, 2006). While research shows that cognitive planning and decision making by teachers has an important contribution to student's learning (Schunk, 2009), we can argue that this also has an effect on students' attitudes. Mohamed and Waheed (2011) when reviewing literature aimed at understanding attitudes and the influences on their development in relation to differences between students, identified factors associated with the school, teacher, and teaching process (e.g., teaching materials, classroom management, teacher knowledge, attitudes towards maths, guidance, beliefs).

Suggestions

The research can provide a review of middle school mathematics teachers 'necessary aptitude, skills, thinking habits and characteristics in mathematics to improve their own and their students' self-efficacy in mathematics.

The role of mathematics teachers includes the acquisition of mathematical knowledge, identifying obstacles that prevent the acquisition of said knowledge, and develop strategies to overcome adversities in teaching. Furthermore, mathematics teacher need to strengthen their students' positive attitude towards mathematics, while possessing fundamental knowledge in the content domain. Relearning and preparing representations during the cognitive learning process is another role that mathematics teachers are required to have. Therefore, improving one's self-efficacy is an important necessity that full-time and prospective teachers should be taken into consideration for students' mathematical achievement.

It is essential for mathematics teachers to see the mistakes/errors they make as opportunities to further better themselves in the field. For this reason, additional studies regarding self-efficacy in instructional behaviour should be carried out and instructional behaviours should put an emphasis on measures that would help develop teachers' self-efficacy. Mathematics as a science is based on five pillars, which are; self-efficacy, cognitive understanding, operational fluidity, strategic

competence, reasoning and behaviour. Teachers should be supported with in-service training sessions to reinforce the aforementioned points.

When leadership is considered, it is often the headmaster of a school that comes to mind. However, as with teachers of other subjects, the leadership of the mathematics teacher should be considered and studies should be initiated on this subject. The contemporary mathematics teacher is someone who puts forward the knowledge of mathematics and its sub-domain content, as well as the relationship between these subfields and the Curriculum. As a teaching leader, the mathematics teachers continue to evaluate the process of learning and the students themselves. They play a role in creating an atmosphere and environment that is suitable for learning and teaching. For this reason, studies can be conducted on the contribution of contemporary mathematics teacher as a teaching leader.

Available research shows that teacher can enhance academic performance of learners. Students' greater understanding of concepts can be influenced by motivating students and by using effective strategies related to learning problem and by motivating learners. Every important cognitive act has motivational consequences that potentiate future self –regulatory actions and feelings self-efficacy (Schunk, 1989, 1995; Malpass, O'Neil, & Hocevar, 1996; Pajares, 1996, 1997; Bandura, 1995). Betz and Hacket (1983) proposed that self efficacy might serve as an important career development mechanism, influencing the educational career decisions, achievement, behaviour, and career adjustment of human. Sense of teacher efficacy is considered to be a variable that influences teacher's action.

Chang (2015) found that fifth-grade mathematics teachers' efficacy significantly influenced both their students' mathematics self-efficacy and mathematical achievement, which was consistent with findings of previous studies (Ashton & Webb, 1986; Rosenholtz, 1989) linking teacher's mathematical self-efficacy to students' attitudes and abilities.

Students actively participating in a mathematics class tend to believe in the message that "they have the necessary skills to learn math". Therefore, students' self-efficacy can also be investigated. The relationship between students 'self-efficacy and teachers' self-efficacy can be sought. The interrelation between personal and environmental factors can be clearly seen between self and social variables. We can investigate environmental factors, students' self-efficacy, and the effects of parents and family. The roles of mathematical anxiety, perception of self-efficacy towards mathematics and gender variables in predicting mathematics achievement can be investigated. Secondary and high school students' perception of mathematics self-efficacy can be investigated.

We learn mathematics by internalization and mathematical culture in the classroom environments contributes to this process. Hence, further studies aimed on the subject of teachers' mathematical culture can also be carried out.

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Different Views? The Experiences of International Students Studying HE in Three Non-university Settings

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The purpose of the research was to discover the views of three groups of International students who were undertaking their Higher Education (HE) in a publicly-funded college, rather than a university setting. A comparative survey was undertaken by International students attending an American Community College, an Australian Technical and Further Education Institute and a group of English colleges which offer Higher Education. All three groups were satisfied with their provision. The college setting was perceived to offer higher levels of support than would have been available at a university, plus enhanced employability prospects and lower fees than those charged by a university. The status of an Australian, English or American HE qualification was important, as was the reputation of their particular college. The market for International students is highly competitive and largely driven by universities. The English experience suggests that colleges should focus on the marketing of specialist courses. In all cases, the fact that teaching staff were primarily teachers, rather than researchers was highly valued by respondents, as was their currency in their subject. However, there were strong feelings about value for money and the ability to engage with Home students and wider Australian, British or American culture. International students choose to study abroad because they want to broaden their own horizons and learn more about other cultures: many respondents found these opportunities to be limited. In order to help address this, an International student recruitment Checklist for senior college staff is presented as part of the research findings.

Keywords: Higher Education, International students, colleges, value-for-money.

Introduction

Much has been written about International students and universities, with comparatively little attention (in England, at least) paid to those who choose to pursue their Higher Education (HE) in a college setting. This paper is about some of those college-based students. It reports the findings of a survey carried out in 2017-18 into the views of International students who are studying for HE qualifications in a publicly-funded college rather than a university. We set out to answer the question "Are there any lessons and successful practice to be drawn from the experiences of International students studying in non-university contexts in three English-speaking countries?"

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The research involved students enrolled in three locations - Holmesglen Technical and Further Education Institute (TAFE) in Melbourne, Australia, Moraine Valley Community College near Chicago, in the United States and members of the Mixed Economy Group of English Further Education (FE) colleges. With some local adjustments to reflect use of language and academic terminology within the three countries, the same survey questionnaire was used with all three groups of students, making it possible to compare the responses to particular issues. The Mixed Economy Group (MEG) had carried out a similar survey of International students within its member colleges in 2013.

The survey set out to compare responses to a number of areas of student life. These included accommodation; sources of course funding; teaching and learning issues; social integration; motivation to study in Australia, England or the US, whether or not the student felt welcome in the country/on campus and their overall views on the value for money offered by their institution. We focus our paper on these last four issues. They were the subject of much discussion at national level in each country at the time of the survey, and continue to be so at the time of writing. The responses to the section on teaching and learning are referred to in less detail. This is not to undervalue them: teaching and learning formed a large component of the survey and is better served by being the subject of a separate document.

Our paper is set out in eight sections. Section 2 offers an overall context for our work, section 3 looks at previous research into the same area and as a precursor to our results we describe the three separate college contexts in section 4. Section 5 looks at the methodology and 6 gives the results of the three surveys, the significance of which we discuss in section 7. Our final section offers a commentary and suggested way forward for colleges. The research output includes a practical Checklist for college leaders and senior managers. Alongside this primary research we also comment on the impact of national policies on local college experiences.

Survey Context

Considerable change has taken place in the English HE political and educational landscape since the MEG carried out its first survey of International students in 2013. Whilst the spectre of Brexit casts a long shadow over many UK educational institutions' plans for internationalisation, these are made worse by the UK Government's long-standing commitment to a reduction in immigration numbers. Despite much debate, International students are included in these figures. Whatever the political rights and wrongs of these matters, there is a general sense amongst prospective International (and European Union) students that they may not be welcome in the UK (UK Council for International Student Affairs, 2017).

A similar degree of ambivalence surrounds the actions of the American and Australian Governments. Spokesmen for both countries have repeatedly voiced their determination to exercise more control on immigration whilst actively promoting their HE provision to international markets.

In all three countries International students pay considerably higher fees at university than Home students, providing valuable income to institutions which may otherwise struggle to balance their books. Within any year group of students following a particular course, some may be paying three times as much as others for identical provision. Whilst this situation is less likely to apply in a college setting (fees are higher for International students, but far less than in the university system) the surveys aimed to gauge whether these students consider their courses are value for money and whether they feel welcome in Australia, England or the USA.

During the period in which the research was conducted and in the year following, International students and their choices of HE provider came under increasing focus by all three Governments and their national HE institutions. The value of International students, both economic and in terms of the internationalisation of university/college campuses, had always been understood but gained increasing focus. Competition for this group of students increased significantly as Education budgets in the US, UK and Australia were cut.

In the UK evidence began to emerge that conflicting Immigration and Education policies and the implications of Brexit had led to a decline in International student numbers. Second only to the US as a venue for these students for decades, UNESCO data suggested that the UK had now been overtaken by Australia. A useful overview of the history of UK International student recruitment, including the values that shaped successive policy decisions, is to be found in Kumari (2018). This was written for the Higher Education Commission as its contribution to the swathe of debate surrounding International students and Immigration policy that took place in the UK across 2018. Similar documents appeared in Australia and the US during 2017-19, often building on concerns that had emerged a decade earlier (NAFSA, 2009; and 2019a, in the US).

In England these discussions led to a long-overdue commitment to increase International student recruitment, but with only minor changes to the existing immigration and visa constraints. At around the same time, Conlon, Halterbeck & Hedges (2019) examined the financial contribution made by International students who graduate and then find employment in the UK. The main headline from this was that just one cohort of such graduates raised £3.2 billion in taxes. Countering another suspicion, the report was also able to prove that far from displacing Home graduates in the job market, International students typically worked in sectors suffering from acute skills shortages. Similar conclusions with regard to the economic value of their own International students were reached in the US (NAFSA, 2019b) and Australia (ICEF Monitor, 2018).

Literature Review: The International Student Experience in Colleges

Unsurprisingly, given their status as a recognised part of the American HE system, research in this area is greatest around Community Colleges. It is also far from recent. Lee & Rice (2007) noted that host communities can be intolerant and sometimes had racist views. Vafors Fritz, Chin, & DeMarinis (2008) concluded

that International students were often wrongly regarded as a homogenous group. They found that some issues were more stressful to some nationalities than others and that academic staff were less sensitive to these differences than might have been assumed. Yeh & Inose (2010) discussed acculturation stresses as did Smith & Khawaja (2011) who again concluded that the host society had a key role in helping students to adjust to their new surroundings.

One particular piece of research provides a backdrop for our study. In a doctoral thesis published in 2017, Guyton noted that International students in rural Community Colleges sought out students from the same country for emotional and social support, especially those in higher years who were following the same course. English language support was frequently referred to, often in the context of having learnt English as a second language and, within that, British English rather than US English. Many International students found that US students were polite but not interested in socialising with them, reverting to their own longer-established local friendship groups after class. Loneliness was a problem for the International students, made worse by a rural location.

In her conclusions, Guyton (2017) recommends that college staff actively promote social contacts in the college and in the community, including organising summer internships in order to promote employability skills amongst International students. This would also enable local businesses to benefit from their skills. She noted that the impact of different educational systems is often underestimated: in some cultures the teacher is a respected individual whose word is simply not to be challenged. In UK, US and Australian HE settings, a far greater degree of interaction is expected, which further exacerbates any lack of confidence in spoken English skills. The cultural sensitivities of teaching and non-teaching staff were perceived to be an issue. Guyton concluded that formal training in internationalisation and in different learning styles should be mandatory in any Community College that recruits from abroad. Linked to this was a conclusion that staff make too many assumptions about International students and the extent of their preparation before arriving in the country. Many students spoke about a lack of clarity over the true cost of courses, which were often far higher in practice than they had assumed from their initial research. When coupled with limited opportunities to work on campus, this led to hardship.

These findings are reflected in subsequent research and commentaries. In Australia Tran & Dempsey (2017) authored an overview of internationalisation in vocational and educational training (VET). This noted that during the 1980s, Australia shifted its approach to teaching International students, moving from seeing education as a form of aid to one of trade. International students were subsequently regarded as revenue and Government funding to providers was reduced. The book refers to VET providers as significant but often-neglected players within the field of international education. The editors suggest that whilst many types and sizes of institutions are caught up in the drive to recruit International students, managing that process and then adapting as institutions to a new student balance requires careful consideration and planning.

Leask & Carroll (2013) offered pragmatic advice to staff teaching International students, focusing on how to help their integration into the wider community.

Martin (2018), writing in The Interpreter (the Lowy Institute) noted that the majority of Chinese students leave Australian universities disappointed by their social experiences. They have few local friends and are unlikely to have found meaningful work in local companies. She concluded that their time is marked by isolation and little cross-cultural engagement. Martin poses the question that since International students pay three times the fees of their domestic peers, is it unreasonable to invest some of this income in improving their social experience? As elsewhere, Chinese students in Australia consider that their Australian peers are indifferent to making friends with them. Martin suggests that young Australians want and need to develop an understanding of their Asian neighbours but somehow lack the skills to talk to students sitting in the same classroom. She concludes that this could be remedied by a systematic and informed approach to training Home students and their teachers about how to make the most of the valuable social and cultural resource sitting in their midst.

In England, little has been written about International students pursuing their HE in an FE college setting. This reflects both the arrangements concerning the delivery of HE in the UK (see next section) and the numbers of students involved. The attention that has been paid to International students is largely from a university perspective, but typically reflects many of the findings referred to above. Mellors-Bourne et al (2013, p. 12) offers a useful summary:

> *"Many host institutions and wider communities become far more multi-cultural through the presence of International students. However, whether exposure to students from other cultures manifests in greater tolerance can depend on the nature of these interactions and the degree of integration of internationally mobile students into their host communities. There is potential for a 'darker side' which can include racism or violence against International students, concerns about over-representation of International students on university campuses, and a lack of integration between domestic and International students."*

Our research covers these same issues and seeks to see if any ways forward can be found.

Setting the Scene

In the US, the 1,103 Community Colleges are an established part of the HE world. Many students begin their undergraduate life on an Associate Degree in a local college before transferring to a university to complete their Bachelor's degree. Whilst most universities are in urban environments, Community Colleges enable those in rural locations to access technical and higher skills.

In the UK, the 257 Further Education colleges cover a similarly wide geographical area, fulfilling the same functions as their American equivalents. Unlike the US and Australia, however, a long-standing distinction exists between Further and Higher Education. Further Education offers a range of courses post-school but at a level below a US Associate Degree or English Foundation Degree or HNC/D. Until recently, only universities were able to award and

deliver HE courses: whilst this has changed, 90% of HE is still awarded and delivered by universities. Only two colleges have full degree-awarding powers, with seven being able to offer two-year Foundation Degrees.

In Australia, the Technical and Further Education Institutes provide opportunities for students to access a similar range of skills as their Community College and FE College counterparts but with the difference that 11 TAFEs are recognised HE providers in their own right. However, unlike the situation in the UK and US, Domestic students following HE courses in TAFEs are generally unable to draw down government-funded student loans.

All three types of college are characterised by an approach to HE that is employer/employment focused. This is often described as Higher Technical Education or Higher VET (HVET) as a means of distinguishing it from the more traditional approach of a campus university. Students are more likely to be in their mid-20s and older, are often the first in their families to experience HE and are more likely to live at home. Across all three institutions, the majority of the students in our survey were following HVET courses, such as Nursing, Accountancy, and Hotel Management.

English Colleges

The number of International students (i.e. not Home or European Union students) studying HE in an English FE college in 2015-16 was 1,190. A year later, this had dropped to 879, of whom 566 were attending MEG member colleges. These students were largely split between three MEG institutions - two specialist maritime providers and an agricultural college with specialist provision in the field of equine science. By 2017-18 numbers had declined significantly. Only 667 International students were enrolled on college-based HE courses, of which 384 were attending a MEG college. As in previous years, most of these were enrolled on specialist courses (Higher Education Funding Council for England, 2017, 2018).

In parallel to the student survey, a separate survey of MEG representatives revealed that one college had no International students on roll at all, despite having been one of the biggest recruiters within the college system across the last 5 years. Of the 23 respondents to this numerical survey, only 3 colleges had more than 30 International students, and only 2 of these had more than 50. A similar pattern emerged with EU students.

In England, most International students pursue their HE in a university. As a comparison to the college figures given above, in 2016-17, 263,825 International students were studying in English universities (Higher Education Statistics Agency, 2018). Most English universities have a long tradition of recruiting International students (Mellors-Bourne et al., 2013) and have well-established related infrastructures as a result.

MEG members agreed that three factors limit International student recruitment to colleges in the UK. Foremost are visa restrictions, including current limitations on employment opportunities for students pre- and post-graduation; heavy reliance on overseas agents, the variable reliability of agents,

and the increasing costs of marketing overseas compared with the anticipated return.

MEG respondents noted that the costs involved in setting up, staffing and maintaining an International Office put colleges at a disadvantage when compared to their university competitors.

Despite recent policy changes, the arrangements governing student entry to the UK remain complex. Immigration policy was rarely developed as a result of discussions across Government Departments, with the result that tensions often exist between national policies concerning Education, Business, and Health and those concerning immigration. Until this year, the UK, unlike its competitors, had never stated an intention to increase International student numbers: perversely, these are included in the country's Net Migration Target. The aim of the present Government is to reduce this to tens rather than hundreds of thousands per year (House of Commons Home Affairs Committee, 2018). Across 2018, various national bodies initiated Inquiries and produced Reports which call for the inequalities and subjective judgements which mire current policy to be abandoned. Each one concluded that an agreed cross-Department policy for determining International student numbers and their means of entry to the UK was needed urgently. As an example of the existing anomalies, International students completing a course below degree level which would lead a Home student directly onto a course of HE are unable to do this (Kumari, 2018). Instead, they are required to return home and begin the whole application process again.

Partly in response to these discussions, a new International Education Strategy was announced in 2019 (Department for Education & Department for International Trade, 2019). This commits to a cross-Department approach to immigration and to expanding International student numbers. It makes some minor changes to length of stay post-graduation - but does not address the problem referred to above.

Most of the UK's International students are from China. Numbers from the Indian sub-continent and African countries have declined significantly in the face of current immigration policies (Kumari, 2018). As elsewhere in the world, International students are required to produce evidence of financial independence: a condition of entry is that they will make no call on the public purse and can fund their own healthcare, accommodation, etc (ibid., 2018).

International students following a course of HE are able to work for 20 hours a week whilst studying. On completion of their courses, they are expected to return home unless they find a graduate–level job within 6 months of completing their studies. In order to comply with visa restrictions, the job must offer a minimum salary of £20,800. Competitor countries such as Australia and the US have more flexible Post Study Work offers.

Moraine Valley Community College, near Chicago, Illinois

There is an overall decline in the numbers of new International students enrolling in Higher Education institutions in the United States (Open Doors, 2019). After a steady year-on-year rise since 2011-12, the data shows a 3.3% decrease in enrolments between 2015-16 and 2016-17and a further 6.6% fall

between that year and 2017-18. Just under 95,000 International students were enrolled on Community College HE programmes in 2017-18, a fall of 2% on 2016-17 (Open Doors, 2019). At the same time, many Community Colleges in the United States are also experiencing a decline in Domestic student numbers.

Many factors can prompt a decline in enrolments as it relates to International students. The political climate, such as the 2017 travel ban policy for some countries and subsequent versions of this, plus on-going rhetoric concerning immigration from within the White House, has had an impact on International student numbers (Redden, 2018). American Community Colleges now face more competition for International students, who are apprehensive about studying in the United States and therefore choosing to study in other countries. Forty nine percent of International students attend colleges in five states - California, Texas, Florida, Washington and New York (Association of American Community Colleges, 2019).

The majority of International students studying in the US are Chinese, Indian or South Korean nationals, a pattern reflected in enrolments in Illinois but not found at Moraine Valley Community College. A noticeably more diverse range of nationalities is found here, with large numbers of students coming from Jordan, India, Vietnam and Korea in fall 2018.

The college experienced record enrolments for International students during 2016-17. However, a reverse began in spring 2017 semester (see Table 1 to track the declining trends with International students.) Although some of the college's International students may have graduated or transferred to a four-year institution, anecdotal evidence suggests that financial considerations and the political climate have impacted International student enrolments.

Table 1. International Student Enrolment Moraine Valley Community College

Fall 2016	**Spring 2017**	**Fall 2017**	**Spring 2018**	**Fall 2018**	**Spring 2019**
325	314	252	216	199	168

Source: Moraine Valley Community College 2019.

In the United States, an F1 Visa is issued to full-time students who wish to pursue a course of study that culminates in a degree, diploma, or certificate from an institution that has been authorized by the U.S. government to accept International students. This is the most common form of student visa issued to International students in the United States. A J1 Visa is issued to students wishing to participate in exchange programmes at similarly accredited schools. The major difference between a J1 Visa and an F1 Visa is the fact that a J1 visa is issued for a limited time and the programmes do not culminate in a degree, diploma, or certificate. Also, the programmes do not have to be strictly academic in nature. This should not be confused with an M1 Visa, which is intended for students pursuing specific vocational programmes in the United States. With all three visa types, students are expected to return to their home countries after completing their course of study, although Associate Degree holders can work in their field of study for up to one year after graduation.

Moraine Valley Community College is currently only approved to issue F1 visas to International students. Students must adhere to the basic requirements for an F1 Visa, but must also meet additional institutional requirements. In order to be issued an F1 Visa, students must provide documentation demonstrating financial eligibility for one year of study and exhibit genuine intent to pursue an academic degree. In addition to this, Moraine Valley requires that all International students have completed all secondary or high school studies. English proficiency is required for an Associate Degree programme, but it is not required for entry into the college. Students who do not meet the language requirements can matriculate into an Associate Degree programme after completing intensive English study.

Holmesglen Institute, Melbourne

Holmesglen Institute of TAFE is an integrated public education provider delivering over 530 programmes to approximately 30,000 students (from vocational college (upper secondary) to Masters level) across four campuses located in Victoria, Australia. In 2017 International students totalled 3,697, sourced from 84 countries across 5 continents.

In partnership with universities, Holmesglen began operating in the HE sector during the 1980's. Since 2004 the institute has written, accredited and re-accredited 15 undergraduate, and 4 post-graduate programmes for delivery under the Holmesglen brand. It also continues to deliver a small number of undergraduate programmes in partnership with Australian universities.

The Institute's HE programmes are developed to provide a clear pathway for students graduating from lower-level vocational studies. Recognition of prior learning is applied, which often reduces the duration of a degree by a minimum of one year. The Australian Government continues to allow 'course packaging' whereby students can package two or more programmes on one student visa as long as there is a clear progression from one programme to another (Department of Home Affairs, 2018a).

International students admitted to Holmesglen's vocational programmes generally pay a reduced fee compared to those applying for direct entry to undergraduate study. It is common for International students to package their visa to combine both vocational and HE study. Since 2008 approximately 60% of International students commencing an undergraduate programme at Holmesglen entered through a vocational pathway. However, during the last two years the number applying for direct entry to year one of the Institute's degree programmes has significantly increased, particularly in the accounting, business and hotel management disciplines.

The largest numbers of International students entering HE programmes through a packaged vocational pathway programme in 2017 came from India, Sri Lanka, Mauritius and China. The Australian Government introduced a simplified student visa framework from July 1, 2016. Overseas students now apply for a single student visa (subclass 500) regardless of their programme of study, with a single immigration risk framework applied to assess all applicants. To be granted a visa, applicants are required to satisfy a number of requirements. These include

meeting a minimum level of English language, and evidence of sufficient funds available, (including living costs indicative of the cost of living in Australia), to cover the duration of their Australian studies.

Providing applicants satisfy the legislative requirements, the Australian Government does not place a cap on the number of student visas granted. As at 30 June, 2018, there were 486,934 student visa holders in Australia. Over one third of these were from China (23.1%) and India (14.4%) (Department of Home Affairs, 2018b).

International students are entitled to work a maximum of 40 hours per fortnight. These restrictions only apply when their programme is in session, thus during semester breaks unlimited hours of employment apply. (Department of Home Affairs, 2018a). Following graduation with a degree from an Australian university or approved TAFE, International students can apply for a Temporary Graduate (subclass 485) visa that allows them to live and work in Australia for up to 4 years after they finish their studies.

The Australian HE sector recorded a growth rate of 14.7% in International student enrolments between 2016 and 2017, with China (38.2%) and India (15.5%) contributing 53.7% of these. Statistics relevant to the 2016 calendar year released by the national regulator show a total of 2,779 International student enrolments at TAFE Institutes, of which 920 were enrolled at Holmesglen (TEQSA, 2018).

In line with the national trend, Holmesglen recorded a sharp increase in International student numbers during 2016. Although commencing student numbers declined slightly in 2017, International students still accounted for 64% of all HE enrolments at the Institute. The majority of these enrolments continue to be concentrated in four discipline areas, namely Nursing, Hotel Management, Business and Accounting.

Methodology

Staff at all three groups of institutions drew the attention of International students to the survey and invited them to complete it on-line. The rubric at the start of the survey explained that this was a research exercise being undertaken with students enrolled in Moraine Valley Community College in the US, Holmesglen TAFE in Australia and a group of English FE Colleges in order to find out what they thought about particular aspects of their HE experience. It was made clear that all three groups were completing the same survey at the same time and that the results would be confidential. The survey was conducted in accordance with the research ethics policies of the participating institutions.

Respondents were asked to agree or disagree with a series of statements, with the opportunity to strongly agree/disagree: a neutral option was also available in some cases. The survey was constructed to enable comments to be made at the end of some sections, thus enabling a qualitative element to enter the research.

A total of 445 International students completed the survey, which ran from October 2017 - February 2018. The questions were loaded onto SurveyMonkey

within Moraine Valley, Holmesglen and the MEG website and the results analysed by a college-based author.

The Results of the Survey

What do International Students in Chicago, Melbourne and England think of their college-based HE?

The majority of survey respondents in all three groups were aged 18-24. Just over half were female and the majority were in year 2 of a three or four year degree programme. The students in all three groups had chosen to study abroad because they wanted to experience life outside their own countries and to improve their English language skills. For many, these two factors, alongside an American, Australian or English HE qualification, were seen as a means of improving their employability prospects.

In most cases, International students chose to study a higher vocational course in a non-university institution because they see a clear link between their chosen programme, their future career, and economic success. Most students make a personal financial investment in their American, Australian or English HE: the majority of respondents take out a personal loan or receive help from their family in order to meet tuition fees. However, students are also sensitive to fee levels and are attracted by the lower cost of college-based HE.

Overall, the survey results show that students share a number of positive views about their experience. These include the high reputational value of an American, Australian or English HE qualification and the reputation of their chosen college. Students place a high value on the teaching skills of college faculty, coupled, in the case of vocational qualifications, with an appreciation of their teachers' up-to-date industrial knowledge. High levels of learning support, often outside the classroom, are perceived to be available in a college when compared to that thought to be offered at a university. This includes easy access to impartial careers information. International students value the clarity of explanation about fees, the help provided when facing issues with visas and the support they receive with course work. These are a testament to the values associated with college-based HE in three different English speaking environments.

However, two concerns are shared across all three survey outcomes, voiced clearly in the qualitative responses within the survey. First, the importance of receiving value for money, given the large personal investment identified above. Second, International students say they feel welcome in England, Australia and the US but suggest that much more could be done by Home students to engage with them and provide a deeper experience of the host community. There was a strong feeling that institutions could do more to address these points.

The MEG Responses

The English results are best interpreted by considering the 55 respondents as belonging to one of three groups, namely a cohort of Nigerian students attending a Nautical Science course at a specialist Maritime College, funded by their Government; a separate group of International students attending a range of colleges, courses and levels of HE, and a third, smaller group, of European Union (EU) students, again attending a number of different colleges and pursuing different courses.

Despite declining International student numbers, the survey results for English colleges indicate that specialist courses are of particular interest to this group of students. In many cases they are either not available in their home country or are not affordable.

> *"I chose to study at Hartpury College simply because the program I am studying is not found at any university. The biggest thing for me was finding the specific program I wanted to study (equine therapy and rehabilitation). There were no other factors (money, location, etc.) besides the fact that I wanted to specialize in equine therapy and there is no university program in my home country that provides this."*

Non-university HE providers intent on International student recruitment should therefore consider whether their curriculum offer contains specialist and employment-focused programmes. FE colleges offering Maritime and Land-based specialisms have clearly succeeded in developing and marketing a niche provision. Other institutions could follow suit in areas such as the Digital or Creative fields.

A second outcome from the survey is the high regard given to college teaching staff. None of the students responding to the survey disagreed with the statement that "My teachers are knowledgeable in their subject area", with most agreeing strongly.

The second group of International students referred to above is perhaps the most representative of overseas students likely to be attending English colleges. They were funded entirely through a combination of personal savings, personal loans and/or support from their families. None attended the college providing the specialist course. They were less satisfied with the administrative arrangements in their respective colleges than this first group and more likely to prefer separate social and academic facilities for HE students, rather than share facilities with often-younger FE students. They were ambivalent about whether or not they preferred to share accommodation with people from their own country but were more likely to be interested in learning about British culture and wanting to socialise with English students. The quality of teaching and careers guidance was well-regarded although several respondents commented on the lack of contact time with tutors and the slow pace of work.

> *"Frequency of classes is lacking - I have had 3 hours of class a WEEK from end of October until Christmas break".*

The outcomes from the survey can be summarised as:

What were your main reasons for studying in England?

- The reputation of English HE
- The experience of living abroad
- Enhanced employability prospects.

Why did you choose to study Higher Education in a college?

- Lower fees than would be charged by a university
- A higher level of support
- Lower entry criteria than a university.

Why did you choose your particular college?

- The reputation of the college
- It offered my preferred course

92% of respondents said that they felt welcomed in England. Overall, 78% of respondents considered that their courses represented value for money.

85% of students agreed that the teaching style in an English college was different to home. This may go some way to explaining unfavourable comments around contact time in the responses received in the English survey. These reinforce a need to ensure that adequate time is set aside to explain mutual expectations between teachers and International students, as well as the arrangements for fee payment, options choices, pastoral care, etc. All students (Home and International) need to be aware from the outset that the development of independent learning skills is a characteristic of Higher Education.

Although most students said that they feel welcome in England, some commented that more could be done to help International and EU students (the latter were included in the English survey) adjust to an English environment. The survey group wanted to learn more about English culture and to make English friends. 65% said that they would like to mix more with British students, with a similar percentage wanting to learn more about British culture. In keeping with wanting to gain experience of living away from home, 82% of respondents said that they would like more contact with students of other nationalities.

"I think students from England should associate with International students".

Given the general perception abroad that England is not welcoming to foreign students, it will be useful for colleges to review their induction and pastoral care arrangements for these cohorts.

The 2013 MEG survey results suggested that more attention was given by colleges to meeting the needs of International students than their EU counterparts. In 2018, this sense still prevails. EU students pay the same fee as English Home students but have social and language needs more akin to those of International students. They are still more likely to question value for money or the

administrative arrangements surrounding their studies than their International counterparts. International students know that they pay higher fees than Home or EU students and they know that colleges do not wish to lose the fee income that they bring. English colleges must take care not to overlook the needs of EU students in this context.

Under current proposals post-Brexit, EU students studying in England will pay International fees and have no entitlement to English student loans. FE colleges must review their support arrangements for existing EU students if they want to ensure on-going positive feedback to these students' home countries and future recruitment from Europe.

In response to the survey findings, English colleges have implemented or further-refined a number of initiatives. These include organising sessions specifically for overseas learners on specific evenings. These are social events, but are also used to promote British values and help non-Home students to acclimatise to British culture. The sessions are largely promoted to new arrivals to the UK.

Colleges are also developing relationships with local communities sharing a cultural or religious background with their International students. This can then act as a bridge to the wider community. As an example, a college with significant numbers of Nigerian students on its Nautical Science course has developed a link with a local Nigerian Pastor. He has helped the college to organise celebrations such as those for Nigerian Independence day, including the provision of traditional Nigerian food. (The college supports these events financially.) Non-Nigerian students are welcome to take part in these celebrations, adding an international multi-cultural dimension to the experience of Home students. This is often complemented by international social programmes which involve both International and English students.

International students have also expressed a wish for greater attention to be paid to achieving an appropriate balance between International and Home students when setting up class and seminar groups and allocating places in halls of residence. The same principle can be extended to induction sessions at the start of the academic year. Many colleges hold sessions dedicated to International students, who are identified as a discrete group, separate from English students. However, opportunities to integrate these activities are often missed.

International students believe that an early start to integrating them with Home students will have benefits for all concerned. One successful example of this includes establishing a "buddy" system, giving International students a friendly face in their year group whilst at the same time offering the Home student an opportunity to broaden their own social experience.

One college is building on its existing partnerships with European colleges to build links which go beyond the strictly transactional.

> *"Students take part in a Trade Mission project where they work with students from across the EU trying to promote a local business abroad. We are hosting the Trade Mission next year which will involve 100 EU students and approximately 50 of our HE students from various subject areas, taking part in joint activities."*

In this way international awareness becomes embedded in the curriculum, helping to break down barriers for International students as they adjust to a new country and a different culture.

Some colleges recognise the international culture already implicit in some courses. The Head of the specialist Nautical Science course commented that:

> *"Our learners are from the Global Maritime sector. Seafarers, in general, are truly multicultural. The sector is officer-based with a hierarchical structure. There is an inherent willingness in all of our learners to explore and experience other cultures: we merely facilitate this".*

Moraine Valley Community College

56 International students (24% of the total) from 10 largely HVET curriculum areas completed the survey. Based on these responses, International students report that they are generally satisfied with Moraine Valley Community College. Some of the key outcomes from this survey included the following:

What were your main reasons for studying in the United States?

- To enhance employability prospects
- To improve my English
- To gain some experience studying abroad

Why did you choose to study Higher Education at a Community College in United States?

- Lower fees compared to a university
- Higher level of support compared to a university

Why did you choose to study at Moraine Valley Community College?

- Friends or family studied at Moraine Valley
- Location
- Lower Fees
- Reputation of Moraine Valley

Over 87% of the International students who completed this survey responded that they felt welcome on campus, and 72% would recommend the college to friends.

> *"I have been here for almost 3 years. I improved myself a lot. I achieved my dreams at MVCC"*

> "*Everybody welcomes you. They provide support and adequate information as well as help.*

87% expressed a wish to mix more with US students and 69% wanted to learn more about American culture. A small majority of students (56%) stated

that the approach to learning in the US was different to that in their home countries but 70% were satisfied with both the range of options within their courses and the resources available in the college library.

Despite high satisfaction levels overall, only 36% considered that what they received in terms of education programmes and resources was equal to what they paid in fees and other costs. Many students took the opportunity to add comments at the end of this particular question, reflecting the strength of feeling surrounding the overall cost of their course, payment methods and limited opportunities to work in order to supplement income

> *"Allow international students to get on payment plans. The amount paid upfront is insane".*

> *"I think MVCC has really good curriculum for studying, but it is too expensive paying tuition for International students. I still don't understand why should we pay 3 times tuition to compared with local students."*

Several areas for improvement emerged from the survey results. These included revising the tuition fee structure to include a more flexible payment plan for International students, coupled with increased opportunities to secure scholarships. International students were also keen to increase the hours of paid work available on campus. Away from financial matters, International students revealed that they would like more opportunities to engage with local students, and more events and activities that enabled them to experience American culture.

Based on these results, the college's International Education Committee has already scheduled events to increase the engagement between International students and Domestic students in and outside of the classroom. It should be noted that the International Student Ambassador Club has its highest member participation in 2018-19, with 38 students in total: 26 students are International and 12 students are Domestic. Many of the latter joined the International Student Ambassador Club as a means of learning more about their non-US peers.

Other events that took place during International Education week included International Education Trivia in which students were able to answer Trivia questions related to international education using Kahoot. "Teas around the World" saw students dressed in traditional clothing serving tea from various countries. Guests at the event were given a copy of the International Cookbook produced by the students. International students also participated in sports activities such as ping pong and basketball as part of an activity aimed at sharing experiences of the Olympic Games.

Away from these social activities, International students and students who have participated in Study Abroad shared their experiences at an International Student Panel. Students from different cultures presented facts about their country and culture in a Poster Sessions Showcase. Finally, the college organised an International Education Week, involving collaboration from different departments across campus, including the Celebrating Diversity Task Force, the International Education Committee, the Global and Diversity Education Programme and the International Student Affairs department.

Holmesglen Institute

A total of 334 International students (38% of total) across eight HVET discipline areas completed the survey in 2017. Key findings included the following:

What were your main reasons for studying in Australia?

- Reputation for the standard of its HE programmes
- Gain experience living abroad
- Enhance employability prospects
- Safe country for International students

Enrolling in HE as a path to living permanently in Australia only ranked as the 7th most important reason for studying in Australia. In contrast, when asked to rank their intentions upon graduation, seeking permanent residency ranked in the top three. However, consistent with the top three ranking of the importance of enhancing employability as a reason for studying in Australia, students also indicated their number one intention upon completion of their studies is to seek employment in Australia. The survey data reinforces the relevance of the Temporary Graduate (485) visa streams to International student choice of Australia as a HE destination.

There is also some similarity to responses by students at Moraine Valley and within the MEG colleges who ranked enhancing employability prospects and gaining experience studying abroad in their top three reasons for studying in America and England. Holmesglen students, however ranked 'improving English language' much lower (8th most important) than at Moraine Valley. It is perhaps worth investigating if this is related to government and admission requirements regarding English language, and/or the mix of countries each provider currently targets as a source of overseas students.

As with both Moraine Valley and the MEG group, reference was made to teaching style, with 85% agreeing/strongly agreeing that the style of learning in Holmesglen was different to that which prevailed in their home countries. 41% of those who had reservations about their HE experience wanted to be provided with additional academic support - perhaps reflecting the situation found by MEG (above) in relation to contact time.

Why did you choose to study higher education at Holmesglen Institute?

- Lower fees compared to a university
- Offered preferred course of study
- Reputation of the Institute
- Higher level of support compared to a university.

In line with the findings at Moraine Valley and MEG, lower fees compared to a university ranked as the most important reason students selected Holmesglen as their HE provider. This was reinforced by the 71.6% of respondents who, amongst

some comments that fees had been increasing, still expressed the view that the institute offered good value for money.

It should be noted that 53.4% of respondents had studied a vocational pathway programme either at Holmesglen or another provider. As previously stated, International fees tend to be lower in vocational programmes, as these programmes are generally mapped for transfer to a relevant degree. The overall cost of study to overseas students entering HE via a pathway programme is thus reduced.

Further analysis of the survey data is required to determine if there is a difference in the perception of value for money between pathway students to those who gain direct entry to undergraduate study.

Regardless, the survey data provides further evidence of the popularity of pathway entry and the importance of lower fees in provider choice. The impact of the Australian Government allowing overseas students to package two or more programmes on one student visa should not be underestimated.

91.3% of the International students who completed this survey responded that they feel welcome in Australia. 78.9% expressed a desire to mix more with students from different cultures and nationalities. 74.9% also wanted the opportunity to mix more with Australian students. This strength of feeling is reflected in the comments added to this section of the survey.

> *"Maybe our school could have more activities like a movie club or some other activities that can help students from other countries meet together".*
> "*I believe that the best way to experience another culture is through food! A food fair where different cultures present their food would be awesome! "*

Similar areas for improvement to those noted by Moraine Valley emerged. Students had strong feelings about fee levels and payment methods. In response, the Institute reviewed a number of procedures. These included increasing the number of fee payment instalments available for International students through a revised payment plan and increasing scholarship opportunities.

International students also wanted to have more input into teaching and learning, student administration, and life on campus (including mixing with Domestic students and those from other cultures). They wanted to do this by engaging their voice in academic governance, expanding International representation in the Student Association and increasing participation in focus groups.

The Institute has listened to these concerns and aims to find ways of empowering International students through a number of structural reforms. As part of that response, an Executive Director responsible for support and engagement across the Institute has been appointed, along with a Student Engagement Manager responsible for student experience initiatives across the Institute and a Student Engagement Manager with specific responsibility for the International student experience.

Holmesglen has also appointed International student ambassadors and representatives to faculty governance committees and the student association. They will provide feedback and make recommendations regarding teaching and

learning, life on campus and social activities from an International student perspective. This includes support for an International student cricket team competing in a local district cricket league.

International students organise and lead study groups, mentored by academic staff. This complements a "degree buddy" system to support International students aiming to progress to a higher level vocational programme.

Finally, the Institute has joined a national pilot programme to enhance student engagement in decision-making and governance. Holmesglen is the only non-university provider to participate in this programme, alongside 10 Australian universities. Holmesglen will provide an International student as a member of the programme's Steering Committee and Reference Group.

Discussion

Our research began with the intention to explore the experience of International students studying HE in non-university institutions in three Anglophone countries. We considered work previously undertaken in this area, noting that it was predominantly from within the US Community College system, with lesser inputs from Australia and England.

Although this paper draws on that body of work, and confirms that many of the findings remain valid, it provides a fresh perspective by undertaking a comparative study across three different countries. That perspective continues to recognise the strength of the student voice, with perhaps surprising similarities across all three countries.

Based on the survey results, International students appear to enjoy their experience of studying for a higher level qualification in a college setting. They appreciate that they are taught by effective teachers who have relevant professional experience in their chosen field. Significantly, those teachers see themselves primarily as educationists, focusing on student learning rather than academic research. Staff and students consider that this enhances employability, which consistently emerges as a key motivation behind studying a vocational course overseas.

This reflects recent research elsewhere. The link between International student choice of HE provider and employability was discussed in ICEF Monitor (2019). This concluded that:

> *"Employability is now a top priority among international students when planning for study abroad*
>
> *Many international students, especially those from developing economies, are keenly interested in studying in countries where there is a clear path toward employment after graduation and after that, even permanent residency."*

The three colleges offer high levels of student support. This includes language support where needed but also more general pastoral support, including help with living away from home in a different country.

> *"I think the academic staff is the reason why I stayed at Holmesglen. I can't thank most of my teachers enough for their encouragement".*

Classes tend to be smaller in size than found in many universities, allowing greater individual interaction. Taken together these factors appear to outweigh any concerns about not studying in a traditional university.

However, International students are not uncritical of their experience. Many students reported concerns with issues of value for money, perceived or actual. Fees were seen to be high, especially when compared with the fee charged to Home students. This also extended to the inflexibility of payment methods and the bureaucracy which often surrounds visa and other regulations. Failure to address these issues could result in reduced International recruitment.

International students were also concerned at some of the obstacles which they felt made integration with Home students more difficult. They do not see themselves as a homogenous group, coming as they do from different social and cultural backgrounds. They had a strong desire to meet and form friendships with Home students both inside and outside the classroom. They did not want to learn or mix socially exclusively with people from their own countries. They felt more could be done to assist integration, for example by ensuring that tutorial groups were mixed and social activities were accessible to all. Changes such as these would be simple to devise, easy to deliver and inexpensive. In a comment reminiscent of Guyton 2017, one Chinese student pleaded:

> *"The class size is too small - which is a reason why I find it so hard to mix with the local students. Most of the local students in the class were friends (before they came to college) so when we do the group assignment then they already have premade group".*

For institutions with large numbers of International students, failing to respond to these concerns could ultimately have an adverse effect on recruitment. This could in turn impact on the viability of courses and the experience of Home students. For all institutions participating in the survey, there are further steps which could be taken to enhance the international experience of local students without the need for travel.

As noted by Mellors-Bourne 2013 and Martin 2018, International students present a valuable resource. They bring global issues and experiences to Home students who may themselves be reluctant or unable to travel. Taking this approach may help to reduce the impression that International students are simply a source of income to the institution, illustrating instead that they form an important part of the experience for all students.

As was noted by Tran & Dempsey 2017, recruiting International students calls for an institution-wide shift in management decision-making. Any initial effort will be more than rewarded with sustained recruitment and satisfied students. There is increasing competition for International students in all three countries represented in this research. Our survey results suggest that these students recognise the advantages offered by a college setting. However, in order to retain this recruitment advantage, non-university providers must address

existing weaknesses through systemic change. We offer a means of promoting this through our Checklist (see Appendix).

Conclusions

This research paper sought to investigate a possible link between the personal experiences of International students studying in non-university contexts and successful practices by each institution regarding the integration of those these students. Our primary recommendation for institutions enrolling International students is to ensure a high level of support and integrative activities (Wu, Garza, & Guzman, 2015).

In the course of the research, it became obvious that there were clear links between each Government's immigration policies (and within that their approach to International students) and the numbers of such students recruited each year. Reflecting our own findings, the three most recent national strategies for international recruitment, from France, Canada and the UK, all give prominence to increased student support measures, including social inclusion; help with housing; counselling, including support over mental health concerns, and, in the case of France and Canada, a significantly-more streamlined visa application process. As one respondent noted, colleges should not underestimate:

> *"The time it takes to adapt and transition into a new country including the challenges of securing accommodation and finding a job".*

Our research output includes a Checklist of areas for discussion by senior management teams in colleges with International students. If such recruitment is a genuine strategic priority (as opposed to a particular interest on the part of a Departmental head, for example) then time must be given to planning how resources and activities are managed to deliver that strategy successfully. We consider that that the significance of this process is under-estimated, despite cumulative evidence from the voices of International students.

Whilst the higher policy issues identified may lie outside the remit of institutions, the good practice points identified in the Checklist will be of immediate use. They will help to inform decision making at institutional level and improve the International student experience.

Sharing information and experience across three countries has underlined what works and signposted the advantages of an inclusive approach to International students. This recognises not only the value added to them as individuals but also the benefits for Home students as they prepare for work in a global economy.

This three-way study may not only offer a useful comparator for the institutions concerned, but will also broaden the wider HE community's understanding of International students' views, given that the starting point was a different style of learning to that offered in a traditional university setting.

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Appendix

International student recruitment: Checklist for senior college managers

How does the recruitment of International students fit with the strategic priorities of your college?

- Are you aware of the current visas and immigration service procedures surrounding the admission of International students to the UK/Australia/ USA? Is this reflected in the information given to potential applicants?
- Does your college have the systems and procedures required to satisfy compliance with national arrangements such as the UK's Highly Trusted Status? How do you monitor this?
- Have you considered the level and sensitivity of the fee charged to International students? Would student numbers be affected by a change in fees?
- Are International students a significant part of the student community? If so have you considered what different or additional support needs they may have? Can such support be provided on an individual basis?
- Do you provide appropriate facilities and support for your International students e.g. assistance with housing, dedicated pastoral or language support?
- How does your college support and educate staff, such that they understand the cultural sensitivities that they will encounter when dealing with International students?
- Does the level of academic support offered help both International and Home students to succeed?
- In addition to the high academic standards and quality of learning experience that your International students expect, have you provided opportunities for them to gain a wider knowledge or experience of life in the UK/Australia/USA?
- Are you fully informed about regional internationalisation programmes? For example, in Europe, EU programmes such as Erasmus and Jean Monet?
- Is the blend of nationalities in your HE classes as balanced as it can be? Does it enable International students to mix with Home students and build networks and friendships outside the classroom?
- How are you using your International students to broaden your curriculum with a more global context?

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Examining How Biology Teachers' Pedagogical Beliefs Shape the Implementation of the Omani Reform-Oriented Curriculum

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Khalid Alkharousi[‡]

Research on science-education reform affirms the importance of taking into consideration teachers' pedagogical beliefs in relation of the constructivist perspective to ensure successful implementation of a reform-oriented curriculum. In addition, prominent studies pinpoint the need for teachers to have sufficient pedagogical content knowledge (PCK) to adapt a reform-oriented science curriculum to meet students' abilities and interests. This study focused on the reform-oriented science curriculum in Oman, and in particular, the grade 12 biology curriculum. The new biology curriculum emphasizes constructivism and encourages student-centered instruction, inquiry-based learning, cooperative learning, problem-solving, and critical thinking. However, since its implementation in 2008, various obstacles and challenges have been reported by teachers. These include a mismatch between the planned curriculum and the implemented curriculum. This mismatch has been attributed to a lack of motivation and PCK among teachers that would allow them to shift their teaching practices. Consequently, the purpose of this study was to understand how teachers' pedagogical beliefs about student-centered learning have shaped their implementation of the curriculum. The study also sought to identify how biology teachers perceive the relationship between their PCK and their pedagogical decisions. An ethnographic approach to data analysis was employed, with multiple data sources including classroom observations, learning artifacts, reflections, and semi-structured interviews used. The findings of this ethnographic study indicate that Omani teachers' beliefs and PCK shape the implementation of the reform-oriented curriculum by influencing their conceptualization of the curriculum, their identification of students' misconceptions, their decisions about classroom teaching practices, and the level of their students' engagement. The results of this study corroborate and expand upon previous research that suggests that teachers' beliefs and PCK should be taken into consideration when designing and planning for new curriculum materials, teacher-education programs, and professional development opportunities.

Keywords: pedagogical beliefs, reform-oriented curriculum, pedagogical content knowledge (PCK), constructivism, curriculum implementation.

Introduction

Teachers are considered the most effective and important agents in improving students' motivation and science learning. Teachers' beliefs about science, pedagogy, and students' understanding influence their classroom actions, functioning as filters through which the teachers make their decisions.

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Understanding teachers' beliefs and how they inform their instruction is critical to improve science education. The recent global reform of science education, which is rooted in constructivism, has introduced assumptions about learning and approaches to teaching that are together known as reform-oriented instruction (Le, Lockwood, Stecher, Hamilton, & Matinz, 2009). Reform-oriented instruction is marked by three key characteristics: It is (a) standards-based, (b) student-centered, and (c) inquiry-oriented (Sawada et al., 2002).

Reform-oriented instruction implies that teachers seek to understand the processes and levels at which students comprehend scientific concepts and then adjust the design of instruction in such a way as to challenge students' perceptions (Park, Jang, Chen, & Jung, 2011). Therefore, teachers need to develop particular types of knowledge that enable them to transform the content knowledge (CK) they have into pedagogically powerful forms but that also give them the flexibility to adapt to their students' differences in prior knowledge, interests, understanding levels, and learning preferences (Park et al., 2011). This knowledge is what Shulman (1986, 1987) conceptualized as pedagogical content knowledge (PCK). Some scholars (e.g., Park et al., 2011) have assumed that PCK is essential for teachers' successful implementation of instructional practices that are aligned with the underlying principles of reform-oriented science education.

Given the ongoing global reform movement in science education, it is essential to analyze to what extent teachers implement reform-oriented teaching practices (RTPs) in their classrooms. Understanding teachers' beliefs about teaching and their perceptions of reform is critical because beliefs and perceptions impact teachers' motivation to change their instructional practices and to achieve the reform goals.

Background

Oman engaged in a major educational reform in 1998 and introduced a Basic Education System (BES, grades 1–10) with the aim of enhancing students' learning outcomes (Al-Balushi & Griffiths, 2013). BES emphasizes a student-centered approach to learning, inquiry-based learning, and continuous assessment (Ministry of Education [MOE], Oman & World Bank, 2012). In 2008, a new Post-Basic Education System (Post-BES, grades 11 and 12) was introduced. Almost two decades after the implementation of the reform-oriented curriculum, there is evidence from a variety of sources to suggest that students' learning outcomes lag behind expectations at the national and international levels (MOE & World Bank, 2012). Additionally, new teachers' skills have not been adequately developed through pre-service teacher education due to a lack of emphasis on pedagogical skills and the limited use of practical training (Issan & Gomaa, 2010).

We believe that the mismatch between the planned curriculum and the implemented curriculum stems from a top-down approach to policymaking and curriculum development. In particular, we argue that the new curriculum introduced student-centered and inquiry-based instructional approaches without properly preparing teachers and ensuring the adequacy of the learning

environment. Teachers often shape and alter a new curriculum if they find that it is inconsistent with their beliefs (Pedersen & Liu, 2003). Therefore, the effective design of a student-centered curriculum must take into account teachers' beliefs about student-centered learning and the likely influence of these beliefs on teachers' implementation of the curriculum (Richardson, 1990; Pajares, 1992).

Research Questions

This study addresses the following primary research question: How have biology teachers' pedagogical beliefs shaped the implementation of the reform-oriented curriculum in Muscat, Oman? The secondary research questions are:

1. What types of biology curriculum implementation and practices are twelfth graders actually encountering, as observed in biology classrooms?
2. How do biology teachers rationalize their practices and curriculum implementtation decisions in light of their personal beliefs regarding the reformed biology curriculum?
3. How do biology teachers' perceptions of the relationships between PCK and reform-oriented practices influence their approaches to teaching the curriculum in their classrooms?

Literature Review

Theoretical Framework: Constructivism and Socio-Constructivism

Constructivism was used as the framework for this study because it is considered the philosophical and theoretical rationale underlying the current reform movement. Constructivism theorizes that knowledge is not discovered but constructed by individuals based on experiences that are developmentally, socially, and culturally mediated (Fosnot, 1996). Vygotsky's theory (1986) indicates not only that all learning is socially mediated, but also that it is affected by a child's present and past experiences as an active member of society. Learning science from a constructivist perspective is thus an active, social process of making sense of experiences and is something students do, not something that is done to them (National Research Council [NRC], 1996).

From the socio-constructivist perspective, the role of the learner is one of selecting and transforming information, constructing knowledge, and making decisions, rather than relying on the teacher's knowledge and textbooks to solve problems. The role of the teacher is to recognize students' prior conceptions and to design activities that build upon the students' knowledge, using strategies such as experimentation, problem-solving, reflection, concept-mapping, and dialogue to create deep knowledge and understanding (Brandon & All, 2010).

Reform-Oriented Teaching Practices in Learning Science

The term "reform-oriented teaching" describes a collection of instructional practices that are designed to engage students as active participants in a student-centered learning environment and in inquiry-based activities that enhance the development of complex cognitive skills and processes (Le et al., 2009; Manno, 2011). Bektas and Taber (2009) described student behaviors that an observer expects to see in a constructivist classroom: students who are active and heavily involved in classroom discussion and in a range of activities; students who ask as well as answer questions; and students who give extended answers and explanations in dialogue with the teacher. Most of the work in the classroom is collaborative. Scientific ideas are linked to learners' own experiences and concerns. Assessment tasks are integrated into learning and are designed to generate deep understanding rather than to produce reliable data on surface features of learning. Reform-oriented teachers work as facilitators, helping their students construct knowledge and understanding through inquiry-based activities that engage students in learning communities where ideas are shared and valued (Sampson, Enderle, & Grooms, 2013).

Measuring Reform-Oriented Teaching Practices. In this section, we present studies that have proposed measurable elements of reform-oriented instructional practices (RTPs) and the methods used to collect data on classroom reform-oriented instruction. Sawada et al. (2002) developed the Reformed Teaching Observation Protocol (RTOP) to provide a strong evidential basis for measuring the impact of a given reform. The RTOP contains three scales: lesson design and implementation, content, and classroom culture (Sawada et al., 2002). The researchers concluded that RTOP is strongly predictive of how much students learn in their classrooms and that it helps in making holistic judgments about features of lesson design and classroom culture (Sawada et al., 2002).

Yager, Akcay, Dogan, and Yager's (2013) instrument includes items to measure teaching practices, teacher-student interactions, and student-student interactions. They targeted science/technology/society (STS) reform-based classes implemented in Iowa. The instrument items used for their study were developed from videotaped classroom observations of science teachers who were involved with STS groups (Yager et al., 2013). Focusing on the concept of inquiry-oriented teaching, Borko, Stecher, and Kuffner (2007) created ten dimensions of RTPs for teaching science based on the NRC's (1996) standards. These are:

1. Grouping
2. Structure of lessons
3. Use of scientific resources
4. Hands-On
5. Inquiry
6. Cognitive depth
7. Scientific discourse community
8. Explanation/justification

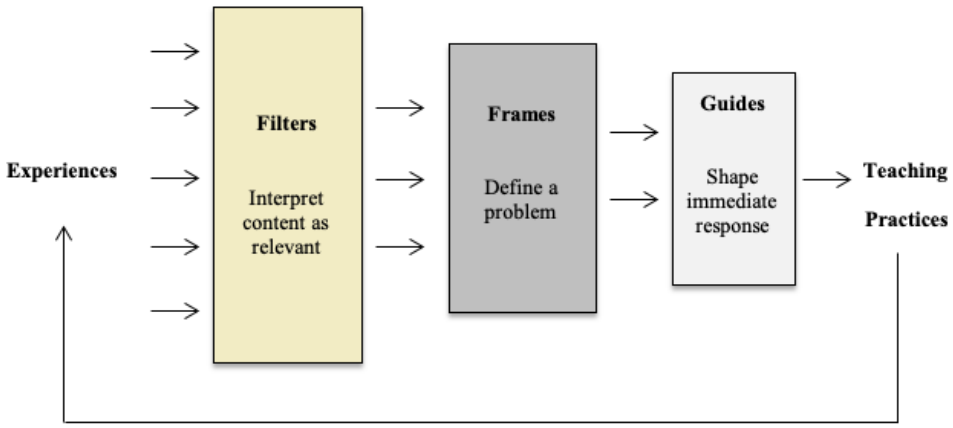
9. Assessment
10. Connections/applications

Other researchers have focused on developing a reliable and valid instrument that can help to overcome conceptual and technical challenges associated with measuring classroom instruction. Significantly, Martinez, Borko, and Stecher (2012) designed an instrument that combines artifact collection (lesson plans, handouts, rubrics, readings, worksheets, assignments, student homework, projects, portfolios, vignettes) and teachers' self-reporting (logs) and called it the Scoop Notebook. The authors contended that the combination of artifacts and teachers' self-reporting is useful for measuring instructional practices with reliability similar to measures based on classroom observation (Martinez et al., 2012).

Defining Teachers' Pedagogical Beliefs

In educational settings, the convictions, philosophies, understandings, and views that individuals hold about teaching and learning are referred to as pedagogical beliefs (Haney, Lumpe, & Czerniak, 2003). According to Kagan (1992), teachers' beliefs are "tacit, often unconsciously held assumptions about students, classrooms, and the academic material to be taught" (p. 65). Research has shown that beliefs can guide instructional decisions and influence classroom practices (Jones & Carter, 2007; Pajares, 1992). Fives and Buehl (2012) identified three roles that beliefs serve related to teachers' practice: filters for interpretation, frames for defining problems, and guides for practice (Figure 1).

Figure 1. The Roles of Teachers' Beliefs



Source: Fives & Buehl (2012, p. 478).

When implementing a curriculum reform, teachers' beliefs about teaching (as student- or teacher-centered), their knowledge, and the learners themselves will either support or undermine the implementation of the new initiative (Fives & Buehl, 2016). Therefore, it is crucial to examine and address teachers' epistemic beliefs (beliefs about knowledge) and pedagogical beliefs (beliefs about teaching and learning) in light of the reform initiative. Traditional pedagogical beliefs are

associated with behaviorism and are characterized by teacher-centered instruction. In contrast, constructivist pedagogical beliefs are grounded in constructivism or socio-constructivism and are characterized by student-centered instruction (Deng, Chai, Tsai, & Lee, 2014). Teachers holding student-centered beliefs act as facilitators and use a process of teaching that is responsive to the needs of learners. They promote students' construction of meaning and understanding based on the students' prior knowledge and personal experiences. They create learning environments that facilitate students' active sense-making and use formative assessment to making teaching decisions (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017).

Relationship between Pedagogical Beliefs and Implementation of the Constructivist Curriculum

Research has shown that teachers' beliefs about the teaching and learning of science, the reform curriculum, and their own roles alter and "filter" innovative practices, even as teachers claim publicly to implement reform-oriented practices (Sampson et al., 2013). Feldman (2002) found that high-school teachers implemented a reform-driven physics curriculum in very different ways that reflected their beliefs. Feldman explained that the teacher whose beliefs were best aligned with those of the reform-based curriculum fully adopted the curriculum. The teacher who believed that his role was to promote interest in physics only partially implemented the reform-based curriculum, eventually abandoning it because it did not fit well with his beliefs. These findings support Cronin-Jones's (1991) conclusions that when middle-school science teachers firmly believed that science is a body of factual content and students lack the required skills for independent learning, the teachers' teaching practices were not compatible with the given reform-oriented constructivist curriculum.

Roehrig and Garrow (2007) confirmed that teachers' beliefs about what students should learn and students' capability to learn are critical factors in the implementation of reform-oriented practices. Furthermore, it has been shown that the teachers tend to overstate their level of implementation of reform-based practices, despite a lack of knowledge, for the sake of "social desirability." Yildirim and Kasapoglu (2015) reported that Turkish teachers who held positive views of the constructivist student-centered curriculum tended to believe that they implemented constructivist teaching and learning practices more frequently. However, the researchers indicated that the teachers did not fully endorse a constructivist curriculum due to their lack of knowledge about curriculum content, learner-centered instruction and technology, and non-traditional assessment.

Teachers' PCK for Teaching a Reform-Oriented Curriculum

The concept of PCK was introduced by Shulman (1986), who defined it as "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learning, and presented for instruction" (p. 8). Grossman

(1990) broadened Shulman's (1987) definition of PCK by proposing four components: (a) knowledge and beliefs about the purposes of teaching a subject; (b) knowledge of students' understanding, conceptions, and misconceptions; (c) knowledge of the curriculum; and (d) knowledge of instructional strategies. Cochran, King, and DeRuiter (1991) defined PCK from a constructivist perspective as "the manner in which teachers relate their pedagogical knowledge to their subject matter knowledge in the school context, for the teaching of specific students" (p. 1). Park and Oliver (2008) identified the following five elements of PCK for science teaching: (a) teachers' beliefs about and orientations to science teaching, (b) knowledge of students' understanding of science, (c) knowledge of the science curriculum, (d) knowledge of instructional strategies and representations for teaching science, and (e) knowledge of assessments of science learning. Rozenszajn and Yarden (2014a) argued that PCK is topic-specific, personal, and situation-specific.

Several studies have investigated the relationship between teachers' PCK and its impact on teaching. For instance, Carlsen (1987) suggested that low levels of PCK are associated with the frequent use of simple factual recall questions. In regard to biology education, Rozenszajn and Yarden (2014a) observed that biology teachers often indicate that they are more focused on acquiring content knowledge (CK) rather than PCK to stay up-to-date with the most recent developments in the field of biology. In another study, Rozenszajn and Yarden (2014b) indicated that mathematics teachers viewed CK and PCK as related components, whereas biology teachers tended to view CK as separate from PCK. The authors suggested that biology teachers may invest time and energy to keep up-to-date with developments in biological knowledge, thus neglecting the need to update their PCK (Rozenszajn & Yarden, 2014b).

Park and colleagues (2011) examined the relationship between a teacher's PCK level and the extent to which her/his instruction was reform-oriented. The results showed that a teacher who has more developed PCK is more likely to implement higher levels of reformed science instructional practices. Furthermore, it has been reported that regardless of mathematics teacher beliefs, the lack of knowledge and understanding limits teachers' ability to align the curriculum and instruction with students' needs (Lui & Bonner, 2016). On the other hand, research indicates that many mathematics teachers with strong content knowledge tend to implement traditional instructional methods (Mewborn, 2001). Wilkins (2008) justified this phenomenon that some teachers with strong content knowledge refer their success to the ways they were taught. If they were taught using traditional methods, it is likely that they consider these methods as effective for teaching mathematics and will tend to use traditional methods.

Implementation of the Reform-Oriented Science Curriculum in Oman

Research shows that Omani science teachers have encountered challenges in implementing inquiry-based learning for reasons related to a lack of time and resources and large class sizes (Ambusaidi & Al-Balushi, 2015). Meanwhile, research investigating Omani science teachers' beliefs about using inquiry-based

teaching and cooperative learning shows that teachers hold positive perceptions of inquiry-based learning (Al-Harthi, 2008). Al-Balushi and Al-Rawahi (2011) examined Omani physical education and science teachers' beliefs about cooperative learning. They reported that Omani teachers showed weak intentions to use cooperative learning in their classrooms.

To understand science teachers' pedagogical beliefs about constructivist-based teaching, Ambusaidi and Al-Balushi (2012) conducted a longitudinal study targeting prospective science teachers. They examined College of Education at Sultan Qaboos University teachers' beliefs after the teachers had completed the first science-methods course and again after they had completed the second science-methods course and the practicum. The results showed that the prospective science teachers tended towards using a teacher-centered approach even after having the opportunity to learn about different student-centered teaching practices. The researchers explained that this tendency is due to prospective teachers' own experiences as students and common practices in schools and colleges (Ambusaidi & Al-Balushi, 2012).

Recently a comprehensive joint study conducted by Oman's Ministry of Education and the World Bank (2012) aimed to evaluate the Omani educational system after the reform. The study findings pinpointed that teachers lack the PCK necessary to implement a student-centered learning approach. Teachers' insufficient level of PCK was attributed to minimal emphasis on pedagogical skills and the limited use of practical training during pre-service teacher education. Furthermore, teacher-educators did not have any teaching experience in school settings (MOE & World Bank, 2012).

As these studies suggest, the implementation of the constructivist science curriculum in Oman has been problematic due to factors related to teachers' beliefs and their lack of pedagogical content knowledge. Therefore, it is necessary to investigate how Omani biology teachers' pedagogical beliefs and their PCK predict their levels of implementation of constructivist instructional practices.

Methods

In investigating the proposed questions, we employed an ethnographic approach to data analysis. We combined classroom observations, learning artifacts, and semi-structured interviews to generate rich data.

Research Sample

Research Site. The study was focused on the Omani province of Muscat. The focus was on Post-BES public schools (grades 11–12), because biology is taught as a discrete subject at this level. According to the Ministry's data 2017–2018 there were 34 public Post-BES schools employing 55 biology teachers in Muscat (Omani and non-Omani teachers) during 2017-2018. The selection criteria for schools and teachers included in this study were based on the number of students studying biology in a given school. Schools with at least 20 biology students each

were preferred. In addition to the number of students, factors such as gender, location, and student achievement levels were considered. Ultimately twelve schools were involved in the study (five all-boys' schools and seven all-girls' schools); as shown in Table 1 below. It is worth noting that students' levels of achievement were compared in two consecutive years (2016 and 2017). Hence, we selected the all-boys' and all-girls' schools with the highest and lowest average percentages in each of the states to provide a better representation of teachers' beliefs and practices.

Table 1. Sample of Schools Visited

State	**Total Number of Schools**		**Number of Schools Visited**			
	All boys' Schools	*All girls' Schools*	*All boys' Schools*	*Level of achievement*	*All girls' Schools*	*Level of achievement*
Mutrah	2	2	1	High	1	High
Bowsher	1	2	1	High	2	High
A'Seeb	4	5	1 1	High Low	2 1	High Low
AlAmerat	1	1	1	Low	1	Low

Participants

Purposeful sampling was utilized to select research participants. Biology teachers were selected based on their gender and their students' achievement level on national tests. Fourteen teachers were included in this study: five males and nine females as more female teachers than expected were willing to participate (Table 2). Pseudonyms were used to represent all participants.

Data Collection

Classroom Observations. The reform-oriented practice measurement instrument used for this study was developed based on a literature review of existing reform measurement instruments (Appendix A). The instrument was designed to encourage the use of multiple data-collection methods beyond classroom observations to obtain a more thorough picture of teachers' practices and beliefs. The validity of the instrument was ensured by consulting with a group of educators from the Ministry of Education, including the chief and senior supervisors for science subjects and an assessment specialist. Furthermore, four twelfth-grade biology teachers validated the instrument. They all approved of the instrument and indicated its alignment with constructivist theory practices and the Post-BES reform curriculum.

Table 2. Demographics of the Biology Teachers Involved in the Study

Teacher	Gender	Age	Years of Experience	Classes and Subjects Taught	Education
KM	F	30	7	Biology (Grades 11–12)	B.Ed major biology- Nizwa University
LS	F	32	6	Biology (Grade 12)	B.Sc major biology- Higher College of Technology Diploma in Education- UAE
ZS	F	35	10	Biology (Grades 11–12)	B.Sc major biotechnology- Sultan Qaboos University Diploma in Education- SQU
WL	F	45	21	Science, biology, science and the environment, science and technology (Grades 5–12)	B.Sc major biology- Sultan Qaboos University Diploma in Education College of Muscat
MK	F	48	26	Science and biology (Grades 4–12)	B.Ed major biology- Sultan Qaboos University
RH	F	29	7	Biology (Grades 11–12)	B.Ed major biology- Sohar University
HM	F	33	11	Biology, science and the environment, and science and technology (Grades 11–12)	B.Ed major biology- Sultan Qaboos University
AR	F	29	6	Biology, science and technology, and science (Grades 8–12)	B.Sc major biotechnology- Sultan Qaboos University Diploma in Education- Ajman University
MG	F	25	3	Biology (Grades 11–12)	B.Ed major biology- Sultan Qaboos University
MN	M	47	27	Biology (Grade 12)	B.Ed major biology (2010)- Rustaq College of Education Diploma (1992)- College of Education- Muscat
QF	M	35	12	Biology (Grade 12) and Science (Grade 10)	B.Ed major biology (2008)- Sultan Qaboos University
OZ	M	32	11	Biology (Grade 12)	B.Ed major biology (2009)- Sur College of Education
AS	M	31	9	Biology and science and the environment (Grade 12)	B.Ed major biology(2010)- Rustaq College of Education
MM	M	44	15	Biology and science and the environment (Grade 12)	B.Ed major biology and earth sciences- Sultan Qaboos University

The classroom observations were conducted by two researchers who are familiar with the Omani education context and have substantial experience with teaching and supervision. The inter-rater reliability was obtained by conducting two preliminary classroom observations together and discussing how both researchers rated the teacher on each item included in the instrument and to what extent the item description was helpful. The inter-rater reliability was 94%. Observations were conducted during March and April 2018. Due to the context and topic specificity of PCK, all observations conducted centered on the same unit of instruction (Unit 4: Heredity). All teachers from the sample were observed once. Afterward a second round of observations was conducted. The total number of classroom observations was 24.

Pre-Observation and Post-Observation Reflections. Each teacher was asked to reflect on each of their observed lessons twice, first before execution and then after execution. The aim was to gain insight into the teachers' perceptions of their CK, PCK, and the relationship between their PCK and classroom practices. The pre-observation form (Appendix B) asked the teachers what they took into consideration in planning the observed lesson. On the post-observation form (Appendix C), the teachers were asked to provide an analysis of the observed lesson. The total number of forms collected was 48.

Teaching and Learning Artifacts. The participating teachers were asked to provide samples of students' work, such as worksheets, notebooks, quizzes, tests, laboratory reports, assignments, and projects. The teachers were also asked to provide teaching artifacts such as lesson plans, task sheets, and class activities. The artifacts served to support and expand upon the observations and the responses of the participants during interviews. All student artifacts collected were anonymized to protect students' privacy.

Semi-Structured Interviews. All interviews were conducted in the teachers' schools and after the second classroom visit had taken place for each teacher. The interviews started with the Curriculum Platform Q-sort (Badiali, 2005; Appendix D). The Curriculum Platform Q-sort asked the participants to order various statements in four groups (aims of education, nature of knowledge, teacher's role, and curriculum purpose) according to their beliefs. The teachers were then asked to elaborate on their order of statements and choices. The interview guide includes informational questions about participants' demographics and questions about educational philosophy orientation. The questions were broad and open-ended and centered on the participants' practices, views, and justifications of their views and practices regarding the reform-based biology curriculum. Each interview took between 25 and 40 minutes.

All interviews with the biology teachers were conducted in the interviewees' first language, which is Arabic. The interviews were audio-recorded after obtaining the participants' permission. The audio recordings were then transcribed using the 1:09:02.2 version of Express Scribe Transcription Software. All the transcribed interviews were subsequently translated from Arabic into English.

Follow-up interviews were then conducted by phone or email with all the participants for member checks and to clarify some of the points they highlighted.

Data Analysis

We employed Braun and Clarke's (2006) thematic analysis approach to identify, analyze, and report themes within the data. We presented the findings and emerging themes and subthemes by discussing evidence from multiple data sources (Creswell & Plano Clark, 2011). Theoretical codes derived from constructivist instruction were used to analyze teachers' implementation of the curriculum. Additionally, inductive coding was employed by carrying out participant-oriented data analysis to allow for emerging themes and in-depth analysis.

For each code, we contrasted each participant's practices with their beliefs in order to detect how their espoused beliefs align with their enacted beliefs and practices. Codes were grouped and interpreted based on their frequency. Afterwards, we grouped similar codes into initial themes. Additionally, we compared data segments from different participants to uncover the extent to which participants who hold the similar beliefs have similar classroom practices.

Trustworthiness and Ethical Considerations

We employed Lincoln and Guba's (1985) trustworthiness criteria-*credibility, transferability, dependability,* and *confirmability*- to establish the study's research validity and reliability. We utilized multiple methods of data collection (classroom observations, interviews, field notes, teachers' reflection, and artifacts) for triangulation. We designed the data-collection procedures and data-analysis methods based on methods that had been successfully utilized in previous comparable studies. Hence, we developed thick and detailed descriptions of the teachers' experiences in an attempt to convey the actual situation.

For greater transparency, we conducted member checks to ensure the accuracy of the data collected from the interviews (Creswell & Plano Clark, 2011). In addition, we implemented the strategies suggested by Bogdan and Biklen (2007) and Maxwell (2013) to ensure that the study was carried out ethically. We obtained individuals' verbal consent to participate in the study. Most importantly, the study adhered to the ethical requirements of The Pennsylvania State University's Institutional Review Board (IRB) and the Omani Ministry of Education's research regulations.

Limitations of the Study

The limitations are related to the methods used. Selecting schools based on students' achievement on national tests was difficult due to differences in school populations. In addition, school data suggesting that girls outperform boys led to a sample consisting exclusively of high-achieving girls' schools. Thus, the selection criteria needed to be adjusted to ensure the inclusion of both all-boys' and all-girls' schools, as well as schools of varying achievement levels and from different states

in Muscat. Purposeful sampling rather than the random selection of participants was employed. Hence, the findings of this study may have limited generalizability. Furthermore, the value of the data depends on the participants' decisions to provide responses that represent their true beliefs rather than responses that are simply socially desirable. For such reasons, the triangulation of data-collection methods was used in this study.

Results

Teachers' Pedagogical Beliefs

The teachers' pedagogical beliefs are discussed based on their ordering of the statements in the Curriculum Platform Q-sort and their responses during the interviews (Table 3). Three teachers (OZ, HM, AR) held progressivist views. Three of the teachers (MK, MN, QF) held social reconstructionist views. Two teachers held beliefs that aligned equally with progressivism and reconstructionism. This indicates that a total of eight teachers held beliefs that aligned with constructivism. Two teachers (AS, MM) held perennialist views. Two other teachers (LS, RH) held mixed beliefs that aligned with both critical theory and progressivism. One teacher (WL) held mixed beliefs that aligned with both essentialism and perennialism. When teachers elaborated on their pedagogical beliefs in terms of knowledge, students' learning, their role in the classroom, and the curriculum, the following themes emerged.

Table 3. Teachers' Ratings on the Curriculum Platform Q-sort

Teacher	Orientation
MN	Reconstructionism
MK	Reconstructionism
QF	Reconstructionism
OZ	Progressivism
HM	Progressivism
AR	Progressivism
ZS	Progressivism & Reconstructionism
KM	Progressivism & Reconstructionism
RH	Progressivism & Critical Theory
LS	Critical Theory & Progressivism
AS	Perennialism
MM	Perennialism
WL	Essentialism & Perennialism

Theme 1: Teachers Believed that Students Construct Knowledge Based on Pre-existing Knowledge

Eleven of the teachers interviewed (OZ, AR, LS, ZS, HM, MM, AS, MN, QF, KM, and MK) believed that knowledge should focus on growth and development and that it is constructed through active and relevant learning

experiences. Nine of them held beliefs that aligned with progressivism and/or reconstructionism, while two held beliefs that aligned with perennialism. OZ explained why he thought that knowledge is best acquired through active learning by saying:

> "I try to implement active learning as I could…In active learning the student learns indirectly. In both methods (traditional and active learning) he achieves the learning objectives, but in active learning he achieves them while he enjoys learning. In traditional methods its compulsory to get the grade"

On the other hand, WL and RH believed that knowledge should focus on essential skills and academic subjects, mastery of concepts, and principles of subject matter. WL held beliefs that aligned equally with essentialism and perennialism, while RH held beliefs that aligned equally with critical theory and progressivism.

Theme 2: Teachers Believed that Students Learn by Engaging in Inquiry and Problem-solving and by Connecting Concepts to Real-world Applications

The majority of the teachers agreed that their students learn better when they are actively engaged in inquiry-based leaning, cooperative learning, and problem-solving. They elaborated on this by providing examples of how their students learn biology best, such as by making connections with the real world, applying their knowledge, using visual representations, engaging in dialogue and discussion with peers, investigating, brainstorming, and doing hands-on activities (Table 4).

Table 4. Ways Students Best Learn Biology, as Reported by Teachers

Teacher	**Best learning methods**
WL	Active learning
MK	Dialogue and conversation
KM	Connections to real world, cooperative learning
AR	Inquiry, research, hands-on activities
HM	Connections to real world, visual clues
RH	Connections to real world, visual clues
ZS	Inquiry, connections to real world, research
LS	Dialogue and conversation, visual clues
MM	Active learning, inquiry, research, brainstorming
MN	Inquiry, research, cooperative learning, learning stations
AS	Connections to real world, ICT
OZ	Role play, visual clues
QF	Active learning, discussions with peers

Theme 3: Teachers believed that their Role is to Guide and Facilitate Students' Learning

The majority of the teachers (MM, HM, AR, KM, RH, OZ, QF, ZS, AS, MK, and WL) believed that teachers are guides for problem-solving and scientific

inquiry. They asserted that the teacher should help students solve problems and develop into inquisitive and curious learners. The teacher should facilitate students' learning by creating a safe environment for interaction and differentiating learning in response to students' individual differences. The teacher should teach students how to learn. The teachers explained their views as follows:

> HM: "In the past the teacher was the knowledge dispenser who presents information and the student is the listener only. But now the student should be the center of the educational process and we should give her opportunities to try and explore and solve problems…If the teacher acts as a guide and the student do research and inquiry, the teacher would be able to know to what extent the student has acquired the knowledge and skills"

> ZS: "The teacher is no longer the only source of knowledge. So, the teacher should put some effort and much care to create and train this generation to be curious toward learning and become critical thinkers"

Theme 4: Teachers had Different Perspectives on the Curriculum's Definition and Purpose, which were influenced by their Pedagogical Beliefs

The teachers approached the curriculum from different perspectives. Six teachers (KM, AR, QF, AS, MK, and RH) believed that the curriculum should focus on the students' interests, involve the application of knowledge to authentic problems, and connect knowledge to real-world applications.

> KM: "If the curriculum is not centered on students' interests than it will be just an abstract subject that the student can't accept. There has to be research and inquiries that the students do to connect knowledge with the real world"

However, five teachers (MM, WL, OZ, ZS, and LS) believed that the curriculum should center on essential skills and major content areas. HM and MN thought that the curriculum should center on social problems:

> HM: "I believe that the student should be aware of the problems around her to identify her role in the future. She should connect the curriculum with the real world and be aware of her society issues and problems, so she can contribute in the future in solving these problems"

Interestingly, the teachers defined the student-centered curriculum differently. Some of the teachers (MN, MM, and OZ) simply said that the student should be the focus of teaching and learning. Other teachers (WL, ZS, KM, LS, HM, QF, MK, AR, and RH) defined it as active learning, where the teacher acts as a guide and the student does all the work and engages in research to gain knowledge and does not expect the teacher to be the only source of knowledge. Some of the definitions of the student-centered curriculum/learning that the teachers gave are as follows:

AR: "In student-centered learning we focus on inquiry, research, self-learning and team-work"

QF: "The teacher should guide and supervise students learning in the class, while the student should research for knowledge that he could get it through some probing and leading questions. Or by solving problems that the teacher design for the student to inquire and investigate the solutions and discuss his findings with his peers"

In addition to possessing different definitions of student-centered learning, teachers described active learning differently. For instance, WL said that she has implemented active learning by motivating students, providing incentives, and employing brainstorming and role play. She asserted that she had implemented active learning in the class that the researcher observed. She randomly chose a student to come at the board. Then the student randomly picked a question to solve on the board. In contrast, HM believed that in active learning, the student should do all the work and engage in research to gain knowledge under the teacher's guidance. She described active learning by saying:

"It (student-centered learning) should be like what I saw in the workshop about active learning. Right from the beginning the teacher (the trainer) let the students (the trainees) do everything. She treated us like her students, and she explained how the students should work and do all the tasks. She was our guide and discussed with us our mistakes. We did concept maps and she helped us get to the final conclusion by discussing our findings and asking questions. When we faced a problem, she helped us identify it and discussed with us the solutions. We worked in groups"

Teachers' PCK

In this study, we employed Park and Oliver (2008) definition of teachers' PCK. First, we shed light on teachers' level of confidence about their CK and PCK. Then we discuss to what extent the teachers believed their PCK has shaped their implementation of the curriculum.

Theme 5: Teachers perceived that they have Strong Content Knowledge (CK) but that they Lack the Pedagogical Content Knowledge (PCK) Necessary to Teach the Reform-oriented Curriculum

All teachers showed confidence in their CK and described their college-level content preparation to be strong, in-depth, relevant, and applicable to the real world. AR studied biotechnology in college. She explained that her strong preparation in the applications of biotechnology enabled her to substitute some of the textbook experiments that she thought were not useful for achieving the learning goals with other experiments. She introduced new experiments that were easy to conduct, interesting, and helpful in achieving the learning goals. Teachers who had significant teaching experience and had taught the old system's

curriculum (MK and WL) claimed that they had strong CK due to their extensive experience and their time teaching the old curriculum, as the old curriculum was more comprehensive and covered topics in depth. WL compared her CK with her PCK, saying:

> "With respect to content knowledge yes (confident), but not with pedagogical knowledge. We have stronger background, but the new teachers are better prepared in the use of technology and the use of computers, ipads, and smart applications. They apply them in the lessons which is good for this generation. We are somehow hesitant to use technology. But the new teachers come to us on the basics such as how to prepare the lesson, the content knowledge, teaching methods because of our long experience"

Theme 6: Teachers Sought to improve their PCK to Effectively Implement the Reform-oriented Curriculum

Knowledge of Instructional Strategies. The teachers did not express the same level of confidence about their PCK. Most of them indicated that they have developed better PCK with experience and by engaging in independent learning. They indicated that their pedagogical preparation was suitable at the time they graduated when only traditional methods of teaching were accepted in schools. With the shift towards student-centered learning and the expansive use of ICT, however, the teachers recognized that they needed to stay up to date with the new teaching and learning methods.

> MK: "When I graduated the teaching methods were few and simple in the nineties. There was no cooperative learning, team-work, or active learning. Now there are many new methods and the teacher should learn these methods and stay up to date"

One teacher (AR) said her preparation in education did not include any courses in teaching methods but that she had received support from her supervisor and learned teaching methods by observing other teachers teaching or attending workshops:

> "In terms of teaching methods, I need more experience I have only 3 years of experience. At SQU I did not study education but outside the country, but there was no course for teaching methods. So, I faced challenges when I started teaching. My supervisor helped me by conducting exchange visits with my peers inside and outside the school and sometimes she showed me how to teach by observing her teaching the class... I learned teaching methods also by self-directed PD through reading and research and observing other biology teachers' lessons"

The teachers claimed that in college they had learned traditional instructional methods that depended on lectures, memorization, recitations, and discussions. However, they relied on self-directed learning, ongoing professional development,

supervisors, collaboration with peer teachers, lessons learned from teaching, and research to keep up to date in terms of CK and PCK:

> QF: "My preparation in college was in the traditional style lectures, memorization, and recitation. I was a passive recipient of knowledge and the teacher was always the dispenser of knowledge. I keep researching, inquiring for knowledge so I don't face challenges in terms of my level of confidence about myself, the curriculum, or how to deal with knowledge to make it easy to understand and accessible to students. At the same time, I continuously learn from my students on how they better learn or their perceptions about what they are learning, and I consider this is one of the ways that helped me grow"

Knowledge of Students' Understanding. The teachers reported that they used multiple and different indicators to identify effective learning moments. Most of the teachers described moments of effective learning as moments when their students were able to apply the concepts, solve different levels of problems, and achieve learning goals independently or in groups. For example, OZ described a moment of effective learning when his students provided evidence to support their answers and they were able to create challenging questions and debate with other students. QF described a moment of effective learning when he challenged his students to evaluate him and correct his intended mistakes. On the other hand, AS, MM, LS, and RH considered students answering the teacher's questions and repeating the answers as indicators of effective learning. Interestingly, those teachers' beliefs aligned with perennialism, critical theory, or progressivism.

In the majority of the lessons observed, the teachers indicated that they change their teaching methods from one section to another. The teachers explained that they change their teaching methods because of individual differences, students' levels, students' preferences for learning, students' interactions, self-reflection on teaching, and allotted time. All these teachers held beliefs that aligned with progressivism. AS indicated that he does not change his teaching methods from one classroom to another because the learning objectives are the same and problem-solving is the best method to teach the topic. His beliefs aligned with perennialism.

Knowledge of the Curriculum. In the classrooms observed, the teachers showed good knowledge of the curriculum. They indicated that they have to enrich and teach it in-depth. They emphasized that the curriculum is dense in terms of the number of topics included but that each topic is covered superficially.

Knowledge of Learning Assessments. Three teachers (OZ, QF, and WL) relied heavily on formative assessment, while three other teachers (MN, MM, and ZS) used it only occasionally to assess students' learning. Most of the teachers thought that applications of concepts through problem-solving were sufficient to indicate that their students had learned the new concepts. Some teachers (MN, WL, OZ, ZS, and MM) adjusted the problems based on their students'

performance. Both the teachers and students focused heavily on solving test-type problems and their concern was how to excel in solving problems to meet the test-marking criteria. However, only QF effectively used the data he gathered from formative assessment to adjust his teaching to address students' challenges with the application of the concepts. Teachers who used assessment effectively held beliefs that aligned with progressivism, reconstructionism, and perennialism.

Teachers' Espoused Beliefs. Most teachers expressed beliefs that aligned with student-centered learning. They emphasized the role of the student as that of an active learner who solves problems independently or in collaboration with others. They acknowledged that their students learn better by engaging in active learning and inquiry than by traditional teaching methods. Nevertheless, they pointed out that it was not always possible to implement active learning in the classroom because they had to prepare their students to obtain high scores on the tests.

Teachers' Instructional Practices

In this section we address the types of instructional practices implemented in the observed biology classrooms. We also discuss to what extent teachers' beliefs influence their decisions about the implemented instructional practices (Table 5).

Table 5. Relationship between Teachers' Beliefs and Classroom Practices

Instructional Practices		**Teachers' Beliefs**
Students' Pre-Existing Knowledge		All Teachers
Alternative Conceptions		Reconstructionism Progressivism
Instructional Practices	Grouping	Reconstructionism Progressivism
	Hands-On Activities	Progressivism
	Inquiry	Progressivism
	Connections/Applications	Reconstructionism Progressivism (many) Essentialism (one) Critical Theory (one)
	Scientific Resources	Progressivism (two) Perennialism (two)
	Assessments	Reconstructionism Progressivism
	Cognitive Depth	Reconstructionism (all) Progressivism (all) Essentialism (one)
Active Interactions	Teacher–Student Interactions	Reconstructionism Progressivism Essentialism/ Perennialism (one)
	Student–Student Interactions	Reconstructionism Progressivism

Theme 7: All Teachers Considered Identifying Students' Pre-existing Knowledge to be Crucial to Learning

All teachers indicated in their reflections that they take into consideration students' prior knowledge when planning lessons. This was confirmed in the interviews and observed in the classrooms. Another important factor that the majority of the teachers (RH, KM, AR, MN, AS, MM, and QF) indicated that they take into consideration students' individual differences. Teachers (HM, AR, MN, AS, and QF) highlighted the importance of connecting knowledge and concepts with real-world applications and students' lives.

> AS: "It is important to connect the concepts and topic with pre-existing knowledge and knowing students' abilities and individual differences"
> ZS: "I take into consideration students' pre-existing knowledge, student's common misconceptions, the difficulties that students encounter based on my experience, and teaching methods that will help to clarify the topic and how to make sure the students have understood the concept"

Theme 8: Teachers with Beliefs that Aligned with Constructivism were Able to Identify and Challenge Students' Alternative Concepts

Most teachers (10 out of 13) expressed awareness of the misconceptions or alternative concepts that their students might encounter when learning new concepts; this awareness was based on their previous experience teaching the concepts. Seven teachers (MN, OZ, AR, KM, ZS, AS, and MM) identified the alternative concepts they expected their students would struggle with when learning the new concepts. HM did not expect her students to have misconceptions that would interfere with learning the new concepts based on her experience. However, she was able to identify new alternative concepts that she did not know about during the lesson. She noticed her students were confused about "how the ovule is released," so she explained the new concepts, discussed the differences, and provided examples to help students see the differences.

The strategies used by the teachers to address alternative concepts varied, which might suggest that their beliefs influence their selection of strategies. Teachers who held both critical theory and progressivist beliefs (RH and LS) did not emphasize alternative concepts in their lesson plans and hence were not able to identify or address alternative concepts while teaching new concepts. Teachers who held beliefs that aligned with perennialism (AS, MM, and WL) and/or essentialism (WL) addressed the alternative concepts using strategies with the least potential to be effective (Hashweh, 1996), such as explaining, repeating, and asking questions. On the other hand, teachers who held beliefs that aligned with reconstructionism (QF, MN, OZ, and KM) and progressivism (OZ, AR, HM, ZS, and KM) used the most potentially effective strategies (Hashweh, 1996), such as restructuring, giving examples, engaging students in cooperative learning, peer learning, research, and problem-solving.

Theme 9: Teachers with Beliefs that Aligned with Constructivism Implemented Active and Inquiry-based Learning in their Classrooms

Following the theoretical framework of this study, the instructional practices that characterize constructivism teaching practices include grouping, inquiry, hands-on activities, cognitive depth, assessments, applications and connections, and the use of scientific resources.

Grouping. Six teachers implemented group work during their lessons; three of the aforementioned six implemented it in both lessons observed. In terms of the group configuration, all six teachers confirmed that they had established rules for group work at the beginning of the semester and had divided students into heterogeneous groups for the whole semester or particular tasks. Three teachers (OZ, HM, and KM) spent all of the lesson time with the students working in groups. OZ used groups in both lessons observed for all or most of the lesson time, and there were fewer than five students in each group. In general, the beliefs of six of the teachers who implemented group work (KM, HM, AR, OZ, QF, and MN) aligned with progressivism and/or reconstructionism.

Hands-on Activities. OZ was the only teacher who employed hands-on activities and investigations in which the students were physically involved. He acted as a guide to direct the students' analysis and conclusions. His beliefs aligned with progressivism.

Inquiry. Three teachers (OZ, KM, and AR) allowed their students to complete investigations in groups and discuss scientific ideas, processes, and the results of their investigations with each other and their teacher. All three teachers held beliefs that aligned with progressivism.

Connections/Applications. The teachers attempted to make connections with the real-world context (8 teachers) and students' own experiences (10 teachers). The beliefs of eight teachers aligned with either or both progressivism and reconstructionism. Two teachers of the eight heavily focused on knowledge application in both lessons (OZ and HM). One teacher held beliefs that equally aligned with progressivism and critical theory, and another teacher held beliefs that equally aligned with perennialism and essentialism.

Cognitive Depth. In terms of the lesson structure, it was frequently observed that all teachers designed conceptually coherent lessons. Only one teacher (OZ) planned his lessons to engage the students in inquiry and to have the students' explorations precede the theoretical presentation. Ten teachers out of the fourteen visited emphasized making sense of scientific ideas and processes by asking "how" and "why" questions and encouraging students to think deeply. This was observed in the lessons of all teachers who held progressivist or reconstructionist beliefs. With regard to encouraging scientific thinking (analysis, reflection, and reasoning from evidence), four teachers (WL, HM, KM, and AR) moderately emphasized it. HM and AR focused on covering a few topics in depth in both

lessons and making sure their students achieved the learning objectives before moving forward. It can be concluded that teachers with beliefs that aligned with progressivism and/or reconstructionism emphasized cognitive depth in their lessons.

Assessment. Eight teachers used formative and summative assessment to track students' achievement of learning objectives. All teachers' beliefs appear to have aligned with progressivism and/or reconstructionism, except for one teacher whose beliefs aligned equally with essentialism and perennialism. In terms of using data from formative assessments to inform pedagogical decision-making, it was observed that only one teacher (QF) heavily used the data obtained to adjust his teaching. QF held beliefs that aligned with reconstructionism. The learning and teaching artifacts revealed that all teachers designed assessments and activities that represented both lower-order thinking skills (understanding and application) and higher-order thinking skills (analysis and evaluation). Teachers MK, AR and OZ employed projects and collaborative and team activities. Their beliefs aligned with either progressivism or reconstructionism. Only OZ used rubrics for students' projects and teamwork.

Theme 10: Teachers with Beliefs that Aligned with Constructivism Actively Engaged Students in Learning

It was clear that all teachers who held beliefs that aligned with progressivism and reconstructionism encouraged and facilitated teacher–student interaction by using different and multiple means in the classroom. This level of interaction was not observed in the classrooms of teachers who held beliefs that aligned with perennialism (AS and MM) or equally aligned with critical theory and progressivism (RH).

The most common ways involved acknowledging the active participation of students (11 teachers), using students' answers that had personal value (10 teachers), and encouraging students to ask intriguing/useful questions (8 teachers).

Students' interaction with other students was not emphasized clearly in the classrooms observed. It seemed that teachers were mainly concerned about individual student learning at this stage. Interestingly, only teachers who held beliefs that aligned with progressivism and/or reconstructionism allowed interactions among students in their classrooms. KM encouraged her students to collaborate with others and seek help and involve other students in their projects. Arguments and debates among students and instances of students investigating other students' questions were observed only in three classrooms (LS, AR, and KM). Collaborative efforts were encouraged in KM's and AR's classrooms. Six teachers utilized teamwork in their classrooms (HM, AR, OZ, KM, QF, and MN).

Theme 11: Teachers Perceived that the Curriculum and National Test Policies have led them to Focus on Content Delivery rather than Teaching based on their Beliefs

The Curriculum. The teachers' perceptions of the curriculum highlighted some of the challenges they have been facing in attempting to implement it as planned. First, some of the teachers (WL, KM, OZ, AR, MK, and MM) asserted that it did not help them to implement student-centered learning. OZ and QF thought that the curriculum was designed to be presented and explained by the teacher because the curriculum does not meet students' needs and does not provide students with opportunities to engage in inquiry and research. AR said the learning environment and lack of resources hindered the implementation of student-centered learning.

> OZ: "The curriculum for grade 12 needs to be changed because it is old now and does not enrich students' knowledge and does not meet their needs. The curriculum does not focus on student-centered learning. It is designed to be explained by the teacher and does not give any opportunity for the students to do research"

Second, the majority of the teachers (WL, AR, RH, MK, KM, HM, QF, OZ, LS, ZS, MM, and MN) agreed that the curriculum is superficial, lacks depth in its coverage of CK, is vague and unclear, is inconsistent, and fails to provide complete knowledge. They claimed that the content is dense, and that the curriculum emphasizes the quantity of topics rather than quality and depth of knowledge. Third, many teachers (WL, AR, MN, OZ, ZS, LS, RH, and KM) complained about the inconsistency of the curriculum content in terms of the misalignment between learning outcomes and the textbook content. Fourth, the teachers claimed that some of the experiments in the textbook are not applicable and indicated they often try to substitute them with others or simply teach them theoretically. Finally, the teachers pointed out that the curriculum has not changed since it was developed in 2008, although it contains many scientific errors. Teachers suggested that the curriculum needs to be reformed to meet students' needs and interests. Teachers described their perceptions of the curriculum, saying:

> KM: "It needs to be supplied and enriched with so much information that is missing in the curriculum. It is superficial, but the learning outcomes are detailed and deep. The curriculum is not compatible with the outcomes…. Some of the experiments are not applicable, but we look for alternatives from the internet for better experiments. I change them if possible, but if not possible, I just teach them theoretically"

> HM: "It is very dense, and the content is too much. The curriculum is so shallow no depth, so I have to enrich it. I am nearly adding as much as half of the content. I need to cover it in depth. There are too many topics but superficial"

The teachers indicated that they have to comply with the curriculum in terms of the content due to the strict guidelines issued by the Ministry that prohibit any changes to the curriculum. In addition, the final test is on the curriculum's particular content. Below are some excerpts from our interviews with the teachers:

> AR: "No we can't omit any topic we should implement the curriculum as it is designed because the test is on the textbook's content. But we can add and enrich it or ask students to do research by themselves"

> LS: "We are required to deliver the curriculum exactly as it is planned for, but I change the order of the topics based on students' needs"

The National Test. All the teachers confirmed that the national testing policy has a negative impact on students' learning. The students' goal and focus are on earning high test scores rather than understanding and applying knowledge. Teacher WL said that "it is normal that the students work to get high grades, but in grade 12 it has become an obsession." Furthermore, RH, AR and KM said that their students think about the test almost all the time. KM said that she would focus more on addressing students' interests and learning preferences and making learning more meaningful and interesting if the testing policy were changed.

> "If national test policy is changed, I will focus more on taking into consideration students' interests and preferences on what they like to learn. The curriculum would not be so rigid then and we just have to comply and teach it as it is. If we have more freedom, learning would be more interesting and meaningful to students"

The impact of the national testing policy on teachers' practices was apparent in the classes observed. The teachers talked about the test and explicitly used test questions and explained how to answer them in all classes observed. They devoted a good portion of the lesson time to preparing students to solve test problems and avoid common mistakes. The students were similarly invested in learning for the test and were very overwhelmed with trying to master the best ways to answer test questions. This contributed to the focus on individual learning instead of cooperative learning. Teachers and students focused on solving problems individually.

Discussion and Assertions

This study focused on the reform-oriented grade 12 biology curriculum in Oman. The new biology curriculum emphasizes constructivism and encourages student-centered instruction, inquiry-based learning, cooperative learning, problem-solving, and critical thinking. However, since its implementation in 2008, teachers have reported some challenges stemming from the mismatch between the planned curriculum and the implemented curriculum. Consequently, the purpose of this study was to understand how teachers' pedagogical beliefs have shaped their

implementation of the reform-oriented science curriculum. The study also sought to identify how biology teachers perceive the relationship between their PCK and their decisions about their instructional approaches.

This study employed an ethnographic approach to data analysis. Multiple data sources were used to generate rich, in-depth data including classroom observations, learning artifacts, reflections, and semi-structured interviews. Three assertions emerged from this study in response to the primary research question: How have biology teachers' pedagogical beliefs shaped the implementation of the reform-oriented curriculum in Muscat, Oman? A discussion of the assertions with supporting evidence from the literature and study data follows.

Assertion 1: Teachers' pedagogical beliefs have shaped the implementation of the reform-oriented curriculum by influencing the teachers' conceptualization of the curriculum, their identification of misconceptions, their decisions about classroom teaching practices, and the level of their students' engagement.

Teachers' conceptualizations of the curriculum and student-centered learning were situated within their wider belief systems concerning pedagogy. Consequently, there was a lack of agreement among teachers on the conceptualization of the curriculum in general and the student-centered curriculum and active learning in particular. Teachers' pedagogical beliefs also informed their definitions of the curriculum. The teachers' definitions of active learning reflect a similar lack of agreement. Some teachers (e.g., WL) with significant experience in teaching considered themselves to be implementing active learning when they asked a few students to solve problems on the board. On the other hand, teachers (e.g., AR and HM) who had the opportunity to participate in professional development programs that addressed active learning were more specific when they discussed the expected roles of the teacher and students in active learning.

The literature shows a lack of agreement among researchers about the definition of the curriculum in general. The definition is influenced by the perspective of policymakers and practitioners on the one hand and by the purpose the curriculum serves on the other hand. Hence, it is imperative that reform policies and in particular the reform-oriented curriculum adopt an agreed-upon definition for the curriculum, the student-centered curriculum, student-centered learning, and active learning. These definitions should be made public to help guide practice.

Although most of the teachers were able to anticipate their students' misconceptions when learning a new concept based on their experiences, the strategies used to address these misconceptions were influenced by the teachers' beliefs. Teachers who held beliefs that aligned with perennialism and/or essentialism addressed the alternative concepts using strategies such as explaining and asking questions. On the other hand, teachers who held beliefs that aligned with reconstructionism and/or progressivism used strategies such as confronting, problem-solving, teamwork, and research. These findings are in alignment with Hashweh's (1996) findings that constructivist teachers are better prepared than empiricist teachers are to induce student conceptual change. Hashweh (1996) said this was because the constructivist teachers perceive scientific knowledge development as a process of conceptual change; hence, they utilize effective

strategies to confront alternative misconceptions and facilitate cognitive restructuring. Teachers with beliefs that aligned with progressivism and reconstructionism focused on cognitive depth, hands-on activities, inquiry-based learning, and cooperative learning to enhance student learning. They employed formative assessments to adjust their teaching. They actively engaged students in discussions and problem-solving. Furthermore, they employed different teaching strategies in the lessons observed. However, teachers who held mixed sets of beliefs or beliefs that aligned with essentialism or perennialism tended to rely on discussion and problem-solving. These findings correspond with other studies' (e.g., Levitt, 2001; Wallace & Priestley, 2011; 2017) findings that when teachers' beliefs resonate with the philosophy of a reform, they enthusiastically promote the reform. This study's findings are also in line with those of Feldman (2002) and Cronin-Jones (1991), both of whom found that teachers' practices are compatible with a reform-oriented constructivist curriculum if their beliefs are well aligned with the curriculum.

Teachers with constructivist beliefs encouraged the active engagement of students by asking them to provide evidence supporting their responses or to identify alternative ways to solve problems. They emphasized students' interaction with other students through debates, arguments, and investigations of other students' questions. Van Uden, Ritzen, and Pieters (2014) pointed out that teachers' beliefs should be consistent with their actions in the classroom; hence, these beliefs should ultimately impact student engagement.

Assertion 2: Teachers believe that it is their role to develop their PCK to be able to implement reform-oriented instruction.

The participating biology teachers indicated that they sought to develop their PCK through interactions with students, mentors, and colleagues. Opportunities to learn from peers and supervisors also shaped and developed the teachers' PCK. Additionally, the teachers indicated that engagement and experiences with reform-oriented curriculum implementation encouraged them to research and learn about inquiry-based learning, student-centered learning, and active learning.

These findings correspond with those of previous research. Some studies have reported that new science teachers develop their PCK as they interact with students (Luft, Firestone, Wong, Ortega, Adams, & Bang, 2011), mentors (Simonsen, Luebeck, & Bice, 2009), colleagues, and curricular materials (Schneider & Krajcik, 2002). Our findings challenge Rozenszajn and Yarden's (2014b) assertion that biology teachers neglect the need to update their PCK while investing time and energy in keeping up-to-date with developments in biological CK. The biology teachers in our study tended to focus on developing their PCK, probably because they realized their lack of PCK was insufficient to implement the reform-oriented curriculum. In addition, they saw that their preparation in college had not prepared them for a student-centered learning environment.

Interestingly, all teachers indicated they lacked PCK regardless of the type of qualification they held. Ten teachers had a Baccalaureate of Education and four had a Baccalaureate of Science (major biology) and one-year Diploma of Education. The results show that beliefs had more influence on teachers' instructional practices than their level of CK or PCK. This finding aligns with

Mewborn (2001) and Wilkins (2008) assertion that teachers beliefs shape their instruction more than their level of CK and PCK. However, teachers with progressivist and reconstructionist beliefs strove to improve their PCK so that they would be prepared to teach the reform-oriented curriculum.

Moreover, the study findings suggest that there is room to improve teachers' implementation of the reform-oriented curriculum and instruction by designing specific professional development programs to influence the teachers' beliefs and hence practices. Moreover, teachers' practices can be strengthened by continuing to focus on the teachers' self-directed learning and learning from peers and by linking this learning to improved professional learning communities (PLCs).

Assertion 3: Reform-oriented curriculum implementation procedures contribute to a lack of congruence between teachers' pedagogical beliefs and practice.

The phenomenon of science teachers holding positive beliefs related to reform-oriented teaching but facing challenges in enacting these practices in school cultures of accountability has been documented as a significant barrier to adopting innovative practices (Wallace, 2014). The biology teachers expressed tacit beliefs that were more in accordance with the constructivist perspective and student-centered approach to learning. However, they indicated that national test and curriculum implementation procedures had hindered them from teaching in alignment with their beliefs. The majority of the teachers believed that the curriculum did not stress student-centered learning because it focused on CK and lacked opportunities for students to practice research, active learning, and inquiry-based learning. All teachers remarked that because of the test, they spend less time on inquiry-based learning and research than they do on teaching to the test.

Conclusion

The limitation of this study is related to the purposeful sampling of participants rather than random selection. School and teacher selection criteria based on students' achievement needed to be adjusted to ensure the inclusion of both all-boys' and all-girls' schools, as well as schools of varying achievement levels and from different states in Muscat. Hence, the findings of this study may have limited generalizability.

The results of this study emphasize the complex relationship between beliefs and PCK, which highlights the need for professional development programs for newly hired science teachers and in-service teachers to sustain and strengthen their beliefs and PCK. Such programs should promote pedagogical beliefs and knowledge related to student-centered learning and focus on relevant classroom practices so that the enacted science instructional practices promote students' learning. Moreover, teacher-education programs need to place greater emphasis on developing science teachers' beliefs and PCK. Future research might investigate how teachers' beliefs develop and change with experience and which aspects of professional development programs lead to changes in teachers' beliefs. Additional research on the beliefs of teacher-educators and how these beliefs

shape their instruction is critical to understand the influence of teacher- educators' beliefs and practices on teacher-candidates' beliefs.

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Appendix (A)

Reform-Oriented Classroom Observation Protocol

Researcher:
Teacher:
School/State:
Topic of lesson:
Day and Date:

Instruments employed, and data collected:

- Classroom observation protocol
- Teacher's pre-observation feedback
- Teacher's post-observation feedback
- Teaching and learning artifacts (lesson plan-assessments-quizzes-final tests-research-projects-homework-classroom activities-students notes and notebooks-worksheets)

Domain	**Items**	**Indicators**	**Usage of Reform Practices***		
			Never used	Average use	Highly used
D1: Planning and Lesson Design	Entry	Students prior knowledge			
		Students questions/ ideas			
	Lesson Structure	Conceptually coherent			
		Logical sequence of tasks			
		Student engagement in inquiry/experimentation			
		Student exploration precedes formal presentation			
		Activities based on relevant real-world phenomena and scientific ideas			
	Lesson Elements	Focus on important problems, issues, or questions about phenomena			
	Closure	Conclusions or generalization from evidence			
D2: Instructional Practices	Grouping	Heterogeneous configurations			
		Work in pairs			
		Groups of 3-5 students			
		Groups of more than 5 students			
		Group work for less than 10 minutes			
		Group work for more than 10 minutes			

		Group work for the whole lesson time			
		Group work for one or two tasks			
	Use of Scientific Resources	Scientific material and aids			
		Lab equipment			
		ICT			
	Hands-on	The teacher guides and shapes student understanding			
		The teacher orchestrates classroom investigation and discussion			
		Students are physically engaged in activities to explore scientific phenomena			
	Cognitive Depth	The teacher focuses on the central concepts or ‘‘big ideas’’			
		The teacher emphasizes making sense of scientific ideas and processes			
		The teacher asks questions rather than only presenting knowledge			
		The teacher encourages scientific thinking (analysis, reflection and reasoning from evidence)			
		The lesson/teacher explores fewer topics in greater depth			
		Students actively participate in investigations			
	Inquiry	Students design investigations, collect data, analyze evidence, and draw conclusions based on evidence			
		Students discuss scientific ideas, processes, and the results of their investigations with each other and their teacher			
		Students do investigations in groups			
	Connections/Applications	The lesson helps students apply science to			

		real world contexts			
		The lesson helps students connect science to their own experience			
	Assessment	Formal assessments used			
		Informal assessments used			
		Informal assessments inform instructional decision-making			
D3: Teacher Knowledge	Content Knowledge	Teacher has a deep, connected understanding of scientific facts and concepts			
	Pedagogical Content Knowledge	Knowledge of instructional strategies			
		Knowledge of curriculum			
		Knowledge of students understanding			
		Knowledge of assessment			
		Teachers beliefs and orientations to science teaching			
D4: Classroom Culture/ Environment	Encouraging Teacher-Student Interactions	The teacher asks students to suggest new directions			
		The teacher asks students to evaluate ideas suggested by other students			
		The teacher expects students to offer multiple evidences for explanations offered			
		The teacher encourages asking intriguing/useful questions from all students			
		The teacher identifies and uses questions related to students' personal problems			
		The teacher finds and uses answers that have personal value for students			
		The teacher helps students assess the value and personal use of project results			
		Active participation of students is encouraged and valued			

		The teacher acted as a resource person working to support and enhance student investigations			
		The teacher models values and dispositions associated with science, such as curiosity, openness, skepticism, and enthusiasm			
	Encouraging Student-Student Interactions	The student asks for help and involvement of other students in their projects			
		The student uses varied sources for needed information			
		Students provide multiple evidences for all ideas offered by other students			
		Students participate in groups working as teams			
		The teacher encourages arguments and debate among all students			
		Students investigate questions proposed by other students			
		The teacher supports collaborative efforts regarding varying interpretations among students.			

*Never used= 0 times used. Average use= 2-4 times or 20-50% of the lesson time. Highly used= more than 4 times or more than 50% of the lesson time.

D1: Planning and Lesson Design

- **Entry**: The Lesson begins with provocative thoughts, e.g., students' questions or observations, and provides for experimentation or other means of gathering information, rather than being organized around exposition and recall of material. The instructional strategies and activities respect students' prior knowledge and the preconceptions inherent therein. The lesson is planned to address student ideas and prerequisite ideas needed for understanding, rather than just covering the topic. The lesson is designed to engage students as members of a learning community.
- **Lesson structure:** The lesson is organized in ways that promote scientific understanding. The lesson is conceptually coherent, and the activities are organized to build upon on one another in a logical manner. The teacher involves the students in a sequence of tasks to shape students' scientific thinking and sense-making about the question under study (explaining, predicting, describing, analyzing), rather than in just a set of assignments related to a topic but not structured to foster scientific understanding. Student exploration planned to precede formal presentation. The teacher identifies relevant real-world phenomena and representations of scientific ideas that match with learning goals and students' ideas and experiences, to

develop a logical sequence of instructional activities, rather than just selecting interesting activities connected to the general topic of study without attention to specific content.

- **Lesson elements:** The Lesson includes effective elements to achieve the goal of scientific understanding. Topic/Lesson begins with a focus on important problems, issues, or questions about phenomena that are interesting or familiar to students, rather than topics chosen for unknown reasons.
- **Closure:** Lessons culminate in conclusions or generalization from evidence, rather than just finishing an activity or a period of time.

D2: Instructional Practices

- **Grouping:** The extent to which the teacher enables students to work together in groups to complete scientific tasks. The teacher organizes students in a variety of configurations to promote social interaction and collaboration as required by the task at hand (e.g., partners for lab experiments, discussions, or presentations by groups of four); they do not confine instruction to whole-class or individual modes.
- **Use of Scientific Resources:** The extent to which a variety of resources (e.g., ICT, laboratory equipment, and scientific tools) are utilized. Appropriate materials are available and are used. Instructional materials emphasize key science concepts, take into account likely student knowledge about the content being addressed and provide opportunities to confront and reconsider misconceptions. The Teacher has access to wide variety of general instructional materials and consumable supplies, so instruction does not have to rely solely on textbooks and worksheets.
- **Hands–On:** The extent to which students are physically engaged in activities to explore scientific phenomena by handling materials and scientific equipment. The role of the teacher includes orchestrating classroom investigation and discussion, so students' ideas are central, rather than always being the authority who presents knowledge. The teacher guides and shapes student understanding by providing knowledge at the right moment when the student needs to know it to complete a task.
- **Inquiry:** The extent to which the lesson allows the students to actively participate by asking scientific questions, design investigations, collect data, analyze evidence, and draw conclusions based on evidence. Students should be engaged in activities that support the development of scientific understanding like taking an active role in their education by formulating questions, collecting information, and synthesizing results, rather than merely reading about or listening to explanations of science. Students discuss scientific ideas, processes, and the results of their investigations with each other and their teacher (learning how to reason from evidence, connect ideas to those of others, challenge ideas, etc.), rather than just reciting facts previously learned from the teacher or textbook. Students understand why they are doing each activity and how it links with target concept being taught, rather than completing activities as given with no sense of connection. The teacher asks students to participate in scientific exploration in groups, using real materials rather than just explaining facts and describing procedures.
- **Cognitive Depth:** The teacher focuses on the central concepts or ''big ideas'', connections, and relationships among science concepts. The teacher emphasizes making sense of scientific ideas and processes and extracting concepts from what has occurred, rather than just learning facts and procedures. The teacher asks questions that will help students focus on and come to understand science concepts and the connections among them, rather than only presenting knowledge. The teacher supports scientific habits of mind by encouraging scientific thinking

(analysis, reflection), rather than accepting knowledge without question. The teacher encourages reasoning from evidence and focus on "how we know" scientific concepts, rather than accepting knowledge without justification. The lesson/teacher explores fewer topics in greater depth to encourage understanding, as opposed to providing limited exposure to a wide variety of topics. The teacher motivates students to be engaged and to participate actively in science learning, rather than being passive or uninterested.

- **Assessment:** The extent to which the lesson includes a variety of formal and informal assessment strategies that measure student understanding. They are used to inform instructional decision-making for gauging students' learning, rather than merely evaluating students' achievement at the end of instruction.
- **Connections/Applications:** The extent to which the lesson helps students connect science to their own experience, apply science to real world contexts, or understand the role of science in society. The teacher focuses on relevance of knowledge by connecting science to students' own experiences and perceptions of the natural world, rather than presenting it in isolation.

D3: Teacher Knowledge

- **Content knowledge:** Teacher has a deep, connected understanding of scientific facts and concepts and the ways in which they are used in the real world.
- **Pedagogical content knowledge:** Teacher has extensive knowledge of strategies for communicating information and developing conceptual understanding in alternative ways. Following Park and Oliver (2008), PCK refers to (a) teachers' beliefs and orientations to science teaching, (b) knowledge of students' understanding in science, (c) knowledge of science curriculum, (d) knowledge of instructional strategies and representations for teaching science, and (e) knowledge of assessments of science learning.

D4: Classroom Environment/Culture

- **Encouraging Teacher-Student Interactions:** The teacher asks students to help with suggesting new directions and evaluates ideas suggested by other students. The teacher expects students to offer multiple evidences for explanations offered. The teacher encourages asking intriguing/useful questions from all students and identifies and uses questions related to personal problems. The teacher finds and uses answers that have personal value for students and encourages use of science class experiences in the daily lives of students. The teacher helps students assess the value and personal use of project results. Active participation of students is encouraged and valued. Students are encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence. In general, the teacher is patient with students. The teacher acted as a resource person working to support and enhance student investigations. The metaphor "teacher as listener" is very characteristics of this classroom. The teacher models values and dispositions associated with science, such as curiosity, openness, skepticism, and enthusiasm, rather than fostering a reliance on authority and established sources of information.
- **Encouraging Student-Student Interactions:** The student asks for help and involvement of other students in their projects. The student uses varied sources for needed information and tries new ideas and explanations for use in whole class discussions. Students provide multiple evidences for all ideas offered by other students. Students participate in groups working as teams. The teacher encourages arguments and debate among all students. Students investigate questions proposed by other students and share ideas and interpretations with others in the school and

community. The teacher supports collaborative efforts regarding varying interpretations among students.

Appendix (B)

Teacher's Pre-Observation Reflection Form

1. Could you briefly describe today's lesson?
2. What kinds of things did you take into consideration in planning this lesson?
3. What concepts in this topic do you believe are the most important for your students to understand by the end of the instruction of this topic? Why?
4. What content or concepts do you expect students would have difficulties with today? Why do you think so?
5. Reflecting on your experience of teaching this topic, what kinds of student misconceptions associated with this unit/topic have you noticed?
6. How do you challenge the misconceptions/How would you help them correct the misconceptions?
7. What evidence are you looking for that students have been successful in addressing the goals and understand the concepts you try to teach today?

Appendix (C)
Teacher's Post-Observation Reflection Form

1. How do you feel about the lesson today?
2. What do you consider the most effective teaching moment was in the lesson? Why? How did you achieve it? Why did it work?
3. What signaled you that students were learning?
4. Were there any student misconceptions you identified during the class that you haven't known? If yes, how did you respond to challenge the misconceptions? Did it work? Why do you think it worked?
5. Did you make any changes in the class that I just observed differently from the other class periods or lesson plan? Why?

Appendix (D)
Personal Curriculum Q-Sort (Adapted from Badiali, 2005)

Below you will find 20 statements that characterize our public system of education. These statements are arranged in four categories; they address 1) the aims of education; 2) the nature of knowledge; 3) the role of the teacher; and 4) the purpose of the curriculum. These are foundational considerations for curriculum. Your task is to prioritize these statements by numbering them one to five in each category. Assign the number 5 to the statement you believe best represent your beliefs, 4 to the statement you believe represents your beliefs next best, and so on until you have numbered all 5 statements in each section. At the end of the Q-sort there is a scoring rubric.

Aims of Education

A. --- To improve and reconstruct society; education for change

B. --- To promote democratic, social living, to foster creative self-learning

C. --- To educate the rational person; to cultivate the intellect through transmitting worthwhile knowledge that has been gathered, organized, and systematized
D. --- To provide for the construction of active citizens; to nourish civic literacy, citizen participation, and political responsibility
E. --- To promote the intellectual growth of the individual; to educate the competent person for the benefit of humanity

Nature of Knowledge

A. --- Focus on skills and subjects needed to identify and ameliorate problems of society; active concern with contemporary and future society
B. --- Focus on past and permanent studies, mastery of facts and universal truths
C. --- Focus on reconstructing a visionary language and public philosophy that puts equality, liberty, and human life at the center of the notions of democracy and citizenship
D. --- Focus on growth and development; a living-learning process; active and relevant learning
E. --- Focus on essential skills and academic subjects; mastery of concepts and principles of subject matter

Role of the Teacher

A. --- Teachers are critical intellectuals who create democratic sites for social transformation. They empower students to question how knowledge is produced and distributed
B. --- Teachers serve as change agents for reform; they help students become aware of problems confronting humanity
C. --- Teachers should help students think rationally; teach based on Socratic method, oral exposition, relaying explicit traditional values
D. --- Teachers are guides for problem solving and scientific inquiry
E. --- teachers should act as authority figures who have expertise in subject areas

Curriculum purposes

A. --- Curriculum centers on classical subjects, literacy analysis. It is constant
B. --- Curriculum centers on social critique and social change dedicated to self and social-empowerment
C. --- Curriculum centers around essential skills in the 3 R's (readin`, `ritin`, `rithmetic) and major content areas (English, science, math, history, foreign language)
D. --- Curriculum centers on examining social, economic, and political problems, from present/ future, national/international perspectives
E. --- Curriculum centers on student interests; involves the application of human problems; subject matter is interdisciplinary

Scoring guide for curriculum philosophy Q-sort (Badiali, 2005)

When you have completed the Q-sort exercise, go back and look at each category. Place the number that you assigned to each statement in the space provided in the following rubric. Add the columns to determine the educational/curricular philosophy with which you most agree. Grouped together, these statements represent major tenets of five educational/curricular philosophies.

	Perennialism	Essentialism	Progressivism	Social Reconstructionism	Critical Theory
Aims	C	E	B	A	D
Knowledge	B	E	D	A	C
Teacher's Role	C	E	D	B	A
Curriculum	A	C	E	D	B
Totals					

The taxonomy below is adapted from Badiali (2005)

	Philosophical Base	**Instructional Objectives**	**Knowledge**	**Role of Teacher**	**Curriculum Focus Trends**	**Related Curriculum**
Perennialism	Realism	To educate the rational person; to cultivate intellect	Focus on past & permanent studies; mastery of facts and timeless knowledge	Teacher helps students think rationally; based on the Socratic method and oral exposition; explicit teaching of traditional values	Classical subject; literary analysis; constant curriculum	Great books Paideia proposal (Hutchins, Adler)
Essentialism	Idealism; Realism	To promote the intellectual growth of the individual; to educate the competent person	Essential skills and academic subjects; mastery of concepts and principles of subject matter	Teacher is authority in his or her field; explicit teaching of traditional values	Essential skills (the three r's) and essential subjects (Eng, math, science, history, for. language)	Back to basics; excellence in education (Bagley, Bestor, Bennett)
Progressivism	Pragmatism	To promote democratic, social living	Knowledge lends to growth and development; a living-learning process; focus on active and interesting learning	Teacher is a guide for problem solving and scientific inquiry	Based on student's interests; involves the application of human problems and affairs; interdisciplinary subject matter; activities and projects	Relevant curriculum; humanistic education; alternative and free schooling (Dewey, Beane)

Social Recon-structionism	Pragmatism	To improve and reconstruct society; education for change and social reform	Skills and subjects needed to identify and ameliorate problems of society; learning is active, concerned with contemporary and future society	Teacher serves as an agent of change and reform; acts as a project director and research leader, helps students become aware of problems confronting humanity	Emphasis on social sciences and social research; examining social, economic, and political problems; focus on present and future trends	Equality of education; cultural pluralism; international education; futurism (Counts, Grant & Sleeter)
Critical Theory	Marxism	To challenge and deconstruct society, the status quo, powerful oppressors; to teach citizens to act politically for social justice	Focus on how the world works to privilege some and not others; awareness of race, class, gender, sexuality, and (dis)ability politics	Teacher acts with conscience and resolve as a social agent of change in the world with students	Teacher opens up societal norms to criticism and action	Some forms of service learning socially active, alternative education programs (Freire, Apple, Giroux)

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Teaching Astronomy in Kindergarten: Children's Perceptions and Projects

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Young children are familiar with astronomical phenomena from everyday life, such as the movement of the celestial bodies or the shift from day to night. The present study examines the extent to which kindergarten students understand abstract concepts related to celestial bodies and processes (such as gravity and time), and whether they change their perceptions of these concepts following an educational intervention. The study also examines what children report about this learning experience. The study, conducted in a kindergarten in Israel with 32 students, combined quantitative and qualitative research methods. The children's knowledge of astronomy was examined before and after the intervention. The teacher conducted observations, collected the children's creative projects, and interviewed them. She also asked them if they enjoyed the learning process and why. The findings show that few of the children had knowledge about concepts related to astronomy prior to the learning process, and some expressed misconceptions. Following the intervention, there was a significant increase in the children's knowledge and ability to explain astronomical concepts and many of their previously expressed misconceptions had been corrected. Most of the children said they were interested in learning, although some said they felt fear during the lessons. The results indicate that kindergarten students are able to study topics related to astronomy, although they are abstract and difficult to demonstrate. The conclusion of the study is that teachers should be encouraged to integrate studies of astronomy and space into the science curricula for kindergartens. This should be done using appropriate pedagogy that will increase the children's interest and involvement in learning and avoid causing them fears.

Keywords: Science education, Astronomy learning in Preschool

Introduction

The people of Earth are conquering the outer space. They explore by observations through elaborate telescopes, and by space vessels and astronauts that exit beyond the boundaries of the atmosphere. Mankind has reached space from the first launch of a Russian satellite in 1957, through the first human launch into space in 1961, a Russian as well, through the first human landing - American - on the moon in 1969, to the establishment of manned space stations for space satellites in increasing numbers. The winners of the Nobel Prize in Physics for this year (2019) are three scientists in the fields of astronomy and cosmology**,** for "contributions to the understanding of the evolution of the universe and Earth's place in the cosmos".

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James Peebles from Princeton University, USA, born in Canada, won the prize for "theoretical discoveries in physical cosmology". Michel Mayor from University of Geneva, Switzerland and Didier Queloz from University of Geneva, Switzerland, and University of Cambridge, UK, both born in Switzerland, won the prize for "the discovery of an exoplanet orbiting a solar-type star."

In February 2019, Israel was the fourth state to launch a spacecraft to the moon named "Genesis", and its developers emphasized that the purpose of the launch was educational - to develop in the younger generation a desire to know and study astronomy and space science. Socially and educationally, there is a worldwide need to raise graduates with space science literacy.

Although reserachers recommended to start teaching about space at early childhood (Spektor-Levy, Kesner-Baruch, & Mevarech, 2011; Eshach, 2006) some teachers are concerned and even avoid teaching of scientific topics in general and astronomy and space issues in particular (Kallery, 2011) because the subject is abstract and difficult to understand (Chastenay, 2018). These difficulties led us to conduct the present study to explore how astronomy can be taught in early age in an effective and enjoyable way that will promote children's ability to recognize and understand abstract concepts in astronomy. The study was also designed to examine whether preschool children may change previous misconceptions about astronomical phenomena and to learn about the children's attitudes and experiences from their learning process.

Literature Review

Teaching Science and Technology in Kindergartens

Educational systems around the world are formulating developmental and social trends and processes in order to fulfill the need to educate students towards science and technological literacy. Studies (e.g. Eshach, 2006; Gelman & Brenneman, 2004; Anderson & Gulberg, 2014) show that science education is appropriate for young children, and that knowledge and understanding of scientific ideas can be achieved at an early age. The prevailing view today in educational systems around the world is that science is an important field in the education of young children (Spektor-Levy, Kesner-Baruch, & Mevarech, 2011). Researchers today no longer ask how early science and technology education should begin, but rather seek the most effective ways to teach it. Exposure of young children to science and math activities is seen by those researchers as important, given their contribution to the development of intelligence and abstract thinking (Eshach & Fried, 2005). However, in practice, it has been found that kindergarten teachers are concerned about the teaching of scientific subjects in general (Spektor-Levy, Kesner-Baruch, & Mevarech, 2011) and topics related to astronomy and space in particular (Kallery, 2011) because these subjects are abstract and difficult to understand. These and other difficulties cause many elementary school and kindergarten teachers to avoid teaching topics related to astronomy and space (Chastenay, 2018).

Although many researchers believe that young children are able to understand scientific concepts, even complex ones, and have the ability to engage in scientific thinking (Eshach, 2006; Gelman & Brenneman, 2004), some previous studies indicate that it is beyond the ability of young children to learn science, and that children aged 4-6 have difficulties in understanding scientific ideas (Kampeza & Ravanis, 2006; Mali & Howe, 1979). Some researchers claim that before age 11-12, children cannot understand that experimental evidence may support or contradict scientific hypotheses and cannot differentiate between variables in a scientific experiment (Kuhn & Pearsall, 2000; Schauble, 1996). According to those studies, young children have difficulty in research-based learning, even when it is done using simple and authentic tasks. Young children find it difficult to formulate a research question, design an experiment to test it, predict the results of an experiment, evaluate its results, identify which variable determines the results, compare variables with each other, and link between cause and effect in a scientific experiment (Kuhn & Pearsall, 2000). It has been argued that young children have difficulty in analyzing the findings of an experiment because they are easily impressed by unusual results and do not pay enough attention to more common outcomes.

On the other hand, many studies published in the last 30 years have shown the opposite (Eshach, 2006; Eshach & Fried, 2005; Gerde, Schachter, & Wasik, 2013). According to these studies, young children do have cognitive abilities that allow them to understand scientific concepts and they are able to acquire and apply the skills relevant to scientific research processes such as selecting a research strategy, formulating research questions and hypotheses, making observations, performing experiments, predicting results of experiments, summarizing the findings, and sharing the results and conclusions. There is evidence that appropriate teaching methods can help young children acquire and learn basic scientific ideas pertaining to common phenomena in the natural world (Eberbach & Crowley, 2009; Kampeza & Ravanis, 2006). According to Gerde et al. (2013), quality science education in early childhood can definitely lay an essential foundation for children's scientific knowledge and interest in science. This foundation further contributes to children's readiness for school and strengthens language literacy and math skills. Researchers also argue that children involved in science research in kindergarten develop a better understanding of scientific ideas when they are older (Eshach & Fried, 2005; Roychoudhury, 2014; Plummer, 2014; Gerde et al., 2013). Early learning experiences can influence children's opinions about and level of interest in various areas of study, how they perceive their own abilities in these areas, and their enjoyment of engaging with them (Eberbach & Crowley, 2009). In addition, encouraging young children to have positive attitudes towards and developing their interest in science and their motivation for achievement in this field improves the likelihood of their short-term and long-term interest in and success in the sciences (Eberbach & Crowley, 2009). The availability of resources in the media and on the internet for children also helps them assimilate difficult and abstract issues. Therefore, the clear conclusion is that it is desirable and even essential to start teaching science as early as kindergarten or even preschool (Eshach, 2006).

Some researchers have found that kindergarten is the most effective window of time for learning; a process during which neural structures undergo change and new synapses are created (Rushton, Juola-Rushton, & Larkin, 2010). It seems that children's ability to think about abstract ideas, their capacity to select the information they need to draw conclusions, their knowledge bases, and their reasoning skills are all often greater than others perceive them to be (Michaels, Shouse, & Schweingruber, 2008). Therefore, it is worthwhile to maximize learning at young ages, especially in science studies.

Astronomy and Space Studies in Kindergarten

Young children have a natural interest in and curiosity about the wonders and beauty of the universe. This inspires them to learn about it, even the aspects that are abstract and not easily observable (Ödman-Govender & Kelleghan, 2011). Although many researchers are convinced that young children can be taught astronomy, pedagogically it is important to transmit accurate scientific knowledge and data to them in an age-appropriate way (Agan & Sneider, 2003). Even more important is training the educational staff so they feel confident teaching about astronomy and space (Chastenay, 2018).

A study by Kampeza and Ravanis (2006) indicates that young children can grasp basic astronomical concepts. Although the surveyed students had little knowledge prior to learning the subject, the astronomy lessons led to considerable progress and most of them developed an understanding of the concepts. According to Plummer (2014), a core concept in science studies is that of the motion of objects in space. Understanding this involves observations of astronomical phenomena that are explained by the relative position of objects in the solar system and beyond.

Plummer developed an instructional program for teaching this issue that incorporates tests to assess how the young students are learning. In this educational framework, children learned about daily movement of the Sun, Moon, and stars, the phases of the Moon, and the shift between day and night. Plummer found that advances in the children's level of knowledge and understanding were made possible by their ability to visualize objects and their movement through different frames of reference, that is, in reference to themselves or in space.

Kallery (2011) similarly demonstrated that young children can be taught astronomical concepts. Her research was among the first to develop and test the effectiveness of a program for teaching astronomy and space that is suitable for six-year-olds. The teaching program included preliminary preparation of six teachers, who taught 104 children. The teachers' training included relevant videos and animations with explanations, a globe of the Earth, and observations of the Sun (during the day) and the Moon (at night). Through all these means of transmitting information, the kindergarten teachers were careful to present scientifically accurate information, The program was taught in three sessions over two weeks. Its effectiveness was assessed through talks with the children, and by looking at the paintings and models they created. Kallery found that the children

gained knowledge effectively, leading her to conclude that young children could be taught about astronomical phenomena and concepts with great success.

Perceptions of Astronomical Concepts among Young Children

Bryce and Blown (2013) conducted an in-depth study of how young children develop their own models to understand the sizes and motion of celestial bodies. They reviewed studies in which semi-structured interviews were conducted with 248 children between the ages of 3-18 from China and New Zealand. The researchers determined that in different cultures young children perceive the shape and size of the planet Earth as part of a general idea of the concept of "the Earth", an idea that includes concepts such as physical form, land as opposed to sky, and the place where people live. Those researchers found that science teachers have a decisive influence on children's perceptions of these astronomical concepts, and that children change their perceptions in this area according to what their teachers tell them. Prior to learning, most of the ideas that children come up with on their own in order to explain the nature of the world around them differ from accepted scientific explanations. Children's ideas and beliefs based on their experiences are converted to cognitive structures that reflect their understandings built on personal experiences (Türkmen, 2015). Children must address and challenge these perceptions as they study science topics at school. This implies that science education should begin as early as possible, to enable young children to acquire tools and observations that prevent them from developing misperceptions and in order to help them develop correct perceptions of scientific ideas and to enhanced their cognitive abilities (Ampartzaki & Kalogiannakis, 2016). According to these researchers, it is beneficial for young children to learn about the forms and attributes of celestial bodies, since these form a basis for their understanding of other physical properties, such as physical forms and geometry, and to understand familiar astronomical phenomena such as the shift between day and night, solar events, and the phases of the Moon. Such lessons can help children understand the Earth and space in physical and astronomical terms, and to appreciate the beauty of these natural phenomena. Astronomy studies in early childhood offer a valuable and important opportunity to develop responsible citizenship, values regarding global sustainability, improving scientific literacy, and forming a positive attitude towards science. Encouraging young children to act as astronomers helps them learn scientific tasks such as observation, sorting, predicting, experimenting, presenting the findings, and so on (Ampartzaki & Kalogiannakis, 2016). To achieve these goals, the researchers propose a structured educational intervention program for teaching the properties of celestial bodies. Their multidisciplinary approach is characterized by development of activities and teaching content that emphasize two elements: (1) learning the spatial thinking that underlies astronomy; (2) an interchange between Earth-based and space-based perspectives of the form, location, and movement of celestial bodies. These form a basic foundation for understanding abstract concepts.

The present study focuses on astronomy studies among kindergarten children

in Israel. For the purpose of the study, an educational intervention was developed, based on a model of research-based learning. The effectiveness of the program was assessed according to two main aspects: the transmission of knowledge of astronomical concepts and processes to the kindergarten children, and fostering their understanding of these concepts and processes. The study also examines the children's reports on their experiences of the learning process, in order to determine the most effective pedagogical methods of teaching astronomy and space in kindergarten.

The objectives of this study were to examine the ability of 4-to-6-year-old children to learn and understand astronomical concepts and processes, following an educational intervention program, and to assess their experiences of this intervention as expressed in their own words and through creative projects.

The Research Questions were:

1) To what extent was there an increase in the level of knowledge, understanding and internalization of astronomical concepts and processes among kindergarten children, following the implementation of an educational intervention program, as compared to their previous level of knowledge?
2) To what extent did the children change their previously held conceptions about astronomy and space?
3) What do the children express, through their own words and their creative works, about the nature of their experiences in studying the topics of astronomy and space?

Methodology

This empirical study used qualitative and quantitative methods to assess kindergarten children before and after an intervention program.

The study population included 32 kindergarten students from a heterogeneous class made up of students from high socioeconomic backgrounds. There were 14 boys and 18 girls. There were two age groups in the kindergarten: 12 children ages 4-5 and 20 children aged 5-6 years old.

Research Tools and Process

The kindergarten teacher taught astronomical concepts with the help of an intervention program developed for the purpose of this study. This intervention program consisted of nine sessions, each lasting 15-20 minutes. It was conducted over the course of seven months.

The three main study topics covered in the program were:

1. The Sun and the solar system: the properties of the Sun, the structure and components of the solar system, the planets, interactions between the Sun and the Earth, the rotation and revolution (orbit) of the Earth.

2. The Earth: its attributes and structure, gravity, movement.
3. The Moon: its properties and motion in space, interactions with the Earth.

During the lessons, scientific explanations were presented with the assistance of videos and animations regarding astronomical events such as the movement of shadows; the rising and setting of the Sun, Moon, and stars; gravity; and the phases of the Moon. In each session, the children did creative projects related to the learned topics, and presented them to the class.

For the purpose of collecting quantitative data, we used a questionnaire designed to examine children's knowledge and understanding of astronomical concepts and processes. The questionnaire (see Appendix 1) included 14 questions. It was based on a questionnaire used in a previous study conducted in Greece (Kampeza & Ravanis, 2006). Each child completed the questionnaire two times: once before and once after the educational intervention. To assess the differences between the mean scores, a T-test was performed.

During the lessons, the kindergarten teacher made observations and documented the children's conversations and statements. The students' creative projects (which included drawing, cutting, and pasting) were photographed. During the program, a supervisor of preschools and kindergartens from Israel's Ministry of Education came to talk with the children about the topics being learned. This conversation was recorded and transcribed.

Results

Responses to Knowledge Questionnaire

A comparison was made of the number of correct responses the children gave, before and after the educational intervention, to the first 13 questionnaire items, which pertained to their knowledge of celestial bodies and astronomical concepts and processes (see Appendix 1). Each child's score was calculated as a percentage of the number of correct answers out of the total number of questions (see Table 1).

Table 1. Comparison of Students' Responses to Astronomy-Knowledge Questionnaire, Before and After the Educational Intervention (N = 32)

	Mean Score	**SD**	**T-test**
Before Study Program	19.73	12.23	-23.657
After Study Program	85.06	17.00	

$p < 0.01$

Table 1 clearly shows that before the children were exposed to and studied the subject of astronomy, their mean score of correct answers on the astronomy-knowledge questionnaire was low, and that their scores improved significantly after the learning program. Thus, effective learning about astronomical concepts occurred in preschool children.

Table 2 gives a summary of the children's answers to each of the questions. Additional details about the questions and their responses are given after the table.

Table 2. Children's Answers to Astronomy-Knowledge Questionnaire, Before and After the Educational Intervention

	Before Intervention				**After Intervention**			
	Correct answer	Partially correct answer	Incorrect answer	No answer	Correct answer	Partially correct answer	Incorrect answer	No answer
1. What is the name of the planet we live on?	8		6	18	31	0	1	
2. What shape is the Earth? (cube / disk / sphere / ellipse)	26		6		31		1	
3. What are the three parts of the Earth's structure?	1	1		30	18	14		
4. What is gravity?	5			27	22	7	3	
5. How does the Earth move?	6		6	20	31		1	
6. What is the Sun? (a star / a moon)	15		17		32			
7. Where is the Sun at night? (behind the Moon / covered in clouds / the Sun has gone to be with the other stars/ on the other side of the Earth)			32		30		2	
8. What is the reason for the shift from day to night on Earth?		2	3	27	29	2	1	
9. What is the Moon?	3		6	23	29		3	
10. What is the orbit of the Moon? The Moon orbits the earth / The Moon orbits around the sun / The Moon does	8		24		31		1	

not orbit)								
11. Does the Moon appear only at night Where is it during the day?	7		23	2	29		3	
12. Which is bigger, the Earth or the Sun?	7		25		30		2	
13. What are the names of the planets in the solar system?	Number of planets named		Number of children who knew the names of this number of planets		Number of planets named		Number of children who knew the names of this number of planets	
	1		2		2 3 4 5 6		2 6 15 2 7	

Question 1: In response to the question "What is the name of the planet we live on?", only eight children knew the name of the Earth, six children gave incorrect answers, and 18 children did not answer the question. Examples of incorrect answers were: Israel, Be'er Sheva (their city of residence); the name of their school, and "the lesser light" (a biblical phrase for the Moon). These answers indicate that the children were unfamiliar with the concept of a planet, and gave answers describing the geographical place where they live.

Question 2: Before the intervention, 26 children correctly answered "What is the shape of the Earth?", six children did not answer. After learning, all but one of the children knew that the shape of the Earth is a sphere. It should be noted that in Hebrew (unlike in other languages), the answer is given in the question. In Hebrew the name (כדור הארץ pronounced *kadur ha-aretz*) literally means "ball of land". In contrast, the words in English (Earth) or in Greek (Γη pronounced *Gai*) do not specify its spatial form.

Question 3: Before learning, 30 children could not answer the question "What are the three parts of the Earth's structure?" They did not know the concepts of the core, mantle, and crust of the Earth. Only one child answered the question at all, responding "There is a volcano in the heart of the Earth". After learning, 18 children gave correct and complete answers using all three terms core, mantle, and crust. Another 14 children remembered one or two of these terms. From this it can be seen that the kindergarten children learned the concept that the Earth is not uniform throughout, but made of three parts, each with its own specific name.

Question 4: The question "What is gravity?" deals with an abstract concept that children are aware of from daily life experiences. However, only five children demonstrated any knowledge of gravity before the intervention, compared to 22 afterwards. For this question, the children were asked to

explain this concept in their own words. Some examples of their answers after learning were:

"Gravity causes us not to fly in the air like in the Moon, and we can stand on the ground."
"Thanks to this, we can stand."
"It holds us so we don't fly."
"Gravity pulls us down."

These examples show that after the learning process most children explained gravity through the relationship between gravity (cause) and the phenomena they experience in their daily life (effect). They learned that there is some power that causes all these phenomena they described, and that what they have in common is the fact that objects remain on the surface of the Earth and do not rise up from it.

Question 5: In answering the question "How does the Earth move?" only six children were able to describe the Earth's rotation around its axis prior to the learning. The rest did not answer or gave incorrect answers. Examples of the misconceptions expressed by the children in the preliminary questionnaire were:

"It jumps."
"It claps its hands."
"The Earth does not move at all."
"It rolls."

These are all types of movement known to children in everyday life, such as their bodily movements, or the movement characterized by a ball. After learning, all but one of the children were able to describe the Earth's rotation around itself and its revolution around the Sun, demonstrating an understanding of Earth's movement in space.

Question 6: In their answer to the question "What is the Sun?", children had to choose between these options: a star / a moon. Before learning, 15 children knew that the correct answer to the question "What is the Sun?" is that the Sun is a star. The other 17 children chose the incorrect answer that the Sun is a moon. During the educational intervention, the children were taught the properties and composition of the Sun. Examples of their answers after the learning are:

"The Sun is a star made up of mostly hydrogen gas."
"You can't get near the Sun because it's very hot."

The children were also able to describe the concept of heliocentrism and explain that the planets of the solar system orbit around the Sun.

Question 7: In order to answer the question "Where is the Sun at night?", the children must have an understanding of an abstract idea and describe a process they cannot see with their own eyes. For this question, the children chose one of four options:

1. At night, the Sun is behind the Moon.
2. At night, the Sun goes to other stars.
3. At night, the Sun is covered in clouds.
4. At night, the Sun is on the other side of the Earth.

As shown in Table 2, before the intervention, none of the children chose the correct answer, and instead guessed one of the incorrect answers. Following the learning, 30 children out of 32 answered correctly that at night the Sun is on the other side of the Earth.

Question 8: The question, "What is the reason for the shift from day to night?" was asked as an open question. In the pre-learning questionnaire, only five children answered the question, of which two explained the phenomenon as God's decision and three children gave explanations describing this from their own experiences of movement, such as:

"When the Sun is tired it sinks into the water."
"Sometimes the Sun leaves and the Moon comes."
"Because this is darkness and this is morning."

Examples of correct answers given following the learning are:

"In Israel it is night because the Earth is spinning and we do not see the Sun from here. Then it is on the other side, where there is light."
"Because of the Earth's rotation."
"The Earth turns and then the Sun on another country."

Only one child answered incorrectly, saying, "The Sun is gone." Comparison of the answers to question 8 before and after the intervention show that there was a significant improvement in the children's understanding of the concepts of day and night. Most of the children were able to give accurate scientific explanations of the relationship between the position of the Sun in relation to us and the states of light (where the Sun is seen) and darkness (the Sun is not seen here; the Sun is seen elsewhere).

Question 9: A similar picture emerges in the responses to the open question "What is the Moon?" Before the learning program, 23 children did not answer the question at all, and six gave incorrect answers, such as: "The Moon is a star," or "The Moon is a half a banana."

Three children gave answers reflecting commonly held perceptions, such as: "The Moon is in the sky, in space," or "The Moon is the lesser light."

After learning, 29 children gave correct answers such as:

"The Moon orbits around the Earth."
"The Moon is a satellite of the Earth."
"It's the lesser light."

"There are lots of craters on it."
"The Moon is made of basalt stones."
"The Moon reflects the sunlight."

It can be seen that the children's answers were not uniform. They expressed varied perceptions and gave different emphases about the concept of the Moon and its characteristics and properties. The children expanded their explanations, using new concepts introduced to them in the intervention process.

Question 10: The children were given four possible answers to the question "What is the orbit of the Moon?" Before learning, eight children knew that the Moon orbited the Earth. The others chose one of the incorrect answers:

1. The Moon orbits the Sun.
2. The Moon does not move.

After learning, 31 children said the Moon orbits around the Earth.

Question 11: The open question, "Where is the Moon during the day?" required the children to give an answer and explain it. In the preliminary questionnaire, 23 children said that the Moon appears in the sky only at night, two children did not answer the question, and only seven children knew that the Moon is also in the sky during the day. After learning, 29 children answered that the Moon is in the sky during the day as well as at night, and only three answered incorrectly.

The following are examples of incorrect answers given to this open question before learning:

"The Moon is only seen at night, and in the day, it is hiding behind the clouds."
"During the day the Moon is with the other stars."
"The Moon is in the sky during both day and night, but during the day it is transparent so you cannot see it."

In contrast, some of the accurate answers the children gave to this question after learning include:

"The Moon is in the sky even during the day, but we do not always see it because the sunlight is stronger."
"The Moon orbits around the Earth, it does not disappear. Sometimes it is on the other side."
"The Moon is always in the sky and there are even days when we see it in the day, but it shines white."
"It is not always seen in the sky because the Sun shines stronger than it."

These examples illustrate the change that took place in the children's understanding of the location of the Moon. At the end of the learning process, the children were able to explain that sometimes the Moon can be seen overhead during the day, and sometimes it is on the other side of the Earth. The children also knew how to describe moonlight as a reflection of the sunlight.

Question 12: From the answers to the question "Which is bigger, the Earth or the Sun?" it can be seen that the educational intervention led to a change in the children's perception of the relative sizes of the Sun and the Earth. After the learning program, the children were able to answer correctly and even were able to describe in their own words that the Sun is a large star, much larger than the Earth, but that looks small due to its greater distance. This means that they learned to relate their perception of the size of a physical object and its distance; that is, they understood that further away an object is, the smaller it looks.

Question 13: In response to the question "What are the names of planets in the solar system?" before the intervention process, only two children could name any planet. After the intervention program, all children knew at least two planets, and some knew the names of up to six planets.

In summary, by comparing the children's answers to the questionnaire before the intervention to the answers they gave afterwards, it can be clearly seen that young children are able to learn astronomical concepts, understand them, and express them in their own words. The children learned to link processes with their results (for example, the rotation of the Earth around its axis as a cause of the shift between day and night). They demonstrated knowledge of many concepts such as the structure and features of the solar system, the effect of gravity, and the structure of the Earth.

Comparative Analysis of Children's Creative Projects Before and After the Intervention

During the lessons, the children were asked to do creative projects related to the program's study topics. A qualitative analysis of their artworks shows that during the course of the learning, they internalized scientific concepts about the structure of the solar system, the movement of the main celestial bodies, the phases of the Moon, and the nature of the Earth's structure and surface.

In one activity, the children were asked to draw the Earth. The drawing shown in Figure 1 was made by a girl prior to the intervention program. She drew a collection of circular shapes. The girl seems to have drawn from her imagination and not from any knowledge.

Figure 1. Drawing of the Earth, before the intervention

After the intervention, the children were again asked to portray the Earth. The artwork in Figure 2 was done after the intervention process by the same girl who made the drawing shown in Figure 1. After she completed this work, the girl was able to explain that she made the Earth in its circular shape and that most of the

surface area is blue because it is covered in water, and that she made the land in different colors according to their elevation.

Figure 2. Drawing of the Earth, after the intervention

In another activity, the children were asked to draw the solar system. The drawing shown in Figure 3 was made by a second child (a boy), who drew the Sun in the center and larger than the other objects - the planets. He colored the Sun yellow, signifying light and heat. Each planet is painted in a different color and at a different distance from the Sun, which indicates that he understands there are multiple bodies in the solar system, and each one is a different distance from the central body. The Earth is colored blue and it is the third in the series. In the background, he drew stars as round, gray shapes. The child demonstrated a basic understanding of the structure of the solar system, in which the star of the Sun is the central body and at different distances from it there are planets, each of which has a characteristic size. In addition, the child demonstrated his knowledge that there are other stars in space.

Figure 3. Drawing of the Solar System, after the Intervention

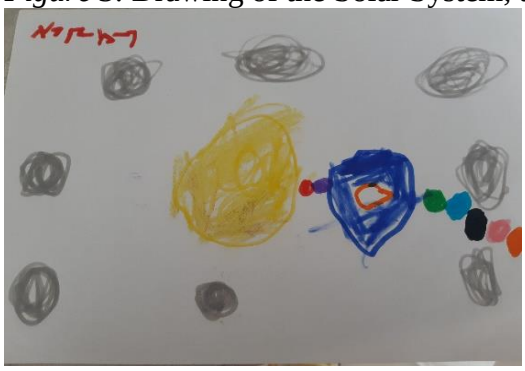


Figure 4 shows the drawing made by a third child (a girl) following the intervention. A large object, not drawn in the center of the page, extends beyond the edge of the page. Its shape is round, and is colored in red, orange and yellow, colors that symbolize light and heat. This represents the Sun. Around this body, are drawn circles in pencil, indicating a path of movement. This girl demonstrated her understanding that each of the planets has its own orbit at a more or less constant radius around the central body, the Sun. Because the Sun extends beyond the edge of the page, the lines symbolizing the orbits are not drawn as closed circles. This implies that the girl imagined the orbits of the planets around the Sun, but drew only a part of the overall picture. In addition, bumps on the surface of the

Sun indicate the release of light or heat from the Sun into space, reflecting descriptions the child heard in the learning process.

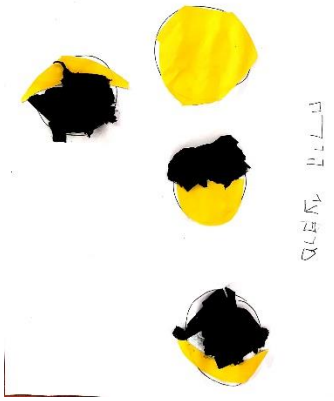
Figure 4. Drawing of the Solar System, after the Intervention

The children were asked to draw the Moon. In this drawing by a fifth child in the class (a boy) the Moon is painted as a yellow circle.

Figure 5. Drawing of the Moon, Before the Intervention

The drawing in Figure 6 was made by the same child who painted Figure 5. This time, when the children were asked to draw the Moon, the boy drew four circles in pencil. Part of each circle was painted in yellow, indicating the visible part of the Moon, and part is painted black, indicating the unseen part. In this work, the child demonstrated a change in his perception of the Moon. He expressed the idea that the way the Moon looks can change.

Figure 6. Drawing of the Moon after the Intervention



Description of Observation: Supervisor's Visit to the Kindergarten

Another aspect of the documentation of the children's explanations of astronomical phenomena is presented in the following partial transcript of an unstructured conversation between the children and a supervisor from the Ministry of Education, who they did not know. The supervisor visited the kindergarten at the end of learning process. The visit lasted about 45 minutes. All the students and the teacher sat together with the supervisor. In the conversation, the children were allowed to express themselves freely in response to open-ended questions from the teacher and the supervisor. The supervisor was not involved in the learning process and did not know what they learned and or to what concepts they had been exposed.

Supervisor: Children, I would like for you to explain to me what you learned about the Sun and the stars
Child 1 (boy): The Sun is very, very hot!
Child 2 (girl): Yeah, it's hot, it's a star you know?
Child 3 (boy): The Sun is made of hydrogen gas and we aren't allowed to go close to it. In fact, we can't because we'd be burned up, even if we are in a spaceship.
Child 4 (boy): Also, the planets orbit around it.
Supervisor: Do you know the planets?
Child 5 (girl): Of course.
Child 2 (girl): There's Saturn and Jupiter and Uranus.
Child 6 (boy): And the Earth, don't forget it, and Mars.
Child 1 (boy): Saturn has rings around it.
Teacher: Children, please explain to our guest why the Earth has life on it and the other planets do not.
Child 7 (girl): It is possible to live here because of the distance from the Sun.
Teacher: Please explain to us what is meant by the distance from the Sun.

Child 7 (girl): Because these planets (pointing to the Mercury and Venus on a poster) are too close to the Sun and the water all dried up, and these (pointing to the planets beyond the Earth) are too far from the Sun, and the water there has frozen, it turned into ice.
Child 6 (boy): And only the Earth is right, where our water is good and we can drink it. This is thanks to God, who put us in exactly the right place.

The children expressed, in their own words, various ideas they learned as part of the intervention program, such as:

1. Characteristics of the Sun - The Sun is a star in space, it gives off light and great heat, it is a body composed of gases.
2. The solar system, the concept of heliocentrism - The planets are bodies in space that maintain a constant rotational motion around the Sun. Every planet has a name, is at a certain distance away from the Sun. The children knew some of the names of the planets.
3. Relationship between the distance from the Sun and heat in a given place - The children expressed the idea that further from the Sun, the temperature decreases. They added that the distance of the Earth from the Sun is appropriate for the existence of life.
4. Relationship between temperature and the state of water - The children described ice as a state of water when the temperature is low, and associated this condition with great distance from the Sun. They described liquid water as a result of conditions in which the temperature is not extreme, and this is dependent on being a certain distance from the Sun - the distance of the Earth from the Sun. They also described a situation where water evaporates ("dries up") when the temperature is high, a condition that occurs close to the Sun.

From this observation, it can be seen that the children learned and internalized diverse ideas about astronomy and space.

Children's Impressions of the Educational Experience

The third research question relates to the nature of the children's experience of the teaching process. Table 3 summarizes the children's answers to Question 14: Did you enjoy learning about the subject? Why?

Table 3. Distribution of Children's Responses to Question 14: Did you enjoy learning about this subject? Why?

Number of children reporting "I had fun."	**Number of children reporting each impression of the astronomy lessons**					
	Interest	*Desire to explore*	*Desire of adventure in space*	*Enjoyable creativity*	*Beauty and Importance of the Universe*	*Fear*
29	3	6	7	5	6	3

The vast majority of the children (29 out of 32) reported having a positive experience of fun and enjoyment. Of those who enjoyed the program, only two did not give a reason; the others gave various reasons.

Three children expressed interest:

"Because it is interesting."
"Space is interesting and big."
"It was very interesting to learn that the Sun does not really sink."

Six children expressed a desire to explore:

"I learned new things."
"Our kindergarten is always exploring."
"I want to be a researcher like Maimonides."
"It's important to learn and explore."
"It is very fun to explore."
"I did research and told everyone I am a scientist."

Seven children said they enjoyed the idea of having adventures in space:

"I want to invent a spacecraft that will land on the Sun even though it is very hot, but nothing will happen to it because it will be the strongest ever."
"I want to hover in space."
"I want to fly into space."
"I've always wanted to go into space and I also want to fly."
"I'll go into space, too, when I grow up and my mother will let me."
"I want to be an astronaut and fly into space and there I will fly a giant Israeli flag."
"I love spaceships."

Five children enjoyed the creative projects:

"I drew a lot of things I never drew before."
"I built a big beautiful spaceship with my Dad, it was a lot of fun."
"The most fun was when I made a model of aliens with my Mom."
"I had the most fun making a spaceship full of buttons."
"I had fun building all the space stuff together."

Six children noted the sense of beauty and importance of the subject:

"The Earth is ... very important."
"Space is very large."
"The Earth is beautiful and the Sun is really special."
"Space is the most beautiful thing there is, and meteors are special."
"It is wonderful and important."
"It is very important that we learn about our Earth."

Notably, three children expressed fear about issues related to astronomy and space:

"I had fun but it was also scary because it's so big and far away."
"I was a little bit afraid because I saw a lot of scary darkness."
"At first I had no fun because it looked scary and big."

In summary, according to the findings presented here, this educational intervention to teach astronomical concepts in kindergarten seems to have been successful on several levels. The children demonstrated knowledge and understanding of astronomical and scientific concepts acquired during the learning program. The children learned many new facts, such as the names of planets, the shape and composition of the Earth. They learned about a variety of processes and knew how to explain them (such as the shift between day and night, orbits of the planets around the Sun, gravity). The children also learned about various connections between general scientific phenomena, such as the relationship between the distance from a heat-emitting body and the temperature, the relationship between temperature and the state of water, and the relationship between distance and the perceived size of an object. Most of the children said that they have enjoyed the learning, yet a few of them revealed some fear when learned about astronomy and space.

Discussion and Conclusions

The purpose of this study was to investigate the extent to which young children have the ability to learn and understand scientific ideas related to astronomy and space. The findings clearly show that after the educational intervention, the children's understanding of both tangible and abstract concepts improved. Their level of knowledge increased significantly after the learning program. The kindergarten students gained knowledge and understanding about the name, shape, structure, and two types of movement of the Earth. They learned about the nature of the Sun and the Moon and were able to explain the structure of the solar system and the movement of the main celestial bodies. The children were able to describe the qualities of gravity and the reasons for the shift between day and night. They also demonstrated an understanding of the relationship between

distance from a heat source and the level of heat and the relationship between the temperature and the three states of water, and the relationship between the distance of the observer from a physical object and its apparent size. In their artwork, the children further demonstrated an understanding of the circular motion of the planets around the Sun and the various lunar phases.

These findings are consistent with previous studies indicating the abilities of 4-6-year-old children to understand various scientific ideas, including those related to space and astronomy (Ampartzaki & Kalogiannakis, 2016; Bryce & Blown, 2013; Kallery, 2011; Spektor-Levy, Kesner-Baruch & Mevarech, 2011). Teaching the science of astronomy at an early age is challenging because it deals with abstract ideas that are beyond children's experiences (objects in space, the movement of celestial bodies, the idea of "forces" and relationships among these celestial bodies). However, these ideas do apply to their daily lives (the shift between day and night, seeing the Sun, Moon, and stars, the daily impact of gravity). Observations and conversations with the children revealed that studying astronomy in kindergarten enriched their conceptual world and scientific language. As a result of this learning, the children acquired new scientific concepts and ideas and were able to express in their own words the ideas they learned. They used terms such as: gravity, living conditions, planet, gas, hydrogen, and the crust, mantle, and core of the Earth. They also expressed through artwork the concept of celestial bodies at varying distances from one another.

The findings of the present study also show that young children who had not yet received formal teaching on scientific subjects had some perceptions about astronomical concepts, but that many of these were incorrect. The learning process succeeded in building their knowledge and enabling the children to express scientifically accurate ideas. An example of this can be seen in the process the children underwent in describing the properties of the Sun. They began with misconceptions, applying human attributes to the celestial body ("the Sun is tired") or describing them as they appear ("The Sun is smaller than the Earth", "the Sun sinks into the sea at night"). Afterwards, they expressed scientifically accurate ideas such as: "The Sun is a star", "The temperature in the Sun is very high.", "The Sun is bigger than the Earth.", "At night the Sun is on the other side of the Earth", "The Moon reflects the sunlight."

The results of this study are consistent with previous studies demonstrating changes in the perceptions of 4-6-year-olds about astronomical phenomena. For example, a study of the perceptions held by 76 preschoolers regarding phenomena on the Earth's surface found that after only two weeks of learning, the children gained new understandings and changed their explanations of these phenomena (Kampeza & Ravanis, 2009). Another example is a study of 33 kindergarten students who, after only two weeks of learning, abandoned their misconceptions and demonstrated new understandings of astronomical phenomena such as the Sun and the Earth as separate spherical objects existing in space (Valanides, Gritsi, Kampeza, & Ravanis, 2000). Some children were able to link the rotation of the Earth around its axis to the shift between day and night. These understandings are necessarily associated with the development of spatial vision (Plummer, 2014), which is crucial for learning engineering and mathematics.

It is not surprising that young children have misconceptions regarding astronomy, as these often originate from experiences that are unexplained or poorly processed. The process by which young children build their knowledge and conceptual world is of special interest, mainly because it can have practical implications for the way elementary school and kindergarten teachers are trained. It is essential that the teachers learn how to teach accurate concepts. Hence, they must first study and understand the subjects they choose to teach (Ampartzaki & Kalogiannakis, 2016). They must have adequate knowledge of the chosen field and the pedagogical skills necessary to teach scientific content and ideas to young children (Andersson & Gullberg, 2014; Bose & Seetso, 2016; Thulin & Redfors, 2017). Lack of knowledge about the subject may lead teachers to hold misconceptions that are similar to their students' misconceptions. Lack of pedagogic skills may make it difficult for them to teach science, since they do not speak the "scientific language" fluently and have difficulty translating it into the language of instruction. Pedagogically inappropriate teaching can lead to the development of fears in children, especially when teaching concepts that seem mysterious or inexplicable. Students should be helped to form perceptions that are as accurate and precise as possible (Eshach, 2006). Hence it is important to encourage and guide kindergarten teachers and properly prepare them to teach astronomy. Kindergarten teachers should be encouraged to become well acquainted with scientific information and pedagogical tools appropriate to teaching science to young children (Andersson & Gullberg, 2014; Thulin & Redfors, 2017) and to help them, through mentoring and training, so that more early education teachers are exposed to the scientific fields and choose to teach science, including astronomy, in to kindergarten students.

Research Limitations and Directions for Further Investigation

The main limitation of this study was its reliance on a relatively small group of children in one kindergarten from a high socioeconomic background. Further studies among different preschool-aged populations are needed. It would also be worthwhile to carry out further studies examining the questions that arise from this study, such as the impact of learning astronomy in early childhood on children's attitudes towards science later in their educational career. Different learning models need to be further explored in order to find the best ways to develop scientific knowledge, thinking, and understanding among kindergarten students.

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Intense Teaching Schedule in Israeli Teachers

By Yaffa Buskila[*] & Tamar Chen-Levi[†]

The teaching profession is highly stressful. Stress is a negative phenomenon that develops under conditions of uncontrollable, prolonged and increased pressure. In this study, our goal is (a) to investigate teachers' perception of the sources of stress in school in light of the neoliberal reforms and (b) to compare these sources of stress in primary school, middle school and high school teachers. We hypothesize that the demands and the workload to improve scores in standardized tests, increase the need of teachers to take work home. Therefore, home demands may conflict with school demands. Furthermore, the greatest pressure is on elementary and middle school teachers: Early efforts to improve student achievements in the lower grades would result in better-prepared students in high schools. Data about the sources of stress is based on a previous study of Buskila, Buskila, Giris and Ablin (2019) that investigated the connection between the effects of stress on teachers on somatic syndromes. Three hundred and twenty-one public school teachers working in the Ministry of Education (MOE) in Israel participated in the study. Findings of the mean of the entire samples revealed that the highest level of stress was caused by intense teaching schedule with insufficient breaks. The second cause was related to the composition of the students in the class, and the third was home demands conflicting with school demands. In the middle schools, the highest levels of stress are caused by school principals (M=5.98, SD=3.09) and second is in high school (M=5.00, SD=3.33). The highest level of stress caused by the superintendent is on primary school teachers (M=3.97, SD=3.33) and the second are the middle school teachers (M=3.79, SD = 2.95). The lowest stress level was in high school (M=2.68, SD=2.83). Three significance differences of stress were found among primary, middle, and high schools: The school principal is the highest source of pressure in the middle schools (P=.034), and the superintendent causes the highest level of stress in primary schools (P=.006). The third cause was in high school, related to physical school conditions (p=.002). These results are relevant to teachers, educators, and policy makers involved in planning and managing educational strategies and teachers' schedules. Identifying and preventing the sources of stress can facilitate better teaching conditions, and a more effective and efficient atmosphere in school.

Keywords: Stress at school, teachers' stress, causes of stress in school

Introduction

Recent research has shown that the teaching profession can be very stressful (Montgomery & Rupp, 2005; Jepson & Forrest, 2006). Stress is defined as a particular interaction between individuals and their environment, evaluated as being taxing or exceeding their personal resources, and, as a consequence, disrupting daily routines (Lazarus & Folkman, 1984). Many factors lead to stress in teachers. These factors may vary from time to time, from place to place and from person to person (Griffith, 2004). Stress can result from conflicting incompatible or unclear expectations, from unsatisfied needs, lack of resources and equipment, and difficult work schedules such as working late or overtime (Eres &

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Atanasosk, 2011). Stressors might optionally be associated with learning capabilities of students and nonproductive learning environments (Griffith, 2004), organizational climate (Eres & Atanasosk, 2011) and student behavior (Montgomery & Rupp, 2005; Verma & Madhavi, 2017). Stress can be associated with teaching qualifications, parental demands (Kyriacou, 2001) or relationships with any of the stakeholders at schools: peers, principals, superintendents and others (Adi-Rakach & Gonen, 2013). The school workload and other demands such as the pressure to increase scores on student achievement tests may put extra stress on teachers (Griffith, 2004; Nir, et al., 2016).

Neoliberal reforms taking place all over the world (Carnoy, 1995) and in Israel *Ofek Chadash* ("*The New Horizon*") and *Oz La Tmura* ("*The Courage to Change*") have made profound changes in the workload of teachers. The goal of these reforms was to raise teachers' professional status (Oplatka, 2017), but in fact, they increased their workload and added to teachers' stress on a daily basis (Schechter, 2015). Teachers in Israel work longer hours than previously, they are expected to increase student achievement on standardized tests, and are required to fill out many administrative forms (Nir, et al., 2016).

Despite the existing research on teachers' stress at work, we have little understanding of how teachers perceive the causes of their stress following the neoliberal reforms. The current study will contribute to our understanding of the effect of these reforms on the lives of teachers. This research is important because, in the recent decades, many countries in the world have legislated reforms that had a major impact on education systems, mainly on the work of teachers and school principals who were expected to implement these changes (Cuban, 1990, p. 22). Moreover, following the reform, teachers are responsible to two different authorities within the educational system: at the national level to the Ministry of Education and at the local level, to the local municipalities, which have the authority to administer the reforms in each city throughout the country. Both the national and the local authorities make demands on schools, which are sometimes in conflict (Nir, et al., 2016). These changes may put pressure on teachers that leads to unresolved disputes among educational communities regarding the value of the neoliberal ideology. Additionally, little information is available on a comparison of the sources of stress at the three school levels.

The study focuses on two questions: What is the source of stress as perceived by teachers in primary, middle, and high schools? Second, what are the differences among primary, middle, and high school teachers regarding the source of their stress?

Literature Review

Stress has been defined as hardship, adversity, force, tension, anxiety or pressure (Online Etymology Dictionary). Goleman (2006) describes two kinds of stress: Eustress is positive stress that refers to the pressure that mobilizes us to action. The neurochemistry of this type of stress is revealing. When we are positively engaged by a challenge, our brain is soaked in a bath of catecholamines

and other substances triggered by the adrenal system. These chemicals prime the brain to stay attentive and interested, even fascinated and energized for a sustained effort, stay alert and productive (Goleman, 2006). The other kind of stress occurs when someone is motivated by a fear of failure, or overwhelmed with anxiety, overloaded (Goleman, 2006). We define stress in this study as a force creating mental, physical, or moral pressure.

Unsatisfactory Work and Challenging Conditions

Teachers represent a specific and unique occupational population. While individuals are typically highly motivated and idealistic (Maaranen, et al., 2016; Haritos, 2004) some report unsatisfactory working conditions: Poor pay, low esteem, and the lack of possibility for professional advancement (Jarvis, 2002). These points might impair teachers' motivation or affect their ability to cope with professional challenges.

Stress can be triggered by various factors that might be associated with students' learning capabilities, behavior (Montgomery & Rupp, 2005; Verma & Madhavi, 2017; Ayub, Hussain, & Ghulamullah, 2018), hyperactivity, aggressive behavior or bulling (Verma & Madhavi, 2017). Moreover, teachers interact with a wide variety of student populations (Travers & Cooper, 1996; Montgomery & Rupp, 2005), and their job consists of many interacting ideas, goals, purposes, and tasks. They have to cope with crises and conflicts with students, parents, peers and each of the school stakeholders (Crick, Barr, Green, & Pedder, 2017). Stress can also be associated with parental demands as well as those of the school community (Kyriacou, 2001). They also have to maintain good relations with parents, peers, school principals and superintendents (Adi-Rakach & Gonen, 2013).

Teachers are also required to perform a variety of activities in addition to teaching, and they have little freedom to decide what to teach their students (Ayub, Hussain, & Ghulamullah, 2018). They are required to maintain a high level of alertness, concentration and physical effort, which all interact in making this lifetime occupation considerably challenging. It is important to note that schools in general, are emotionally charged institutions (James & Vince, 2001) and despite it most principals give priority to administrative work (Grissom, Loeb, & Mitani, 2013), rather than the interpersonal aspects of the profession (Harris, 2002). Technology has become an intrinsic part of teaching, which has brought about many new demands in teachers' work (Cox et al., 1988), increasing their stress (Kniveton, 1991).

Neoliberal Reforms, Standardized Tests and Stress

Neoliberal reforms started during the 1980s, and began as initiatives of the World Bank to help countries in Latin America develop economically and improve people’s lives. Later, these reforms affected education in many countries including Israel. They called for competition, equity, and greater financial efficiency. The introduction of more standardized testing was created to increase competition among schools. It was expected that such competition would improve

the quality of education and raise achievement. Municipalities were required to assume responsibility for education and to encourage private schools and public schools to raise their standards, and to allow students to select the school they wanted to attend. The belief was that such competition would encourage teachers to improve their schools in order not to lose students. Educational planners demanded that limited educational resources be used to achieve greater financial efficiency and higher achievement at a lower cost. The principle of equity demands a quality education with the best teachers as a basic right for all students including the poor, disabled members of minority groups (Carnoy, 1995).

Many countries have enacted neoliberal reforms in the recent decades: United Kingdom, Spain, New-Zealand, French, Chile, Colombia, Australia, USA and Israel. These reforms brought about major changes in education systems, mainly in teachers work, in order to achieve the expected changes (Cuban, 1990, p. 22). In the United Kingdom, they included high-stake tests in 1988 (Hobfoll & Freedy, 1993). In the United States *No Child Left Behind* (DiFate, 2008) was legislated in 2002. In Israel, similar reforms were enacted in 2008 and 2010 and, shortly afterwards, standardized tests were initiated resulting in greater pressure on teachers to improve student achievement (Bogler & Nir, 2014). The reforms in Israel were enacted to enhance teachers' professional development in assessment (Gallagher, et al., 2012) and professional self-esteem (Oplatka, 2017), but they made profound changes on teachers' work (Nir, et al., 2016) adding much stress on a daily basis (Shechter, 2015). The structure of teachers' frame of work was changed, and 30% more hours of work were added. In primary schools, teachers work 36 hours a week. They teach 31 hours and have five hours for planning lessons, evaluation, checking tests or homework, supervising, meeting with peers, with parents, with students, and with school principals, psychologists etc. In middle school, of the 36-hour teacher post, they teach 27 hours and have nine hours for preparation. In high school, teachers work 40 hours, teach 30 hours, and have ten hours for preparations (MOE, 2013). Teachers are also required to document the number of hours spent with students, what they teach, how many hours they teach, the status of student achievement and more. These demands provoked negative responses and major complaints among teachers, arguing that the reporting interrupts their work (Schecter, 2015).

Effects and Costs of the Stressful Conditions

Stress is a negative phenomenon that develops under uncontrollable, prolonged and increased pressure. It has physical and mental health consequences and adverse effects at work (Bellingrrath, Weigl, & Kudielka, 2009). A recent study of 321 teachers in Israel found a high prevalence (9.3%) of fibromyalgia syndrome among Israeli teachers, correlated with high levels of stress, compared to population as a whole (2.4%) (Buskila, et al., 2019). Previous studies focused on specific pain syndromes among teachers, including lower back pain (Bandpei, et al., 2014) and neck pain (Verma & Madahavi, 2013; Rotermund, at al., 2015). Stress also causes headaches, insomnia, indigestion, and exhaustion (Chan, 1998; Cichon & Koff, 1980; Dunham 1992; Dworkin, et al., 1990). It can lead to

depression, anger, anxiety, frustration, fear, self-blame, poor concentration, and memory loss (Blase, 1986; Chan, 1998; Esteve, 1989; Fimian, 1984; Galloway, et al., 1984).

Additional studies demonstrate that occupational stress impairs teaching productivity (Niessen, et al., 2017), damages the quality of teaching, lowers the occupational commitment (Cherniss, 1980), harms effectiveness at work and reduces job satisfaction (Jepson & Forrest, 2006). It also affects the well-being of individuals and the organization as a whole and, as a result, impairs performance and may lead to absenteeism, reduced staff retention and turnover in schools (Jackson, et al., 1986). Job stress in teachers results in burnout (Jepson & Forrest, 2006), and leaving the profession mostly due to centralized education systems (Karsenti & Collin, 2013).

Data on Worldwide Rate of Teacher Attrition

The problem of teacher attrition is worrisome. In England, the teaching profession is highest on the list of stressful professions. In Switzerland, Scotland, Australia, and New Zealand about 80% of the teachers suffer from overload at work (Schneider- Levy, 2016). In the United States, Germany, and Israel about 50% of the teachers leave the profession after five years, and in the United Kingdom, about 44% of the teachers abandon the profession (Dolton & klaauw, 1995). In Canada, the estimations vary. In 2004, it was estimated that 30% of teachers dropped out, and in 2013 it was estimated that 50% of the teachers left in the first two years mostly because of the excessive workload they brought home (Karasnti & Collin, 2013). In East Asia, teachers leave the profession because of pressure, burnout, and overwork (Bas, 2011; Montgomery & Rupp, 2005). In 2017, Professor Oplatka (2017), a senior educator in Israel, warned the policy makers in the Ministry of Education that the reforms may result in good teachers and school principals leaving the educational system because of the stress. On May 2019, the Israeli State Comptroller Report announced a scarcity of 3000 teachers (Detal, 2019).

Leaving the teaching profession and provide replacement staff to schools, and training the new teachers is very expensive (O'Driscoll & Cooper, 1996). The OECD, the Organization for Economic Co-operational, and Development and the AEE, the Alliance for Excellent Education in the United State estimated that the cost of teacher attrition was almost three billion American dollars in 2004 (OECD Publication, 2005), and possibly now it is higher.

Failed Attempts to Deal with Stress

The effectiveness of an educational system is usually evaluated through student achievement. The higher the student achievement, the higher the evaluation of the school is. Some studies have suggested looking at the effectiveness of schools by examining organizational adaptations to stress, rather than student achievement (Griffith, 2004). Stress reflects a failure of modern organization in human and financial terms. Levels of stress can be minimized

when there are adequate resources to meet demands and needs in the workplace (Bala & Hooda, 2013).

Failure to address the needs of teachers and demanding greater amounts of work, results in higher levels of stress in teachers and subsequently a great many teachers leave the profession. Many of those who remain in the education systems do not meet the needs of the students. Many countries, suffer from a scarcity of teachers and the students pay the highest price for these problems. Countries pay billions of dollars to institute educational reforms, which often result in teachers leaving the profession. In light of the changes that have taken place in recent years throughout the world, we have to understand the sources and impact of stress (Karsenti & Collin, 2013). Reducing stress may enhance the performance of teachers (Huppert, 2009). In this study, we aim to investigate teachers' perception of the sources of stress in school in light of the neoliberal reforms and to compare the sources of stress among primary, middle, and high school teachers.

Hypothesis

1. We assume that as the demands and workload on teachers increase in order to improve scores on standardized tests, the need for teachers to work at home will increase. Therefore, home demands conflict with school demands.
2. The greatest pressure exists on teachers in elementary and middle schools: When teachers invest efforts to improve student achievement at the earlier levels, the achievement of students in high school will improve.

Methodology

Description of the Sample

Three hundred and twenty-one *(N=321) teachers* participated in the study, 255 women (79.4%) and 66 men (20.6%). All the participants are currently working as teachers in the Israeli public-school system in five (out of seven) geographic areas of the MOE: the southern district, the Tel Aviv district, the Jerusalem district, the central district and the northern district. One hundred and seventy *(N=170)* participants teach in primary school, sixty-six *(N=66)* teach in middle schools and eighty-five *(N = 85)* teach in high schools (see Table 1).

Table 1. Participants Matrix

Participant Matrix					
	Total	**Percentage**	**Primary School**	**Middle School**	**High School**
Participants	**(N=321)**	**100%**	**(N=170)**	**(N=66)**	**(N=85)**
Gender:					
Men	66	20.6%	20	20	26
Women	255	79.4%	150	46	59
Age:					
20 – 29	59	100%	39	17	3
30 - 39	95	100%	51	22	22
40 – 49	84	100%	45	17	22
50 - 59	55	100%	30	5	20
60 and above	28	100%	5	5	18
Academic					
Education:	177	55.1%	102	42	33
BA, B.Ed	132	41.1%	64	23	45
MA, M.Ed	12	3.7 %	4	1	7
PhD, Ed.D					
Religion:					
Jewish	253	78.8%	127	43	83
Muslim	66	20.6%	42	22	2
Christian	2	0.6%	1	1	0

Methods, Tools and Procedures

Data about stress was taken from a study by Buskila, Y, et al., (2019), which investigated the connection between teachers' stress at school and its effect on somatic syndromes. In order to measure the stress in that study, we used a questionnaire developed by Foa, Cashman, Jay cox, & Perry (1997), which was adjusted for use with teachers by Buskila et al., (2019). Six educational experts checked the content validation of the teachers' stress. The questionnaires included basic demographic questions as presented in graph 1 and a series of questions about what they considered as the greatest sources of stress on a wide range Likert scale of 1 to 10. We asked teachers to rank the sources that cause them the greatest stress: school principals, superintendents, parents, students, peers, overcrowded classrooms, the presence of students with special needs in regular classes, an intense teaching schedule, without breaks, teaching subjects in which they did not have adequate training etc. At the end of the questionnaire, the participants were given an open question to describe their thoughts about sources of stress.

This is a quantitative study. Questionnaires were distributed to teachers by principals, email, or the internet in a Google Doc format. We also sent questionnaires to teachers in graduate programs in educational leadership in three different colleges in Israel.

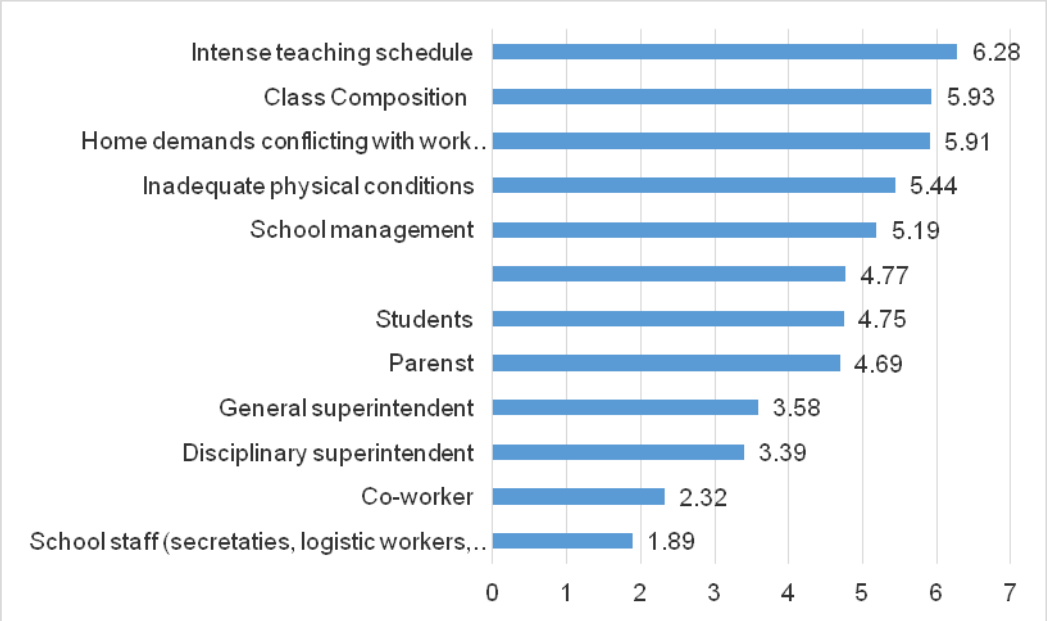
Statistical Analysis

Based on the previous study, we extracted data about the sources and extent of stress and analyzed the data to identify the sources of stress in primary, middle, and high school teachers and compared the sources at the three school levels. We calculated the following data: (a) We checked the stress level of all sources, the means and the standard deviations for each school level separately. The data is presented in descending order for the entire sample and for each school level separately (b) We used an analysis of covariance MANCOVA to compare the sources of stress in teachers by levels of academic education and seniority in teaching, at the three school levels.

Results

As can be seen in the data presented in graph 1, the highest mean of the sources of stress, with average score of 6.28 out of 10 is an intense teaching schedule with insufficient breaks. The second highest sources with average score of 5.93 is the class composition. The third highest source with average score of 5.91 is the conflict between home demands and work. The fourth source with an average score of 5.44 is related to inadequate classroom physical conditions, and the fifth source, with average score of 5.19, is stress that comes from the school administration, such as principals or vice principals (see Figure 1).

Figure 1. The Mean Sources of Stress for all the Sample, Ranged from the Highest to the Lowest Component (N = 321)



Distinctive Statistics for Stress Elements in Each School Type Separately

Primary School

The following table (Table 2) shows descriptive data for teachers in primary school, regarding the sources of work-related stress, ranged from the highest to the lowest.

Table 2. Stress source as Described by Teachers in Primary Schools (N = 170)

	N	Minimum	Maximum	Mean	Std. Dev
25. Intense teaching schedule (not enough breaks)	170	0	10	6.10	3.335
23. Class composition (over-crowding, special education students etc.)	168	0	10	5.75	3.173
27. Home demands conflicting with work demands	166	0	10	5.63	3.451
19. School administration	169	0	10	4.89	3.190
24. Inadequate classroom physical conditions	167	0	10	4.81	3.362
20. Parents	169	0	10	4.59	3.210
26. Demand to teach subjects with inadequate training	165	0	10	4.32	3.556
22. Students	168	0	10	4.27	3.117
17. General superintendent	167	0	10	4.06	3.336
18. Disciplinary superintendent	163	0	10	3.67	3.294
19. Co-worker	169	0	10	2.09	2.341
21. School staff (secretaries, guards, logistic workers etc.)	166	0	10	1.87	2.501

Table 2 demonstrates that the highest source of stress, with an average score of 6.1, is the intense teaching schedule. The second highest source, with an average score of 5.75, is the class composition. The third, with an average score of 5.63, is the conflict between demands at home and at work. The fourth, with an average score of 4.89, is the school administration, and the fifth, with an average score of 4.81, is related to inadequate physical class conditions.

Middle School

The following description shows the descriptive data of teachers in middle schools, regarding the source of stress as they perceive (see Table 3).

Table 3. Stress Source as Described by Teachers in Middle Schools (N = 66)

	N	Minimum	Maximum	Mean	Std. Deviation
25. Intense teaching schedule (not enough breaks)	66	0	10	6.53	3.361
23. Class composition (crowding, special education students etc.)	65	0	10	6.29	3.296
27. Home demands conflicting with work demands	65	0	10	6.18	3.051
19. School administration	65	0	10	6.14	3.097
24. Inadequate classroom physical condition	65	0	10	6.02	3.095
20. Parents	63	0	10	5.24	4.039
26. Demand to teach subjects with inadequate training	66	0	10	5.12	3.131
22. Students	66	0	10	4.65	3.256
17. General superintendent	63	0	10	3.63	2.980
18. Disciplinary superintendent	64	0	10	3.45	3.070
19. Co-worker	65	0	10	2.83	2.929
21. School staff (secretaries, guards, logistic workers etc.)	61	0	10	2.11	3.083

The data in graph 3 demonstrates that the highest source of stress is an intense teaching schedule (not enough breaks) with an average score of 6.53. The second highest is the conflict between demands of home and work with average score of 6.29. The third highest is class composition with an average score of 6.18. The fourth is school administration with an average score of 6.14 and the fifth is related to inadequate classroom physical conditions with an average score of 6.02.

High School

The following description will demonstrate the descriptive data for high school teacher. See Table 4.

As in the primary and middle schools, the data in table 4 demonstrates that the highest stress source is the intense teaching schedule, with an average score of 6.43. The second highest is the conflict between the demands of home and work, with an average of 6.19. The third highest source is inadequate classroom physical conditions with an average of 6.16. The fourth is class composition with an average of 6.08 and the fifth source of stress is the students, with an average of 5.43. This data partially confirms our first assumption. The second question in our study was to find the differences regarding the source of stress in primary, middle school, and high school teachers. We hypothesized that the highest pressure is on elementary and middle school teachers because the earliest the effort to improve student achievement is in the lower grades and this effort would result in better achievement in high school.

Table 4. Stress Source as Described by Teachers in High Schools (N = 85)

	N	Minimum	Maximum	Mean	Std. Dev.
25 Intense teaching schedule (not enough breaks)	83	0	10	6.43	3.437
27. Home demands conflicting with work demands	80	0	10	6.19	3.565
24. Inadequate physical conditions	82	0	10	6.16	3.376
23. Class composition (crowding, special education students etc.)	84	0	10	6.08	3.205
22. Students	84	0	10	5.43	3.402
26. Da subject with inadequate training.	73	0	10	5.38	4.054
16. School administration	84	0	10	5.15	3.381
20. Parents	84	0	10	4.90	3.251
18. Disciplinary superintendent	82	0	10	2.80	2.683
17. General superintendent	82	0	10	2.56	2.789
19. Co-workers	82	0	9	2.37	2.285
21. School staff (secretaries, guards, logistic workers etc.)	81	0	10	1.74	2.630

Table 5. Test F, MANCOVA for Calculating the Mean Stress Sources according to three School Levels: Primary, Middle and High School (N = 321)

Working data	School level	Mean	Std. Deviation	N	Teaching level F(2,273)	Significance p	Significance Seniority in teaching	Significance Education
16. School administration	1 Primary school teacher	**4.80**	3.229	152				
	2 Middle school teachers	**5.98**	3.098	58	**3.418***	**.034**	.149	.574
	3 High school teachers	**5.00**	3.337	68				
17. School superintendent	1 Primary school teacher	**3.97**	3.339	152				
	2 Middle school teachers	**3.79**	2.954	58	**5.220****	**.006**	.424	.245
	3 High school teachers	**2.68**	2.836	68				
18. Disciplinary superintendent	1 Primary school teacher	3.61	3.268	152				
	2 Middle school teachers	3.50	3.102	58	1.912	.150	.644	.694
	3 High school teachers	2.79	2.669	68				
19.Co-workers	1 Primary school teacher	2.16	2.349	152				
	2 Middle school teachers	2.67	2.886	58	.888	.413	.188	.253
	3 High school teachers	2.32	2.269	68				

20. Parents	1 Primary school teacher	4.57	3.172	152				
	2 Middle school teachers	4.52	3.158	58	.147	.863	.424	**.016***
	3 High school teachers	5.19	3.297	68				
21. School staff (secretaries, logistic workers, guard etc.	1 Primary school teacher	1.89	2.487	152				
	2 Middle school teachers	2.21	3.133	58	.263	.769	.258	.860
	3 High school teachers	1.72	2.631	68				
22. Students	1 Primary school teachers	4.29	3.124	152				
	2 Middle school teachers	4.93	3.150	58	2.478	.086	.315	.556
	3 High school teachers	5.51	3.496	68				
23. Class composition (students with special needs in regular class etc.)	1 Primary school teacher	5.76	3.191	152				
	2 Middle school teachers	5.95	3.040	58	.140	.869	.090	.160
	3 High school teachers	6.19	3.233	68				
24. Classroom physical conditions (room inadequate, no A/C, technological problems etc.	1 Primary school teacher	**4.74**	3.365	152				
	2 Middle school teachers	**6.19**	3.198	58	**6.305****	**.002**	.193	.108
	3 high school teachers	**6.44**	3.343	68				
25. Intense teaching schedule (not enough breaks)	1 Primary school teacher	5.96	3.357	152				
	2 Middle school teachers	6.43	3.470	58	.551	.577	.066	.227
	3 High school teachers	6.54	3.462	68				
26. Demands to teach a with inadequate training	1 Primary school teacher	4.16	3.526	152				
	2 Middle school teachers	4.93	4.043	58	1.874	.155	.205	.268
	3 High school teachers	5.46	4.046	68				
27. Home demands conflicting with	1 Primary school teacher	5.51	3.481	15KTJ2	2.259	.106	.487	.131

work demands	2 Middl3 school teachers	6.34	3.359	58				
	3 High school teachers	6.51	3.462	68				

p<.05* p<.01**

As shown in the MANCOVA matrix, the highest levels of stress caused by school principals is in the middle school (M=5.98, SD=3.09). In high schools, this is in second place (M=5.00, SD=3.33). The lowest source of stress caused by school principals is at the primary school (M=4.80, SD=3.22). There are significant differences between schools concerning the stress caused by the superintendent. The superintendent caused a greater source of stress in primary school teachers (M=3.97, SD=3.33) than in middle school (M=3.79, SD = 2.95) or high school (M=2.68, SD=2.83) teachers. This confirms our second assumption. The highest level of stress among teachers in the primary and middle school is caused by superintendents.

Additionally, we found significant differences among schools regarding the physical conditions in the classrooms. In the primary schools we found (M=4.74, SD=3.36) the lowest level of stress. In the middle schools we found (M=6.19, SD=3.19) and in the high schools we found the highest level of stress regarding physical conditions (M=6.44, SD=3.34). Two other components of stress were significant: The first is seniority at work (P=.002) which means, the higher the seniority, the lower the level of stress in teachers. The second is the academic level source. The higher the academic education of the teacher, the higher the level of stress from parents (P = .016). In conclusion, we learn from the MANCOVA test that the three differentiating sources among primary, middle, and high schools are the school principal, the school superintendent and the physical conditions in the classroom. Additionally, the higher the seniority at work, the lower the level of stress and the higher the academic education of the teachers in middle schools, the greater the stress from parents.

Table 6. Comparison and Differenced Matrix Among Schools (N = 321)

The Place	**Primary School**	**Middle School**	**High School**
First place	Intense teaching schedule (not enough breaks) (6.1)	Intense teaching schedule (not enough breaks) (6.53)	Intense teaching schedule (not enough breaks) (6.43)
Second place	Class composition (5.63)	Home demands conflicting with work demands (6.29)	Home demands conflicting with work demands (6.19)
Third place	Home demands conflicting with work demands (5.63)	Class composition (6.18)	Inadequate classroom physical conditions (6.16)
Fourth place	School administration (4.89)	Inadequate classroom physical conditions (6.14)	Class composition (6.08).
Fifth place	Inadequate physical class conditions (4.81)	School administration (6.29).	Students (5.43)

Table 6 compares the differences among the three school levels. The highest sources of stress described by all teachers in the sample (N = 321) is the intense teaching schedule. In second place in middle schools and high schools (N = 151) is the conflict between home and work demands. In primary schools (N=170) the class composition is in second place as a cause of stress. The conflict between home and work is in third place among primary school teachers. Middle school teachers find the class compositions as a cause of stress and in high school, teachers complain about inadequate physical conditions in the classroom.

Discussion

The current study aims to investigate teachers' perception of the sources of stress in school in light of the neoliberal reforms and to compare the perception of stress in primary, middle and high school teachers. We demonstrated that an intense teaching schedule with insufficient breaks is the major source of stress in teachers in the entire sample and at each level. This finding, which has not been previously reported, has significant implications for teachers' work. An overly demanding teaching schedule is difficult to handle. Many teachers complain about the lack of breaks to rest, to prepare themselves for the next lesson, to organize their thoughts before their next lesson, to drink, to eat or attend to go to the toilet. One of the teachers wrote: "Every two lessons, we have a break of 15 minute which is not enough." Another teacher commented: "The pressure is due to the long school day and the short breaks of only fifteen minutes that do not leave us time to breathe." One more teacher added, "Students need our attention during breaks, and we do not have enough time to catch our breath before the next lesson, to go to the restroom or to drink or eat before the next lesson

The teaching schedule hours was expanded: Teachers in primary schools work 7.2 hours a day and teach 6.2 hours a day. They have only one hour a day for preparations, and other assignments such as meetings with parents, co-workers, students, checking exams and homework, preparing lessons, writing programs and coordinating ceremonies, special events, trips, parties etc. Middle school teachers work 7.2 hours each day. They teach 5.4 hours, which means that they have 1.8 hours a day for preparations and assignments. In high schools, teachers work 8 hours per day and teach 6 hours a day, leaving them two hours a day for preparations and many assignments. The non-teaching hours are insufficient for the work involved. This also explains the results in Figure 1: The mean sources of stress for all the samples in third place was the conflict between the home and demands and school demands. These schedules show an over utilization of human resources of teachers as said by teachers in the study of Karsenti & Collin (2013, p. 145): “Too much work has to be done… and too heavy workload.”

Stress can be viewed as a failure of the modern organization in both human and financial terms and can be solved by money (Griffith, 2004). In many countries, billions of dollars are invested every year for reforms, which have not been successful in raising the scores on standardized tests (Barber & Murshed, 2007). The general cost of education in Israel rose tremendously from 2000 to

2012, and today is above those of the OECD (Blasé & Kogan, 2016). There is no reason to believe that there is a lack of resources, but the list of priorities for spending the money should be revised. Teachers work long hours and overtime, have insufficient breaks and work many hours at home adding to their stress (Eres & Atanasosk, 2011) The stress of teachers in Israel is a result of a gap between reality and expectations. Teachers continue to work at home at the expense of time with their families. The demands of the job and their home are often in conflict. Revising the priorities according to the classes and teachers' needs might be helpful. Stress can impair the health of teachers, and harm their self-esteem (Schechter, 2015) making it difficult to achieve the expected performance and leading to ineffective education (Wangui, et al., 2016). These may also explain the low scores in the standardized tests in many countries including Israel despite the investment of efforts to improve these scores.

The three distinct sources among primary, middle, and high schools are the school principal, the superintendent and physical conditions in the classroom. The greatest source of stress in middle school cause by the school principal (P=.034). The superintendent is a greater cause of stress, in primary schools (P=.006) and the greatest source of stress on high school is the physical conditions of the school (P=.002). Apparently, school principals and superintendents are different stressors in primary and middle schools. However, they both share the goal of improving students' performance on national and international standardized tests (Nir et al, 2016) as directed by the Ministry of Education. Our assumption that they would be a greater source of stress in elementary and middle schools than in high school was confirmed.

Two other components of stress were found to be significant. First, at the higher levels of seniority there was less stress (p=.002) at all the school levels. Experienced teachers are better able to cope with a wide range of problems. However, the second result, that teachers with more advanced degrees experience greater the stress from parents (P=.016), is surprising. Learning is very important and contributes to growth and development of teachers, raising their self-esteem, self-confidence and much more. Learning knowledge and skills of teachers are the most important determinants of student success (Darling-Hammond & Youngs, 2002). Learning covers all aspects of education, embracing everything in it (Dhaliwal, 2015). What many studies conclude is that the single most important factor in student achievements is high quality teaching (Haycock, 1998) that meet the challenges of the 21st century, ongoing efforts are needed to improve the education of teachers (Hellenberg, 2010; Nir et al., 2016). There is increased pressure in the United States to provide highly qualified teachers (Cavalluzzo, 2004). As a result, the educational community is focused on the importance of teacher quality and the types of continuing professional development available to teachers to improve the quality of their instruction (Hellenberg, 2010). We believe that the finding that the higher the academic education of teachers the greater the stress they experience from parents is related to the low professional image of teachers in many places in the world (Barer & Murshad, 2007) including Israel, and to the lack of respect for teachers (Karsenti & Collin, 2013) in Israel and elsewhere (Raychel, 2012). There are many reasons for this low image such as low

salaries, demanding work, pressure to satisfy parents and the challenge of relating to parents (Karsenti & Collin, 2013). Teachers work in a turbulent and competitive environment and often face a public satisfied with the educational system (Schecter & Tschanned-Moran, 2006).

Theoretical Contribution, Limitations, further Research and Meaning of the Study

Although considerable attention has focused on stress in teachers resulting from the changes that have occurred in the educational systems around the world, there have been few empirical studies examining stress from the perspectives of teachers. For this reason, studies such as ours are important. Schools still have no autonomy; the public schooling system in 2015 in Israel is more a declarative autonomy (Nir, et al., 2016). Local municipalities have authority on the schools in given areas (Addi -Raccah, 2006). Other organizations have also attempted to cooperate with schools (Berkovich & Folder, 2012) and to participate in the reshaping of the educational system. These initiatives have a direct impact on schools and on teachers and reveal complex and contradictory pressures (Sagie, Yemini, & Bauer, 2016). Recognizing and understanding the causes for changes and stressors are important in order to know how to handle them and how to prevent them.

There are a few limitations in our research. This study was conducted in Israel and the results are influenced by the local culture and society, local management and organizational culture (Luthans & Avolio, 2003). Similar research in other cultures would contribute to our understanding of stress both in Israel and in other countries. We believe that it will help to construct new knowledge. Our results are relevant to teachers, educators and policy makers involved in planning and managing educational strategies. Identifying and preventing the sources of stress can facilitate better teaching conditions, and a more productive educational atmosphere in schools.

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