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Abstract

The Faculties of Education in Egypt seek to develop student teachers' skills for using technology in teaching their subjects through studying education technology courses. Since the arrival of Covid-19, the ability to teach online has become a necessity. The current study aimed to reveal prospective science teachers' level of self-efficacy for teaching science online. The study sample consisted of (253) prospective science teachers who graduated in 2020 from the Primary and General Education Divisions at the Faculty of Education, Beni-Suef University. A five-point Likert-scale was created for this study. The scale included (44) phrases belonging to four dimensions of skills: using online technology, using online pedagogy, managing online behaviour, and identifying online science content. The study results showed that the prospective science teachers in the two divisions had a very low level of self-efficacy for teaching science online. The results also showed that there was no correlation between the prospective science teachers' level of self-efficacy for teaching science online, and their perceptions of the education technology courses they studied during their preparation programme. Based on the findings, the researchers recommend the necessity of practically training student teachers on teaching science online through education technology and science teaching methods courses.

Keywords: Teachers' self-efficacy, prospective science teachers, education technology, online teaching science skills.

مستوى الفاعلية الذاتية لتدريس العلوم عبر الإنترنت لدى معلمي العلوم حديثي التخرج وعلاقته بتصوراتهم لمقررات تكنولوجيا التعليم ...دراسة فى جامعة بني سويف

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ملخص الدراسة

تسعى كليات التربية فى مصر إلى تنمية مهارات استخدام التكنولوجيا فى التدريس لدى الطلاب المعلمين فى كافة التخصصات، وذلك من خلال دراستهم لمقررات تكنولوجيا التعليم. هذا وقد أصبح اكتساب المعلمين لمهارات التدريس عبر الإنترنت أمرًا ضروريًا؛ خاصة بعد انتشار جائحة كورونا. وقد هدفت الدراسة الحالية إلى الكشف عن مستوى الفاعلية الذاتية لتدريس العلوم عبر الإنترنت لدى (٢٥٣) معلمًا من معلمي العلوم حديثي التخرج (عام ٢٠٢٠) من شعبتى التعليم الابتدائى، والشعبة العامة بكلية التربية جامعة بني سويف. وتم إعداد مقياس خماسي الأبعاد لهذا الغرض. وشمل المقياس (٤٤) عبارة تنتمى إلى أربعة أبعاد هى: مهارات استخدام الإنترنت، والمهارات البيداجوجية لتدريس العلوم عبر الإنترنت، ومهارات إدارة السلوك عبر الإنترنت، ومهارات تحديد واختيار محتوى علمى متاح على الإنترنت؛ لتضمينه فى عرض دروس العلوم عبر الإنترنت. وقد أظهرت نتائج الدراسة تدنى مستوى الفاعلية الذاتية لتدريس العلوم عبر الإنترنت لدى معلمي العلوم بالشعبتين. كما أظهرت النتائج عدم وجود ارتباط بين مستوى الفاعلية الذاتية لتدريس العلوم عبر الإنترنت لدى هؤلاء المعلمين، وتصوراتهم لمقررات تكنولوجيا التعليم التى درسوها أثناء إعدادهم بالكلية. وأوصت الدراسة بضرورة تدريب الطلاب المعلمين عمليًا على تدريس العلوم عير الإنترنت سواء من خلال مقررات تكنولوجيا التعليم، أو من خلال مواد الإعداد الأخرى، خاصة طرق تدريس العلوم.

الكلمات المفتاحية: الفاعلية الذاتية للمعلمين، معلموالعلوم حديثو التخرج، تكنولوجيا التعليم، مهارات تدريس العلوم عبر الإنترنت.

Introduction

Online learning has been brought to the forefront due to Covid-19. However, the push for increased technology-based learning opportunities for prospective teachers has been occurring for some time. In 2012, Ottenbreit-Leftwich *et al.* found that (85%) of (1439) American degree-granting four-year teacher education programs offered technology integration courses. A similar trend is found in Egypt with teacher training programs requiring prospective teachers to take at least one education technology course. While many teacher education programs offer required and elective courses in technology it is unclear whether the training is sufficient to prepare prospective teachers for online teaching.

Study Context

With the strong presence of technology in the 21st century classroom, prospective teachers must have digital competence (Gudmundsdottir *et al*., 2020). The European Commission (2018) defines digital competence as involving "the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society" (p.5). For teachers, digital competency refers to a teacher's ability and attitude toward the incorporation of digital technologies into their professional practice and development (Cantabrana *et al*., 2019). However, teachers often view technology as simply a tool for lesson preparation or as a tool to support, enhance and complement existing classroom practices (Dong *et al*., 2019; Savec, 2017). As a result, teachers often lack adequate skills and competencies to design and implement technology in their teaching and learning process because they do not view technology as a means to reshape subject content, goals and pedagogies (Dong *et al*., 2019; Savec, 2017). According to Gudmundsdottir *et al*. (2020), for teachers to have digital competency they must have:

1. General digital competence, which is general technological knowledge, skills, and attitudes.
2. Subject-related digital competence, which is the ability to teach a subject's content with and through technology.
3. Profession-related digital competence, which is the ability to use technology in all aspects of a teacher's day (e.g., classroom management, communication with parents, dealing with cyberbullying, etc.).

Further, Ottenbreit-Leftwich *et al*. (2018a) suggest that even when prospective teachers have the necessary technology knowledge and skills, if teachers have low self-efficacy in technology use, they are less likely to integrate technology into their teaching practices. In addition, when a teacher has low self-efficacy for technology they will set lower goals, are more likely to become frustrated and anxious; thereby, giving up easily when confronted with technological challenges (Aktağ & Tuzcuoğlu, 2016; Didem, 2018). As a result, it is necessary for prospective teachers to develop both technology knowledge in conjunction with prospective teachers' self-efficacy for digital competence.

At Beni-Suef University, prospective science teachers study for four years in one of two divisions: Primary Education or General Education. The Primary Education division (PED) prepares prospective science teachers to be primary school teachers (pupils aged 6-12 years). The General Education Division (GED) prepares prospective teachers to be preparatory science teachers (pupils aged 12-18 years). The prospective science teachers in the GED study educational and scientific subjects focusing on one science discipline, which can be physics, chemistry, or biology. A requirement of the PED and GED programs is to study one or two course(s) in education technology respectively. One of the aims of these courses is to develop student teachers' awareness of and attitudes towards e-learning.

As a result of Covid-19, during the second academic year 2020 all Beni-Suef University (BSU) normal classes moved rapidly to the Learning Management System (LMS). BSU students were required to attend online classes to complete their courses. The first author suggested to her students to use the Zoom program so that they complete a course on methods of teaching science through it. Most students refused to complete the course via Zoom claiming that they could not use it. They asked to use either Facebook or WhatsApp. Currently, with the continuation of the Covid-19 pandemic, it has been urgent for all faculties of education to revise their prospective teachers' technological preparation and make sure of their ability for online teaching.

Since teachers with high self-efficacy have a direct and positive influence on their students' academic achievement (Didem, 2008; Hoy & Spero, 2005; Shahzad & Naureen, 2017; Tschannen-Moran & Hoy, 2001), ensuring that prospective teachers have high self-efficacy for teaching online is as important as having general teaching skills (Mannila *et al*., 2018), which is the aim of the present study.

Study Questions

The study questions that guided the current study are:

1. What is the level of prospective science teachers' self-efficacy for online science teaching?
2. What is the correlation between the prospective science teachers' perceived usefulness of their education technology course(s) and their self-efficacy for teaching science online?
3. What is the level of self-efficacy for teaching science online of prospective science teachers who perceive their education technology course(s) as useful?
4. What is the level of self-efficacy for teaching science online of prospective science teachers who perceive their education technology course(s) as not useful?

Study Importance

- The possibility of teacher preparation programs' benefiting from using the developed self-efficacy scale for teaching science online in evaluating student teachers' belief in their ability to teach online.
- The present study is a response to the current national and international circumstances/trends, which require teachers to be prepared for distance teaching.
- The findings of the present study imply an evaluation of the current technological preparation of prospective science teachers in one of the faculties of education in Egypt.

Study Limits

The present study was limited to:

- Applying the developed questionnaire designed by the authors.
- The participants consisted of (N = 253) prospective science teachers from the Primary Education Division (PED) (n = 108) and General Education Division (GED) (n= 145) who graduated from Beni-Suef University in August 2020. Table (1) provides a description of the study participants:

Table (1):
Characteristics of the Study Participants

Number of Teachers	Primary Education Division Teachers	General Education Division Teachers			Gender[3]
		Physics	Chemistry	Biology	
71	23	15	20	13	Male
182	85	6	42	49	Female
253	108	21	62	62	Number of Teachers

- The teachers' level of self-efficacy for teaching science online was categorized into the following five sets :
- Very low level of self-efficacy= 0 to less than 30%
- Low level of self-efficacy= 30% to less than 50%
- Moderate level of self-efficacy= 50% to less than 70%
- High level of self-efficacy= 70% to less than 90%
- Very high level of self-efficacy= 90% to 100%

Study Hypotheses

The main hypotheses regarding prospective science teachers' self-efficacy for teaching science online are:

1. Prospective science teachers have a low level of self-efficacy for teaching science online.
2. There are no statistically significant differences (*p*= or <0.05) between the mean scores of the prospective Primary Education Division science teachers and prospective General Education Division science teachers in the Self-efficacy Scale for Teaching Science Online.
3. There is a significant correlation (*p*= or <0.05) between the prospective science teachers' perceived usefulness of their education technology course(s) and their self-efficacy for teaching science online.

[3] As the number of males did not exceed 29 % of the study group size, gender was not taken into consideration in the statistical treatment and, in turn, in explaining the study findings.

Study Methodology

The current study employed a descriptive and analytical approach to study the concept of self-efficacy for teaching science online and identified the most important dimensions suited for the study context. A descriptive approach was also used to investigate teachers' level of self-efficacy for teaching science online by applying the designed questionnaire online.

Study Tools

- Online questionnaire aims at measuring prospective science teachers' level of self-efficacy for online teaching.

Study Procedures

- Based on a literature review pertaining to self-efficacy for online teaching, such as Kiray (2016), Gudnundsdottir *et al*. (2020), and Kennedy and Archambault (2012), a questionnaire was designed. The internal validity, which refers to how accurately the measures obtained from the research were actually quantifying what the questionnaire was designed to measure, was established though an expert panel (Appendix 1) who investigated the theoretical construct of the questionnaire. The questionnaire was developed according to their suggestions.
- The questionnaire reliability was also measured through a pilot study consisting of (47) prospective science teachers (19 PEDts and 28 GEDts) who were not from the study sample. As shown in Table (2), the measured value of Alpha for each dimension of the scale was greater than (0.5), which indicates that the scale is reliable.

Table (2):
Scale Reliability

Self-efficacy for Using Online Technology		Self-efficacy for Using Online Pedagogy		Self-efficacy for Managing Online Behaviour		Self-efficacy for Identifying Online Science Content	
N of Items.	Cronbach's Alpha	N of Items	Cronbach's Alpha	N of Items	Cronbach's Alpha	N Of Items	Cronbach's Alpha
13	0.889	12	0.935	9	0.844	10	0.797

- The final form of the questionnaire (Appendix 2) consisted of two parts. The first part of the questionnaire consisted of four questions pertaining to: gender, education division, science specialization, and their perceptions of the impact the education technology courses had on developing their online science teaching skills. The second part of the questionnaire consisted of a Self-efficacy for Online Teaching Scale, which included a five-point Likert-scale that aimed to measure the prospective science teachers' self-efficacy for teaching science online. The scale consisted of (44) phrases belonging to four dimensions of skills: using online technology (13 items), using online science pedagogy (12 items), managing online behaviour (9 items), and identifying online science content (10 items). For each item participants were required to rate the degree to which they believed that they could accomplish a task: 1. I can't do that; 2. I have some ability to do that; 3. I have moderate ability to do that; 4. I can do this well; 5. I can do this extremely well.

- The questionnaire was administered online to the study sample (253) prospective science teachers) via SurveyPlanet in September 2020. By using the SPSS program, the data were statistically treated, where the means, minimum and maximum scores, and percentages were calculated.
- In light of the present study limits, the findings were interpreted and some implications and future research were suggested.

Study Terminologies

Prospective Science Teachers: Prospective science teachers refer to individuals enrolled in a teacher education program, who are working towards a specialization in teaching science.

In the present study, **the procedural definition** of prospective science teachers is individuals enrolled in Primary and General Education Divisions who have a specialization in teaching science and graduated in 2020.

Level of Self-efficacy for Teaching Science Online:

Lippek (2020) defines self-efficacy as the belief in one's own competences in the face of impediments. Corry and Stella (2018) also define teacher's self-efficacy as a measure of the teacher's belief that he/she can affect student success.

Based on these definitions of self-efficacy, prospective science teachers' self-efficacy for teaching science online refers to prospective science teacher's belief in their ability to successfully teach science online in face of impediments.

Prospective science teachers' self-efficacy for teaching science online **procedural definition** in the present study is the ability of the prospective science teachers in the Primary and General Education Divisions to reach a specific score when they respond to a scale prepared for this purpose. Consequently, the level of self-efficacy for teaching science online is determined in the present study by calculating the percentage of the prospective science teacher's mean score in the prepared scale.

Theoretical Framework

Teachers' Self-Efficacy

Throughout both the Primary Education Division and the General Education Division, one of the main purposes of the divisions is to develop prospective science teachers' self-efficacy for teaching. Self-efficacy stems from social cognitive theory and is an individual's belief that they are capable of successfully performing a task (Bandura, 1977; Menon, 2020). According to Bandura (1995) self-efficacy refers to "beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations. Efficacy beliefs influence how people think, feel, motivate themselves, and act" (p. 2). The higher degree of self-efficacy that an individual has, the more likely they are to put forth the effort to initiate a task and persist with the task when faced with obstacles and adverse situations (Bandura, 1977; Mannila *et al*., 2018; Menon, 2020). For the purpose of the current study self-efficacy for online teaching is defined as prospective teachers' beliefs about their competences to teach science online.

Teaching self-efficacy is a teacher's belief in their ability to plan, organize, identify content, teaching methods and tools required to successfully execute a learning process (Didem, 2018; Menon, 2020). When a teacher has high self-efficacy for teaching, they are more likely to identify stronger learning outcomes and improve student learning, than teachers with low self-efficacy (Didem, 2018). Teachers with high levels of self-efficacy have a strong influence on student achievement because the teacher is more likely to learn and implement new teaching approaches and strategies, use positive classroom management strategies, set attainable goals for their students, and persist when their students are facing difficulty or failure (Hoy & Spero, 2005; Tschannen-Moran & Hoy, 2001). Overall, having a high sense of self-efficacy is as important as possessing general teaching skills (Mannila *et al*., 2018).

Developing Prospective Science Teachers' Self-Efficacy for Teaching Science Online

Prospective science teachers' self-efficacy for teaching science online can be developed through four methods (Bandura 1977; Hoy & Spero, 2005; Menon, 2020). First, self-efficacy for teaching science online can be developed through mastery experiences. Mastery experiences refer to authentic classroom teaching experiences, such as a teaching practicum, that enables a prospective teacher to gain confidence in teaching science and experience success as a science teacher (Menon, 2020). In terms of teaching science online, prospective teachers should be provided mastery experiences that target online teaching. Online teaching practicums would provide prospective teachers with the opportunity to move beyond passively watching their professors and/or mentor teachers using technology to being actively engaged with the technology (Tondeur, 2018). Through active engagement prospective teachers can use their experience to gage their ability and thereby increase their confidence.

Second, verbal persuasion provided through positive constructive feedback from mentor teachers, professors, peers and students will assist in building prospective teachers' self-efficacy for teaching science online (Menon, 2020). By providing prospective teachers with the opportunity to discuss and reflect on their experiences with technology it may help prospective teachers recognize the value of technology as well as the benefit of assuming the risk associated with technology integration (Tondeur, 2018).

Third, prospective teachers should be provided with vicarious experiences. Vicarious experiences enable self-efficacy to increase through witnessing others successfully complete a task. Tondeur (2018) stresses the importance of teacher educators acting as a role models for integrating technology. Vicarious experiences can be created by providing prospective teachers with the opportunity to observe their professors and mentor teachers instructing science online (Ebersole, 2019).

Finally, the physiological and affective state of the prospective teacher will affect their ability to handle psychological and emotional impact associated with teaching science online. That is, the less stress and anxiety the prospective teacher experiences, the greater confidence and self-efficacy the prospective teacher will have (Menon, 2020). By providing prospective teachers with the opportunity to collaborate with designing and implementing technology related curriculum materials their feelings of insecurity may decrease (Tondeur, 2018).

Prospective science teachers' self-efficacy for teaching online may be affected by the nuances of their training program; specifically, courses pertaining to technology and observing their professors and mentor teachers' online praxis (Cooper *et al*. 2020; Ottenbreit-Leftwich *et al*., 2018a; Tondeur, 2018). Making self-contained technology courses mandatory for prospective teachers may not be sufficient for preparing them to teach online (Cooper *et al*., 2020; Tondeur, 2018) as the prospective teachers are not provided with an opportunity to observe faculty and mentor teachers' resilience when encountering technological challenges (Ertmer, 2005). Although teachers who lack knowledge or positive attitudes towards technology are less likely to integrate technology into their teaching praxis they will integrate technology if they have positive beliefs about the benefits of technology (Ottenbreit-Leftwich *et al*. 2018b).

As shown in Figure (1) (Koehler & Mishra, 2009, p. 63), TPACK, is the intersection and synthesis of technological knowledge, pedagogical knowledge, and content knowledge (Sensoy & Yildirm, 2018). The key element of TPACK is that pedagogy, content knowledge and technological knowledge cannot be viewed as separate entities, but rather all three components must be viewed as being seamlessly integrated (Mishra & Koehler, 2006). To understand the intersectionality of the TPACK an examination of each component is required.

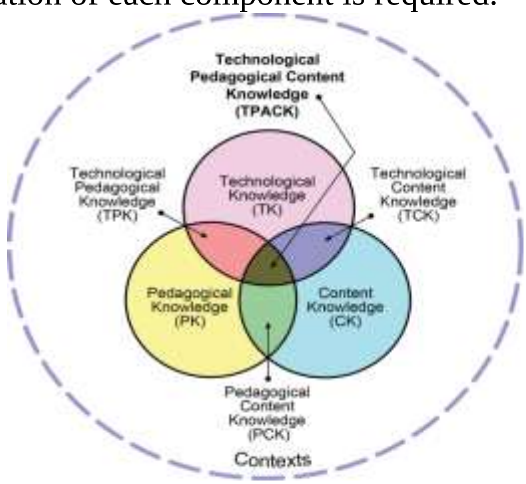

Figure (1): TPACK (Koehler & Mishra, 2009)

Pedagogical knowledge (PK) is the *how* of teaching and refers to how a teacher approaches teaching and learning. Specifically, pedagogical knowledge "is the set of skills that teachers must develop in order to manage and organize teaching and learning activities for intended learning comes" (Koehler *et al*. 2013, p 3). A teacher's pedagogical knowledge includes their understanding of assessment, classroom management, lesson planning, and how students learn (Basaran, 2020).

Content knowledge is the *what* of teaching and refers to the knowledge associated with a particular discipline or subject (Shulman, 1986; Koehler *et al*. 2013). Content knowledge includes a teacher's knowledge about the realities, concepts, theories, laws, organizational frameworks, evidence, application, and construction of knowledge (Basaran, 2020). When pedagogical knowledge and content knowledge intersect (PCK) it enables teachers to successfully develop, organize and integrate curricula. Prior to the integration of technology into the education setting PCK was considered the essential skills of a good teacher (Shulman, 1986).

As technology use increases within the classroom setting, technological knowledge has become essential for teachers. Technological Knowledge (TK) pertains to a teacher's ability to use software, hardware, presentation tools, and the teacher's knowledge of how to learn new technologies and integrate technology into the teaching-learning process (Basaran, 2020; Koehler *et al*. 2013). In other words, teachers must not only know how to use technology, but also be able to identify when and what type of technology must be used to reach a learning objective. When technological knowledge intersects with content knowledge (TCK) an understanding of how technology and the subject content matter influence each other is formed (Basaran, 2020). Without TCK a teacher is less likely to understand how to develop content knowledge through the application of technology (Basaran, 2020).

Basaran (2020) found that to develop prospective teachers' self-efficacy for technology, technological knowledge should be combined with pedagogical knowledge. When technological knowledge intersects with pedagogical knowledge (TPK) it enables a teacher to understand how teaching and learning are influenced by technology without being bound by a specific subject area (Basaran, 2020; Wright & Akgunduz, 2018). However, when technological knowledge, pedagogical knowledge and content knowledge (TPACK) all intersect it enables a teacher to understand "how to use technology to facilitate learning and to cope with problems that students face especially in learning complicated concepts" (Basaran, 2020, p. 86). Teachers who have strong TPACK restrain from applying a single technological tool to all situations. Rather, teachers with strong TPACK are able to select the appropriate technological tool based on their analysis of the content matter and pedagogical approach. However, for TPACK to be successful, teacher educators must be provided with not only technology training, but also training for modeling and facilitating technology integration (Tondeur, 2018).

Overall, past research suggests that for teachers to successfully teach online a strong self-efficacy in digital competence is necessary (Mannila *et al*. 2018). Two of the major barriers that prevent teachers from integrating technology in their classrooms are knowledge of technology and self-efficacy for using technology (Ottenbreit-Leftwich, Liao *et al*. 2018). Teachers' self-efficacy in digital competence affects teachers' attitude and how teachers integrate technologies in their lessons (Dong *et al*., 2019). Furthermore, strengthening prospective teachers' self-efficacy beliefs about technology results in a more positive attitude towards integrating technology in teachers' lessons and praxis.

The majority of past research has focused on the use of technology in the classroom. There is very limited research on preparing prospective teachers to teach subject matter online via the Internet. The relationship between prospective teachers' self-efficacy for teaching science via the Internet and technological knowledge has not been extensively examined.

Study Findings

First Hypothesis

The first hypothesis states that "prospective science teachers have a low level of self-efficacy for teaching science online". A self-efficacy level for teaching science online was calculated as follows:

- The teacher's numeric responses to the (44) questions in Part II of the questionnaire were added and divided by the maximum score of the scale (i.e., 176).
- The teacher's level of self-efficacy for teaching science online was calculated by multiplying the previous result by (100).

- The same mathematical calculations were applied to the four dimensions of the scale.

Table (3) shows the teachers' mean level of self-efficacy for teaching science online, minimum, maximum and mean scores in overall scale.

Table (3):
Prospective Science Teachers' Level of Self-Efficacy for Teaching Science Online

Dimension of skills	Max Score	Min score	Mean score	The number of teachers in every self-efficacy category					Teachers' Mean Level of Self-efficacy for this Dimension
				Very Low Level of Self-efficacy	Low Level of Self-efficacy	Moderate Level of Self-efficacy	High Level of Self-efficacy	Very High Level of Self-efficacy	
Overall Teaching Science Online	129	3	27.482	234 (92.49%)	14	4	1	0	15.615%
Using Online Technology	32	0	2.296	241 (95.26%)	8	4	0	0	4.415%
Using Online science pedagogy	0	35	2.296	242 (95. 65%)	8	2	1	0	5.46%
Managing Online Behaviour	0	24	2.079	240 (94.86%)	12	1	0	0	5.775%
Identifying Online Science Content	2	39	20.486	17	89	128 (50.593%)	7	2	51.215%

According to Table (3), the majority of the prospective teachers (92.49%) had a very low level of self-efficacy for teaching science online and their mean level of self-efficacy for teaching science online was (15.615%). The finding indicates that they believed that they were incompetent to teach science online. Therefore, the first hypothesis is accepted, which agrees with Hussein's (2020) study that indicated that BSU students lacked the technology skills required for e-learning.

As the designed scale consisted of four dimensions, it was considerable to investigate teachers' self-efficacy for every dimension of teaching science online. Table (4) shows teachers' mean level of self-efficacy for these dimensions and the number of teachers in every self-efficacy level.

Table (4):
Prospective Science Teachers' Level of Self-efficacy for Every Dimension of Teaching Science Online

Dimension of Skills	Max Score	Min Score	Mean Score	The Number Of Teachers In Every Self-Efficacy Category					Teachers' Mean Level of Self-efficacy for this Dimension
				Very Low Level of Self-efficacy	Low Level of Self-efficacy	Moderate Level of Self-efficacy	High Level of Self-efficacy	Very High Level of Self-efficacy	
Using Online Technology	32	0	2.296	241 (95.26%)	8	4	0	0	4.415%
Using Online Science Pedagogy	0	35	2.296	242 (95. 65%)	8	2	1	0	5.46%
Managing Online Behaviour	0	24	2.079	240 (94.86%)	12	1	0	0	5.775%
Identifying Online Science Content	2	39	20.486	17	89	128 (50.593%)	7	2	51.215%

Self-efficacy for using online technology refers to prospective teachers' belief in their ability to use online technology. The first (13) questions of the Self-efficacy for Online Science Teaching Scale pertained to this dimension. From Table (4), only four prospective science teachers had a moderate level of self-efficacy for using online technology and eight teachers had a low level. The majority of prospective science teachers (95.26%) had a very low level (4.415%) of self-efficacy for using online technology. This result indicates that the prospective science teachers in the present study believed they were incapable of using the online technology skills required to teach science online.

Self-efficacy for using online pedagogy refers to the prospective teachers' belief in their ability to apply appropriate online teaching methodologies. Questions (14–25) of the Self-efficacy Scale for Teaching Science Online pertained to this dimension.

As indicated in Table (4), only one prospective science teacher had a high level of self-efficacy for using online science pedagogy, two teachers had a moderate level and eight had a low level. It is also shown that the majority of prospective science teachers, (95.65%), had a very low level, (5.46%) of self-efficacy for using online science pedagogy.

Self-efficacy for managing online behaviour refers to the prospective teachers' belief in their ability to address their students' behaviour in an online environment. Questions (26-34) of the Self-efficacy Scale for Teaching Science Online pertained to this dimension. According to Table (4), (94.86%) of the prospective science teachers had a very low level (5.775%) of self-efficacy for managing online behaviour. In other words, they did not believe in their ability to manage their students' behaviour in an online environment.

Self-efficacy for identifying online science content refers to prospective science teachers' belief in their ability to identify and critically analyze online science content that can be incorporated into their online lessons. Questions (35-44) of the Self-efficacy for Online Science Teaching Scale pertain to this dimension. As shown in Table (4), in contrast to the previous three dimensions there is a difference in the distribution in the number of prospective science teachers in the five levels of self-efficacy for identifying online science content. The majority of the teachers (50.593%) had a moderate level of self-efficacy for identifying online science content. This result indicates that although the teachers have a moderate level of self-efficacy for identifying online science content, the teachers have very low level of self-efficacy for using online technology, using online science pedagogy and managing online behavior results in their very low level of overall self-efficacy for teaching science online. This result also indicates that these dimensions are integrated and work together so that the teacher is competent of teaching science online.

Second Hypothesis: The second hypothesis states that "There are no statistically significant differences (*p*= or <0.05) between the mean scores of the prospective Primary Education Division science teachers and prospective General Education Division science teachers in the Self-efficacy Scale for Teaching Science Online." To investigate hypothesis 2, the data resulting from the application of the scale was examined based on the prospective teachers' division and analyzed using T-test, as shown in Table (5).

Table (5):
T-test for prospective science teachers' mean difference in self-efficacy for teaching science online

Dimension	Mean Score		T-test for Equality of Means				
	PEDts	GEDts	Mean Difference	df	Sig. (2-tailed)	t	Std. Error Difference
Overall Self-efficacy for Teaching Science Online	**30.206**	**25.448**	**4.758**	**251**	**0.022**	**2.298**	**2.073**

According to Table (5), the mean difference in the self-efficacy for teaching science online between PEDts and GEDts was (4.758) and *SD* = 2.073. The value of t (2.298) was significant, at significance level (p <0.05). This finding shows that prospective Primary Education Division teachers have higher self-efficacy for teaching science online than prospective General Education Division teachers in self-efficacy for teaching science online. Therefore, the second hypothesis is rejected.

To investigate the mean difference in the teachers' self-efficacy for every dimension of teaching science online, T-test was run as shown in Table (6).

Table (6)
T-test for Prospective Science Teachers' Mean Difference in Self-efficacy for Every Dimension of Teaching Science Online

Dimension	Mean Score		T-test for Equality of Means				
	PEDts	GEDts	Mean Difference	df	Sig. (2-tailed)	t	Std. Error Difference
Self-efficacy for Using Online Technology	4.245	0.838	3.407	251	0.01	5.222	0.650
Self-efficacy for Using Online Science Pedagogy	2.907	2.407	0.50	251	0.460	0.740	0.676
Self-efficacy for Managing Online Behaviour	2.361	1.869	0.49	251	0.308	1.022	0.481
Self-efficacy for Identifying Online Science Content	20.704	20.324	0.38	251	0.593	0.536	0.708
Overall Self-efficacy for Teaching Science Online	30.206	25.448	4.758	251	0.022	2.298	2.073

Table (6) shows that the mean difference between PEDts' and GEDts' self-efficacy for using online technology was (3.407) and (*SD* = 2.073), with a significant value of t (5.222), at significance level (p <0.05). This indicates that prospective Primary Education Division teachers had a higher level of self-efficacy for using online technology for teaching science online than prospective General Education Division teachers.

From Table (6), the mean difference between the PEDts' and GEDts' self-efficacy for using online science pedagogy was (0.50) with a *SD* =0.676. The value of t (0.740) was insignificant, at significance level (p >0.05). This finding indicates that prospective science teachers' self-efficacy for using online science pedagogy did not vary based on the division.

According to Table (6), the mean difference between PEDts' and GEDts' self-efficacy for managing online behaviour was (0.492) with a *SD* =0.481. The value of t (1.022) was insignificant at significance level (p >0.05). This finding indicates that prospective science teachers' self-efficacy for managing online behaviour did not vary based on teachers' division.

Table (6) shows that the mean difference between PEDts' and GEDts' self-efficacy for identifying online science content was (0.38) and *SD* =0.708. The value of t (0.536) was insignificant, at significance level (p >0.05). This result indicates that prospective science teachers' self-efficacy for identifying online science content required for teaching science online did not vary based on the prospective teachers' division.

Hypothesis 3: Hypothesis 3 states that "there is a statistically significant correlation (p= or <0.05) between the prospective science teachers' perceived usefulness of their education technology course(s) and their self-efficacy for teaching science online." To examine the difference between the participants' perceived usefulness of education technology courses and their self-efficacy for teaching science online the prospective teachers were asked whether they thought the education technology course(s) that they studied during their preparation was/were useful regarding developing online science teaching skills. According to their perceptions, they were divided into two groups, those who perceived the course(s) as useful and those who viewed the course(s) as not useful. T-test was calculated to investigate the difference between the prospective teachers' mean scores in each dimension of online teaching skills, as shown in Table (7).

Table (7):
T-test for the Difference between Prospective Science Teachers' Mean Scores Of Self-Efficacy for Teaching Science Online According to their Perceptions of Education Technology Course(S) Usefulness

Teachers' Self-Efficacy	T-test for Equality of Means				
	Mean Difference	df	Sig. (2-tailed)	t	Std. Error Difference
Self-efficacy for Using Online Technology	0.558	251	0.672	0.424	1.316
Self-efficacy for Using Online Science Pedagogy	1.206	251	0.354	0.928	1.300
Self-efficacy for Managing Online Behaviour	0.683	251	0.462	0.737	0.927
Self-efficacy for Identifying Online Science Content	0.344	251	0.801	0.252	1.363
Overall Self-efficacy for Teaching Science Online	2.792	251	0.489	0.693	4.027

According to Table (7), all values of t (0.424, 0.928, 0.737, 0.252, and 0.693) were insignificant (*p* >0.05). This finding indicates that prospective teachers' perceptions of the usefulness of the education technology course(s) studied during their preparation neither affected their overall self-efficacy for teaching science online nor its four dimensions.

To investigate the correlation between the teachers' level of self-efficacy for teaching science online and their perceptions of the education technology course(s) they studied at the university, Pearson Correlation Bivariate was calculated as shown in Table (8).

Table (8)

Correlation between the Prospective Science Teachers' Perceived Usefulness of their Education Technology Course(S) and their Self-Efficacy for Teaching Science Online

Dimension		Correlation between the Prospective Science Teachers' Perceived Usefulness of their Education Technology Course(s) and their Self-efficacy for Teaching Science Online
Self-efficacy for Using Online Technology	Correlation	-.027-
	Sig. (2-Tailed)	.672
	N	253
Self-efficacy for Using Online Science Pedagogy	Correlation	-.058-
	Sig. (2-Tailed)	.354
	N	253
Self-Efficacy for Managing Online Behaviour	Correlation	-.046-
	Sig. (2-Tailed)	.462
	N	253
Self-efficacy for Identifying Online Science Content	Correlation	-.016-
	Sig. (2-Tailed)	.801
	N	253
Self-efficacy for Teaching Science Online	Correlation	-.044-
	Sig. (2-Tailed)	.489
	N	253

From Table (8), the value of Pearson Correlation Bivariate between the prospective science teachers' perceived usefulness of their education technology course(s) and their self-efficacy for teaching science online was (-.044), which is low, negative and statistically insignificant (*p* >0.05). In addition, the values of Pearson Correlation Bivariate between the prospective science teachers' perceived usefulness of their education technology course(s) and the four dimensions of their self-efficacy for teaching science online, online use skills, online science pedagogy, online behaviour management, and online science content, were: (-.027, -.058, -.046, and -.016) respectively, which are low, negative and statistically insignificant (*p* >0.05).. All these values indicate that there is no significant correlation (*p* >0.05) between the prospective science teachers' perceived usefulness of their education technology course(s) and their self-efficacy for teaching science online. Consequently, the third hypothesis is rejected.

Discussion

Around the world, online teaching has become an important aspect of teaching, especially with the invasiveness of Covid-19. Due to Covid-19 teachers have been required to use online educational platforms to ensure the continuance of their students' education. The current study investigated Egyptian prospective science teachers' levels of self-efficacy for teaching science online. The majority of Egyptian prospective science teachers are digital natives. Digital natives are individuals who were born in the 1990s and grow-up surround by and using technology (Qoura, 2020). Since digital natives have grown up with technology integrated into all aspects of their lives, it has been assumed that they will easily and confidently integrate technology into their teaching practice. However, self-efficacy is context dependent (E-Deghaidy, 2006) therefore, as indicated by the current study's findings, being a digital native does not equate to having confidence for teaching science online. While digital natives may have high self-efficacy for using technology in their daily lives (e.g., reading online, texting, Google searches etc.), teacher training programs must consider developing prospective teachers' self-efficacy for teaching science online in conjunction with their general teaching skills and technology skills.

The descriptive statistics showed that the prospective science teachers in this study had very low levels of self-efficacy for teaching science online particularly with regard to using Internet skills, online science pedagogical knowledge, and behavioral management skills. The prospective science teachers only had a moderate level of self-efficacy for identifying and selecting online science content. Although the prospective Primary Education Division science teachers' level of self-efficacy for teaching science online was higher than the prospective General Education Division science teachers' level of self-efficacy, both groups believed that they lack the ability to teach science online.

By investigating the prospective science teachers' responses to every statement in the scale, similarities were found in their responses. For example, the descriptive statistics showed that for using online technology skills, 220 teachers (86.96 %) believed that they could not use the online test feature of a learning platform to create and mark science tests, which comes with the line of Emam's study (2015). Furthermore, (250) prospective science teachers (98.8 %) did not believe that they could deliver an online science lesson that presents science knowledge in a manner that is more in-depth than can be presented in a regular science classroom. Only half of the prospective science teachers (50.2 %) believed that they had some ability to identify online science content that is linguistically sound. In addition, (251) teachers (99.2 %) also believed that they could not implement a variety of behavior management strategies. All these responses reflect the validity of the study results which in turn indicate a limitation in the prospective science teachers' preparation for online science teaching. That is, the prospective science teachers have a low level of self-efficacy for online science teaching.

As there is a direct connection between a teacher's level of self-efficacy and student achievement (Hoy & Spero, 2005; Tschannen-Moran & Hoy, 2001), the prospective teachers' low self-efficacy for teaching online has important implications for their future students. The indication that Egyptian prospective science teachers have low self-efficacy for teaching science online suggests that when teaching online, they will be less likely to persist when faced with the obstacles and adverse situations that accompany teaching online (Bandura, 1977; Mannila *et al.*, 2018; Menon, 2020). In addition, when a teacher has low self-efficacy for teaching science online, they are more likely to have difficulty identifying learning outcomes and providing support for their students. (Didem, 2018). Therefore, to ensure that prospective science teachers are prepared to teach online, equal consideration must be given to developing self-efficacy as to pedagogical, content, and technological knowledge.

As per self-efficacy theory, prospective science teachers can develop their self-efficacy through vicarious experiences, verbal persuasion, and mastery experiences (Memon, 2020; Tondeur, 2018). Based on the findings of the current study, although the participants were provided with the vicarious experience of observing their professors teach science online it was not sufficient for developing the prospective science teachers' self-efficacy for teaching science online. In order for vicarious experiences to successfully increase a prospective science teacher's self-efficacy for teaching science online, they should have the opportunity to observe their mentor teachers and their peers teach science online. Furthermore, for the observation and participation in online learning to influence prospective science teachers' self-efficacy for teaching science online, their professors would need to explicitly explain the pedagogical choices they made and discuss the technological challenges they encounter and overcame. Such explanations may have verbally persuaded the prospective teachers' that they too could successfully teach science online.

In addition, even though the prospective teachers completed education technology courses and were provided with an opportunity to master the technology skills that they were taught, there was not a specific connection between the learning of the technological skills, pedagogy and subject content. As demonstrated by the current findings, without being provided with an opportunity to experience success integrating technology, pedagogy, and subject content into an online teaching platform, the prospective science teachers were unable to develop self-efficacy for teaching science online.

Although the prospective science teachers in this study obtained technological knowledge through one or more education technology courses, the vast majority of prospective science teachers did not believe that the course(s) prepared them to teach science online. The prospective PED science teachers, who are required to take two technology courses, had a higher level of self-efficacy for teaching science online and for Internet use skills than the prospective GED science teachers who only had one education technology course. This indicates that increasing the number of education technology courses in PED did not guarantee an increase in self-efficacy across all dimensions of teaching science online.

The findings also indicated that regardless of whether the participants perceived the technology course(s) as useful or not useful, they all had a very low level of self-efficacy for online science teaching. The only area in which the prospective science teachers reported a moderate level of self-efficacy was for identifying and selecting online science content. The moderate level of self-efficacy for identifying and selecting online science content may be attributed to the availability of online instructional resources for the Egyptian science curricula at all educational levels, such as the Egyptian Knowledge Bank, YouTube, forums, etc. In addition, the prospective science teachers may have moderate levels of self-efficacy for identifying and selecting online science content because they may have been able to connect the online science content to the content training they received during their science teacher training. The connection between technological knowledge and content knowledge (TCK) suggests that the participants may have an understanding of how technology and the subject content matter influence each other (Basaran, 2020). However, the low level of self-efficacy in the other areas pertaining to teaching science online(e.g., behaviour management, pedagogy) suggests that the prospective science teachers may view technology as a tool to support, enhance and complement existing classroom practices rather than perceiving technology as a means to reshape subject content, goals and pedagogies (Dong *et al*., 2019; Savec, 2017).

Overall, like E-Deghaidy's (2006) research, in order to teach science effectively online prospective teachers' confidence for teaching science online must be based on high self-efficacy. The findings from the current study support the need for teacher training programs to utilize a TPACK framework to prepare prospective teachers to teach science online. Although the participants did have some technology knowledge from their technology course(s) and, due to Covid-19, were being instructed online, the online did not believe that they were able to identify when and what technology to use to reach a learning objective (Basaran, 2020). The findings suggest that prospective teachers require direct instruction regarding how to select the appropriate technological tool based on an analysis of the science content matter and pedagogical approach (Basaran, 2020). Furthermore, prospective teachers should not be taught about technology in an isolated course, rather they should be taught and modeled on how to integrate technology within the teaching process and content matter. Furthermore, when prospective teachers are provided with the opportunity to have authentic experiences and internships that integrate technology, it increases the prospective teachers' willingness to use technology (Ottenbreit-Leftwich, Liao *et al.*, 2018). Therefore, through the use of TPACK it will enable prospective teachers to understand how to use technology to facilitate the learning of scientific content and to be able to address the challenges students encounter when learning complicated concepts online (Basaran, 2020).

Implications

Based on the findings of the current study the following recommendations are suggested:

- Education technology courses should address how to identify and use technology that is appropriate for teaching science online.
- Science professors should integrate a variety of online technology into their lectures, thereby enabling a TPACK framework to occur.
- Teacher preparation programs should give equal consideration to developing prospective teachers' self-efficacy as to pedagogical, content, and technological knowledge.
- Prospective science teachers should be provided with the opportunity to practise online teaching.
- Cooperation between the Ministry of Education in Egypt and faculties of education is required to ensure that prospective teachers are aware of updated teaching requirements regarding the integration of technology in subject classes.

Suggested Future Studies

- An examination of how prospective teachers' perception of online teaching influences their online teaching praxis.
- An examination of how prospective teachers' attitudes towards teaching online influences their online teaching praxis.
- A pre- and post- examination of how the use of a TPACK framework influences prospective teacher's self-efficacy for online science teaching.

References

Aktağ, I., & Tuzcuoğlu, S. (2016). Turkish students' computer self-efficacy from colleges of physical education and sports. *International Journal of Human Sciences, 13*(1), 1770-1779. https://doi.org/10.14687/ijhs.v13i1.3606.

Atabek, O. (2020). Associations between emotional states, self-efficacy for and attitude towards using educational technology. *International Journal of Progressive Education, 16*(2), 175-194. https://doi.org/10.29329/ijpe.2020.241.12

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191-215.

Bandura, A. (1995). *Self-efficacy in Changing Societies.* Cambridge University Press.

Basaran, B. (2020). Examining preservice teachers' TPACK-21 efficacies with clustering analysis in terms of certain variables. *Malaysian Online Journal of Educational Technology, 8*(3), 84-99. https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=EJ1260149

Boghdady, M. M. (2020).The differences in the attitudes of students at the Faculty of Education, Beni-Suef University, towards distance, traditional and hybrid education in light of the Corona pandemic, *Paper presented at The International Conference with Cooperation between Thebes Integrated Academy for Science and Technology and Arab Society for Measurement and Evaluation 'electronic tests in the light of distance education'*, 3-4 Oct., Egypt.

Cantabrana, J. L. L., Rodríguez, M. U., &, Cervera, M. G. (2019). Assessing teacher digital competence: The construction of an instrument for measuring the knowledge of pre-service teachers. *Journal of New Approaches in Educational Research, 8*(1), https://doi.org/10.7821/naer.2019.1.370

Cooper, R., Warren, L., Hogan-Chapman, A., and Mills, L. (2020). Pre-service teachers and their self-efficacy toward online teaching. *SRATE Journal*, *29*(2), 1-7. https://eric.ed.gov/?id=EJ1268635

Corry, M. & Stella, J. (2018). Teacher self-efficacy in online education: a review of the literature. *Research in Learning Technology*, *26*. https://doi.org/10.25304/rlt.v26.2047

Didem, I. E. (2018). Development of pre-service teachers' teaching self-efficacy beliefs through an online community. *Asia Pacific Education Review*, *19*(1), 27-40. https://doi.org/1001007/s12564-017-9511-8

Dong, Y., Xu, Chang, Chai, C. S., Zhai, X. (2020). Exploring the structural relationship among teachers' technostress, technological pedagogical content knowledge (TPACK), computer self-efficacy and school support. *Asia-Pacific Edu Res, 29*(2), 147-157. https://doi.org/10.1007/s40299-019-00461-5

Ebersole, L. (2019). Preservice teacher experience with technology integration: How the preservice teacher's efficacy in technology integration is impacted by the context of preservice teacher education program. *International Dialogues on Education, 6*(2), 124-138.

El-Deghaidy, H. (2006). An investigation of pre-service teacher's self-efficacy and self-image as a science teacher in Egypt. *Asia-Pacific Forum on Science Learning and Teaching, 7*(2), 1-22. http://www.ied.edu.hk/apfslt/download/v7_issue2_files/heba.pdf

Emam, S. S. M. (2015). The Effectiveness of Design an Interactive E-Book Based on Web "2.0" Applications for the Development of Design Skills for E-Tests for Students of the Faculty of Education. *Egyptian Society for Education Technology*, 25(3), 259 – 316.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development, 53*(4), 25–40. https://doi.org/10.1007/BF02504683

European Commission. (2018). *Proposal for a council recommendation on key competences for lifelong learning*. https://ec.europa.eu/education/sites/education/files/annex-recommendation-key-compentences-life-long-learning.pdf

Gudmundsdottir, G. B., Gassó, H. H., Rubio, J. C. C., & Hatlevik, O. E. (2020). *Student teachers' responsible use of ICT: Examining two samples in Spain and Norway.* Computers & Education, 152, 1-11. https://doi.org/10.1016/j.compedu.2020.103877

Hoy, A. W, & Spero, R. B. (2005). Changes in teacher efficacy during early years of teaching: A comparison of four measures. Teaching and Teacher Education. 21, 343-356. https://doi.org/10.1016/j.tate.2005.01.007

Hussein, M. H. S. (2020). Beni-Suef University faculty members' and their assistants' attitudes towards hybrid education and electronic tests in the light of Corona pandemic. *Paper presented at The International Conference with Cooperation between Thebes Integrated Academy for Science and Technology and Arab Society for Measurement and Evaluation 'electronic tests in the light of distance education'*, 3-4 Oct., Egypt.

Kennedy, K. & Archambault, L. (2012). Offering perservice teachers field experiences in K-12 Online Learning: A national survey of teacher education programs. *Journal of Teacher Education, 63*. http://jte.sagepub.com/content/63/3/185

Kiray, S. A. (2016). Development of a TPACK self-efficacy scale for pre-service science teachers. *International Journal of Research in Education and Science, 2*(2), 527-541.

Koehler, M. J., Mishra, P., Akcaoglu, M., & Rosenberg, J. M. (2013). *The technological pedagogical content knowledge framework for* *teachers and teacher educators.* New Delhi, India: Commonwealth Educational Media Centre for Asia.

Lippke S. (2020) Self-Efficacy. In: Zeigler-Hill V., Shackelford T.K. (eds) Encyclopedia of Personality and Individual Differences. Springer, Cham. https://doi.org/10.1007/978-3-319-24612-3_1165

Mannila, L., Nordén, L. A., Pears, A. (2018). Digital competence, teacher self-efficacy and training needs. In *ICER 2018 - Proceedings of the 2018 ACM Conference on International Computing Education Research* (pp. 78-85). ACM. https://doi.org/10.1145/3230977.3230993

Menon, D. (2020). Influence of the Sources of Science Teaching Self-efficacy in Preservice Elementary Teachers' Identity Development. *Journal of Science Teacher Education, 31*(4), 460-481. https://doi.org/10.1080/1046560X.2020.1718863

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), pp. 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Ottenbreit-Leftwich, A. T., Brush, T. A., Strycker, J., Gronseth, S., Roman, T., Abaci, S. vanLeusen, P., Shin, S., Easterling, W., & Plucker, J. (2012). Preparation versus practice: How do teacher education programs and practicing teachers align in their use of technology to support teaching and learning? *Computers & Education,* 59(2), 399-411. http://dx.doi.org.roxy.nipissingu.ca/10.1016/j.compedu.2012.01.014

Ottenbreit-Leftwich, A. T., Glazewski, K. D., & Brush, T. A. (2018a). Addressing technology integration concerns: Asynchronous video mentoring between pre-service teachers and exemplary technogy-using in-service teachers. *Australasian Journal of Educational Technology*, *34*(4). 1-15. https://doi.org/10.14742/ajet.3246

Ottenbreit-Leftwich, A., Liao, J. Y., Sadik, O., & Ertmer, P. (2018b). Evolution of teachers' technology integration knowledge, beliefs, and practices: How can we support beginning teachers use of technology? *Journal of Research on Technology in Education*, *50*(4), 282-304. https://doi.org/10.1080/15391523.2018.1487350

Qoura, A. A. S. (2020). The digital teacher: Promises and challenges. *Sohag University International Journal of Educational Research, 2*, 51-64.

Savec, V. F. (2017). The opportunities and challenges for ICT in science education. *LUMAT: International Journal on Math, Science and Technology Education,* *5*(1), 12-22. https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=EJ1227614

Sensoy, O. & Yildirim, H. I. (2018). Impact of technological pedagogical content knowledge based education applications on prospective teachers' self-efficacy belief levels toward science education. *Journal of Education and Training Studies, 6*(10), https://doi.org/10.11114/jets.v6i10.3433

Shahzad, K.& Naureen, S. (2017). Impact of teacher self-efficacy on secondary school students' academic achievement. *Journal of Education and Educational Development*, 4(1), 48-72. http://dx.doi.org/10.22555/joeed.v4i1.1050

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14. http://links.jstor.org/sici?sici=0013-189X%28198602%2915%3A2%3C4%3ATWUKGI%3E2.0.CO%3B2-X

Tondeur, J. (2018). Enhancing future teachers' competencies for technology integration in education: Turning theory into practice. *International Journal of Media, Technology and Lifelong Learning, 14*(2), 216-224. https://journals.hioa.no/index.php/seminar/article/view/2981

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive

construct. Teaching and Teacher Education, 17, 783-805. https://doi.org/10.1016/S0742-051X(01)00036-1