

## Effect of Technology-Embedded Scientific Inquiry on Senior Science Student Teachers' Self-Efficacy

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# Effect of Technology-Embedded Scientific Inquiry on Senior Science Student Teachers' Self-Efficacy

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The aim of this study was to investigate the effect of technology-embedded scientific inquiry (TESI) on senior science student teachers' (SSSTs) self-efficacy. The sample consisted of 117 SSSTs (68 females and 49 males aged 21-23 years) enrolled in an Environmental Chemistry elective course. Within a quasi-experimental design, the technology-embedded scientific inquiry self-efficacy adapted from Ebenezer (2008), was used to collect data. The results revealed that the proposed TESI model was acceptable and feasible for the related context. Also, it can be deduced that interaction amongst the three hallmarks of the TESI model resulted in increasing the SSSTs' self-efficacy. A longitudinal study with the science student teachers is suggested to get more detailed information concerning applicability of the TESI model and TESI self-efficacy.

*Keywords:* environmental chemistry, student teacher, science education, self-efficacy

## INTRODUCTION

Bandura (1997) addressed self-efficacy as “judgments of how well one can execute courses of action required to deal with prospective situations” (p. 122). Phrased differently, self-efficacy involves context-specific judgments rather than decontextualised ones or simply being a generalised personality trait (Pajares, 1996). Researchers need to define “self-efficacy” accordingly. In this current study, self efficacy refers to senior science student teachers' (SSSTs') sense or confidence of future accomplishment within the TESI model (Pajares, 1996). If the SSSTs feel competent and confident on the TESI tasks, they engage and transform them into practice. Otherwise, they will tend to avoid those tasks (Pajares, 1996).

Of 'self-efficacy' studies, Yılmaz and Huyugüzel-Cavaş (2008), investigating the effect of “teaching practicum” course on pre-service primary teachers' science teaching efficacy and classroom management beliefs, reported that almost all pre-service primary

teachers had high science teaching self-efficacy beliefs. Also, they argued that the pre-service primary teachers' science teaching efficacy beliefs did not change with the “teaching practicum” experience, but their classroom management beliefs did. Similarly, Avery and Meyer (2012), who aimed to determine the impact of an inquiry-based science course on pre-service primary teachers' self-efficacy for science and science teaching, understanding of science, and willingness to teach it in their future careers, identified that the inquiry-based science course positively influenced some students' self-efficacy for science and science teaching. Likewise, Lumpe, Czerniak, Haney and Beltyukova (2012) aimed to assess the effect of a large-scale professional development programme on primary teachers' science teaching efficacy and to determine the relationship between this belief and student learning. They found that the participants displayed significant gains in their science teaching self-efficacy.

Some studies have been conducted on self-efficacy in the context of environmental education. Moseley, Reinke and Bookout (2002) investigated the effect of a 3-day outdoor environmental education programme on pre-service primary teachers' self-efficacy and reported that their self-efficacy was high before the programme and remained unchanged by their teaching experiences.

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### **State of the literature**

- The related literature points to a need for studies on environmental chemistry/environmental education and technology embedded scientific inquiry (TESI), since few studies have been carried out on the “environmental chemistry /environmental education and TESI” issues.
- Because self-efficacy is an important indicator in adapting the TESI model (e.g. Ebenezer et al., 2011, 2012) into the ‘Teaching Practicum’ course, further studies should be undertaken to investigate the possible effect of the TESI model on pre-service science teachers’ self-efficacy.

### **Contribution of this paper to the literature**

- The main contribution of this paper to the literature relates to how the TESI model influences SSSTs’ self-efficacy within the ‘Environmental Chemistry’ elective course.
- What the AMOS analysis says about model fit of the TESI model gives researchers and educators an opportunity for getting some evidence of its feasibility.
- Because the Technology-Embedded Scientific Inquiry-Classroom Observation Protocol (TESI-COP) devised by Ebenezer (2008) was adapted for use in Turkish, this present study supplies a valid and reliable TESI self-efficacy for future studies to be conducted in Turkey.

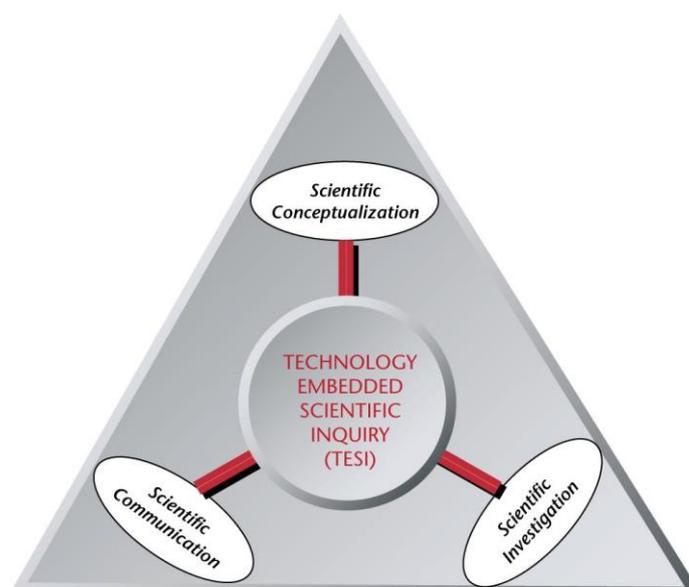
In a similar vein, Sia (1992) developed an instrument that would measure pre-service primary teachers' belief efficacy (self-efficacy and outcome efficacy) in teaching environmental education (EE), noted that “pre-service teachers would display lack of confidence in their own abilities to teach environmental education concepts (negative self-efficacy beliefs), but would show confidence that student learning in EE can be improved by effective teaching (positive outcome expectancy beliefs)”(p.1). Further, he argued that an integrated or separate course was needed to train the pre-service teachers for environmental education teaching. The aforementioned studies indicate an increased emphasis on the role of the teacher, and theoretical connections between teacher self-efficacy beliefs and classroom action. Hence, the foregoing literature calls for a need for studies on environmental chemistry/environmental education and technology-embedded scientific inquiry (TESI) since few studies have been carried out in these contexts.

Because many governments have globally made investments for adapting generic learning technologies and technological instruments in public schools (e.g., Kutluca, 2012; Özsevgeç, 2011), alternative models to

enhance teachers’ competencies of use of technology have generally been sought. For example, Turkish Ministry of National Education (TMNE) has just updated all curricula (science, mathematics, biology, physics and chemistry) based on scientific inquiry and prioritized to integrate these technologies into school subjects. In this context, the TESI model (see Figure 1) embedding technology into scientific inquiry seems to be promising to meet demands of the curricula. ‘Technology’ term in the TESI model embraces both generic learning technology (i.e. online discussion boards and TESI web-site) and technological instruments (i.e. sensors, probes, Logger-Pro software, GPS). In the view of Ebenezer, Kaya and Ebenezer (2011), the first hallmark of the TESI model, technology-embedded scientific conceptualisation, involves understanding subject matter knowledge, and testing and clarifying conceptual ideas. For example, the technology embedded scientific conceptualization affords the students to conceptualize ‘acid rain, sea acidification and pH’ concepts using Texas Instrument-84 (TI-84), Calculator-Based Laboratory (CBL) and pH sensor. The second hallmark of the TESI model, technology-embedded scientific investigation, focuses on critical abilities of students to study issues that have personal meaning, formulate researchable questions or testable hypotheses, demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment, and designing and conducting scientific investigations. For the foregoing acid case, the technology embedded scientific investigation enables the students to explore how an increase in gas emission (e.g. CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>2</sub>) impacts acid rain and sea acidification. Thereby, they are able to collect enough evidence to test their hypothesis by means of TI-84, CBL, pH sensor, GPS, CO<sub>2</sub> sensor, Logger Pro Software. The last hallmark of the TESI model, technology-embedded scientific communication, involves communicating research process, research results and knowledge claims via classroom discourse (Ebenezer et al., 2011). That is, the technology embedded scientific communication gets the students to share their results/views of acid rain and sea acidification with peers, experts and teachers through social internet networks (Facebook, MSN, twitter, discussion board etc).

To sum up, the TESI model hypothesises that students’ understanding of scientific processes is improved if these epistemological frameworks of the TESI model are developed in relevant physical, intellectual and social contexts (e.g. Ebenezer et al., 2011).

In context of the TESI model, a paper by Çalik et al. (2011) synthesising science education technology studies reported different perspectives. A few studies have embedded scientific conceptualisation into varied



**Figure 1.** TESI Model (Ebenezer, Kaya & Ebenezer, 2011, p.97)

technologies (as Technology-Embedded Scientific Conceptualization), e.g. Explanation Constructor (Sandoval & Reiser, 2003), Global Learning and Observations to Benefit the Environment (GLOBE) (Means, 1998), HyperCard Animation (Ebenezer, 2001), Handheld computers as cognitive tools (Chen, Tan, Looi, Zhang & Seow, 2008), and the data logger instrument (Ayvaci, Özseveç & Aydın, 2004). Similarly, for Technology-Embedded Scientific Investigation, several studies have integrated diverse technologies into scientific investigation areas, e.g. Web-based Inquiry Science Environment (WISE) (Linn, Clark & Slotta, 2003), Microcomputer-Based Laboratory (MBL) (Adams & Shrum, 1990), graphing technology and data collecting device (Lapp & Cyrus, 2000), Knowledge Integration Environment (KIE) (Bell & Linn, 2000), Calculator-Based Ranger Activities (CBR) (Kwon, 2002), Multi user virtual environment (MUVE) design (Nelson, Ketelhut, Clarke, Bowman & Dede, 2005), Case-based Computerized Lab (Dori & Sasson, 2008), Central Arizona-Phoenix Long-term Ecological Research (CAPLTER) (Banks, Elser & Saltz, 2005), Apprenticeship/Internship Model (Aydeniz, Baksa & Skinner, 2010; Schwartz, Lederman & Crawford, 2004), Scientific Inquiry Technologies (Friedrichsen, Munford & Orgill, 2006), Environmental Research Projects with Innovative Technology (Ebenezer et al., 2011; Ebenezer, Columbus, Kaya, Zhang & Ebenezer, 2012), subject based scientific inquiry (Reid-Griffin & Carter, 2008). As the third hallmark of the TESI model embeds various technologies into scientific communication in order to communicate and share participants' ideas with peers and experts, a few studies have been conducted on this aspect of the TESI model with different foci - higher-order thinking and discussion through the

Malaria Project with Web-based Inquiry Science Environment (WISE) (Tal & Hockberk, 2003), online discussion with the SpeakEasy in Knowledge Integration Environment (KIE) (Hoadley & Linn, 2000), WebCT Bulletin dialogues (Ebenezer, Lugo, Beiracka & Puvirajah, 2003; Liang, Ebenezer & Yost, 2010), computer-mediated epistemic dialogue (Vries, Lund & Baker, 2002) and discourse, interaction patterns and scientific reasoning complexity on constructed mental models of matter (Hogan, Loughran & Nielsen, 2010). Of these studies, Ebenezer et al. (2011, 2012) followed the entire structure of the TESI model. Ebenezer et al. (2011), following the TESI model, paid more attention to the technology-embedded scientific investigation aspect with respect to Grade 9-12 students' perceptions of their fluency with innovative technologies. Ebenezer et al. (2012) also probed a teacher and his students' innovative technology abilities as an outcome of the same project. Overall, few science education-technology studies have been conducted with pre-service and in-service teachers (e.g. Banks et al., 2005; Ebenezer et al., 2003, 2012; Friedrichsen et al., 2006; Liang et al., 2010; Schwartz et al., 2004). Although teachers are not experts in mastering scientific inquiry, science educators should recognise the importance of acquiring sufficient mastery to teach scientific inquiry in a school context (Ebenezer et al., 2011). The aforementioned issues call for a need for studies to investigate the possible effect of the TESI model on pre-service science teachers' self-efficacy within the 'Environmental Chemistry' elective course. Self-efficacy is thereby turned into an important indicator in the adaptation of the TESI model (e.g. Ebenezer et al., 2011, 2012) into 'Teaching Practicum' course.

### Aim of the study

The aim of this study was to investigate the effect of the TESI model on the SSSTs' self-efficacy.

The following research questions guided the present study:

Is there any significant difference between pre-test and post-test mean scores of SSSTs' TESI self-efficacy?

What does confirmatory factor analysis (AMOS 18.0) say about the TESI model fit based on SSSTs' self-efficacy?

### METHODOLOGY

Because the current study evaluated SSSTs' TESI self-efficacy by means of pre-test and post-test scores, the research design was quasi-experimental in nature of the 'simple casual design' type (Trochim, 2001). Such a research design may be viewed as questionably valid in that its lack of random assignments to experimental and control groups limits confidence in assigning causality to an intervention. However, Trochim (2001) sees the main validity threat as being involved in an 'experiment' (i.e., in this case a teaching intervention) that may result in an apparent improvement in self-efficacy. Since the experimental group is exposed to the teaching intervention within a significant amount of time, it is expected that the students at the experimental group routinely outperform those in the control one on the post-test scores (e.g. Çalik, Ayas & Coll, 2010; Karlı & Çalik, 2012; Sadler, 2009). For the foregoing reasons, the author preferred employing only one experimental group design without a control group.

### Sample

The sample consisted of 117 SSSTs (68 females and 49 males aged 21-23 years) enrolled in the 'Environmental Chemistry' elective course in the spring semester of the 2011-2012 academic year. Three students were eliminated because of their absence for either the pre-test or post-test. In Turkey, elementary teacher education programmes (i.e. Science Education, Mathematics Education, Social Studies Education, and Primary Teacher Education) run a four-year undergraduate program in faculty of education. For the current sample, the SSSTs took 'Special Topics in Chemistry' and 'Instructional Technologies and Material Design' compulsory courses in their third year programme, which seems to have been explicitly related to the 'Environmental Chemistry' elective course. However, they had not experienced technological tools (i.e. probes, sensors, Logger Pro software, GPS) and the TESI model. In final semester of the SSSTs, two elective courses were available: 'Environmental Chemistry' and 'Scientific Research Methods-II'.

Therein, they should have attended one of these elective courses in regard to the course content, its requirements and their interests.

### Data collection

The Technology-embedded scientific inquiry-classroom observation protocol (TESI-COP) developed by Ebenezer (2008) was used to collect data. This instrument could be used to measure both the student self-efficacy (revealing 'confident' term in the five-point Likert scale) and student classroom practice as an observation protocol (pointing to 'able' term in the five-point Likert scale) by means of a few minor revisions (Ebenezer, 2008). To adapt this instrument, the project team (two science educators with PhD degrees and five graduate students from Department of Science Education recruited as scholars for the project in regard to their compliance of the project context) firstly translated each item in Turkish and checked the translations. Then, they ensured the validity of constructs and readability (Please see the link at [http://www.academia.edu/3523840/Ozyeterlik\\_Olcegi](http://www.academia.edu/3523840/Ozyeterlik_Olcegi) for Turkish version of the instrument). Response options to the TESI self-efficacy items used a five-point Likert scale: Almost Never Confident (1 point), Seldom Confident (2 points), Sometimes Confident (3 points), Often Confident (4 points), and Almost Always Confident (5 points). Further, to investigate its comprehensibility and applicability, the instrument was pilot-tested with 71 SSSTs in the spring semester of 2010-2011. Its Cronbach alpha coefficient was calculated to be 0.95 which is higher than the minimum acceptable value posited by Hair et al. (2006). The Cronbach alpha coefficients for the three hallmarks of the TESI model were found to be 0.87, 0.91 and 0.93 respectively. The instrument was administered as a pre-test at the beginning of the semester. After a 14-week-teaching intervention, the instrument was re-administered as a post-test.

### Data analysis

In analyzing data, SPSS 15.0 for statistical analysis (paired-samples t-test, Cronbach's alpha, descriptive statistics) and confirmatory factor analysis via AMOS 18.0 were employed. To explore model fit by using reported indices (Kline, 2005), the SSSTs' post-test scores of TESI self-efficacy were exposed to AMOS 18.0. Fit indices employed include the goodness-of-fit Index (GFI), the standardised root mean residual (SRMR), the root mean square error of approximation (RMSEA), the adjusted goodness-of-fit (AGFI), the comparative fit index (CFI), and the Tucker-Lewis index (TLI) (Çalik & Coll, 2012; Teo & Ursavaş, 2012).

## Intervention

The 14-week (2 hours per week) Environmental Chemistry elective course was taught by the author using the TESI model with respect to Technology-Embedded Scientific Conceptualisation. The SSSTs were initially required to create small groups with 2 or 3 members. Later on, they were asked to sign up to the TESI web site and acquaint themselves with it. Each week, the author discussed the environmental chemistry topics and illustrated how to integrate innovative technologies (i.e. calculator-based laboratory (CBL) instrument, Texas instrument-84 (TI-84), temperature sensor, turbidity sensor, pH sensor, photometry, conductivity sensor, flow rate sensor) into the teaching of chemistry/science. Then, he required the SSSTs to practically exploit the introduced innovative technologies on consultation days aided by the scholars. They were encouraged to not only communicate with peers, lecturer and scholars but also to share their ideas or documents with them using the TESI web site for Technology-Embedded Scientific Communication. They were then asked to devise a project topic, its data collection and its sampling procedure. They were later required to collect and analyse their data and to present these projects. That is, they submitted 32 environmental research papers (e.g. factors that affect to grow up agricultural products, acidity rate of rainwater and its effect on soil, determination of water quality in different regions, determination of water quality in a local stream (Kalenima) in Akcaabat). The following schema outlines what was tracked in 'Environmental Chemistry' elective course (SSSTs worked in small groups of 2-3 members). They were required to conduct their own environmental

research projects using innovative technologies, such as a pH sensor, turbidity sensor, conductivity sensor, CO<sub>2</sub> sensor, calculator-based laboratory instrument, Global Positioning System (GPS) etc, and to make use of them in their 'Teaching Practicum' course at lower secondary schools. In Turkey, the SSSTs, in their final semester, must at least teach 6 class-hours at lower secondary classes (grades 6-8) depending on their mentors' teaching hours. However, this does not mean that the SSSTs under investigation taught the entire class-hours via the TESI model and the technological instruments (e.g. probes, sensors, GPS). That is, whenever the SSSTs thought some topics called for use of the technological instruments and the TESI model, they argued several questions 'How can they integrate the TESI model into teaching practicum? Which technological instruments do they need to implement their lesson plans?' with the author and scholars. For example, in 'respiration' topic, the SSSTs devised their lesson plans including TI-84, CBL, CO<sub>2</sub> sensor and Logger Pro software and then implemented them in the 'teaching practicum'. Using the TESI Website (see Figure 2), the SSSTs shared their gained experiences with their peers, lecturer and scholars. Whenever they needed any assistance, scholars of the project team assisted them on consultation days. Someone may think that the teaching intervention is complex and contains potentially many factors enhancing self-efficacy rather than use of technology. However, since the intervention directly covers the TESI model and its three hallmarks using the 'Environmental Chemistry' elective course as a driving factor, the TESI model, alike an umbrella, includes all factors and appears a principal factor influencing self-efficacy.

**Table 1.** Results of paired-samples t-test concerning the TESI self-efficacy and its three hallmarks

		Mean Difference	Standard Deviation	Standard Error Mean	<i>t</i>	<i>df</i>	Significant (2-tailed)
Pair 1 – Technology Embedded Scientific Inquiry (TESI)	Post-test – Pre-test	1.15	20.76	1.94	5.93	113	.000
Pair 2 – Technology Embedded Scientific Conceptualization	Post-test – Pre-test	3.57	5.68	.53	6.70	113	.000
Pair 3 – Technology Embedded Scientific Investigation	Post-test – Pre-test	3.00	8.57	.8	3.74	113	.000
Pair 4 – Technology Embedded Scientific Communication	Post-test – Pre-test	4.95	8.23	.77	6.41	113	.000

**Table 2.** Fit indices for the model

Model fit indices	Values	Recommended guidelines	References
$\chi^2/df$	1.361	<3	Kline (2005)
SRMR	0.0444	<0.05	Klem (2000), McDonald and Ho (2002)
RMSEA	0.057	<0.05 (good fit) <0.08 (fair fit)	McDonald and Ho (2002)
CFI	0.973	=>0.90	Klem (2000), McDonald and Ho (2002)
GFI	0.887	=>0.90	Klem (2000), McDonald and Ho (2002)
TLI	0.967	=>0.90	Klem (2000), McDonald and Ho (2002)



Figure 2. Some sample screen shots from the TESI web-site

**RESULTS**

Table 1 presents results of measurements of SSSTs' self-efficacy. There was a significant difference between pre-test and post-test mean scores of all four pairs of SSSTs' academic self-efficacy of Pair 1 ( $p < 0.001$ ) in favour of the post-test (see Table 1).

As can be seen in Table 2, these values indicated a model fit suggesting the proposed TESI model was acceptable. Confirmatory factor analysis indicated that a three-factor model for 15 items was acceptable (see

Figure 3). These factors were Item 1 and Items 5-7 for the technology-embedded scientific conceptualisation (factor 1); Items 3-4, Item 6 and Items 8-9 for the technology-embedded scientific investigation (factor 2); Item 1, Items 3-5 and Items 8-9 for the technology-embedded scientific communication (factor 3). Additionally, the values calculated for chi-square and degrees of freedom ( $X^2/df : 1.123$ ) revealed that the TESI-COP was valid and reliable for the items identified above that fit the model.

DISCUSSION

Results of the paired-samples t-test supported this statistically significant increase in favour of the post-test (see Table 1). This reveals that the interactive structure of the TESI model seems to have influenced its own three hallmarks because the SSSTs' self-efficacy in the post-test for each hallmark was higher than that for the pre-test. That is, the SSSTs initially examined any topic within the scope of scientific conceptualisation and then conducted their research related to the concepts in the context of scientific investigation. Later, they participated via the discussion board to share their experiences and research results. Overall, the interactive and gradual structures of the TESI model resulted in an

increase in the SSSTs' self-efficacy.

An increase in the SSSTs' self-efficacy of acquiring relevant information with the Internet for the technology-embedded scientific conceptualisation Item 7 may result from their internet habits. They could easily access internet facilities and frequently use the second-generation social networking sites such as Facebook, MSN and twitter to look for information and communicate with peers. It can be deduced that such habits have the capacity to mirror social phenomena in educational practices and to enhance the SSSTs' self-efficacy. In a similar vein, the TESI web-site may have caused an increase in the SSSTs' self-efficacy of the Internet habit.

An increase in the SSSTs' self-efficacy for the

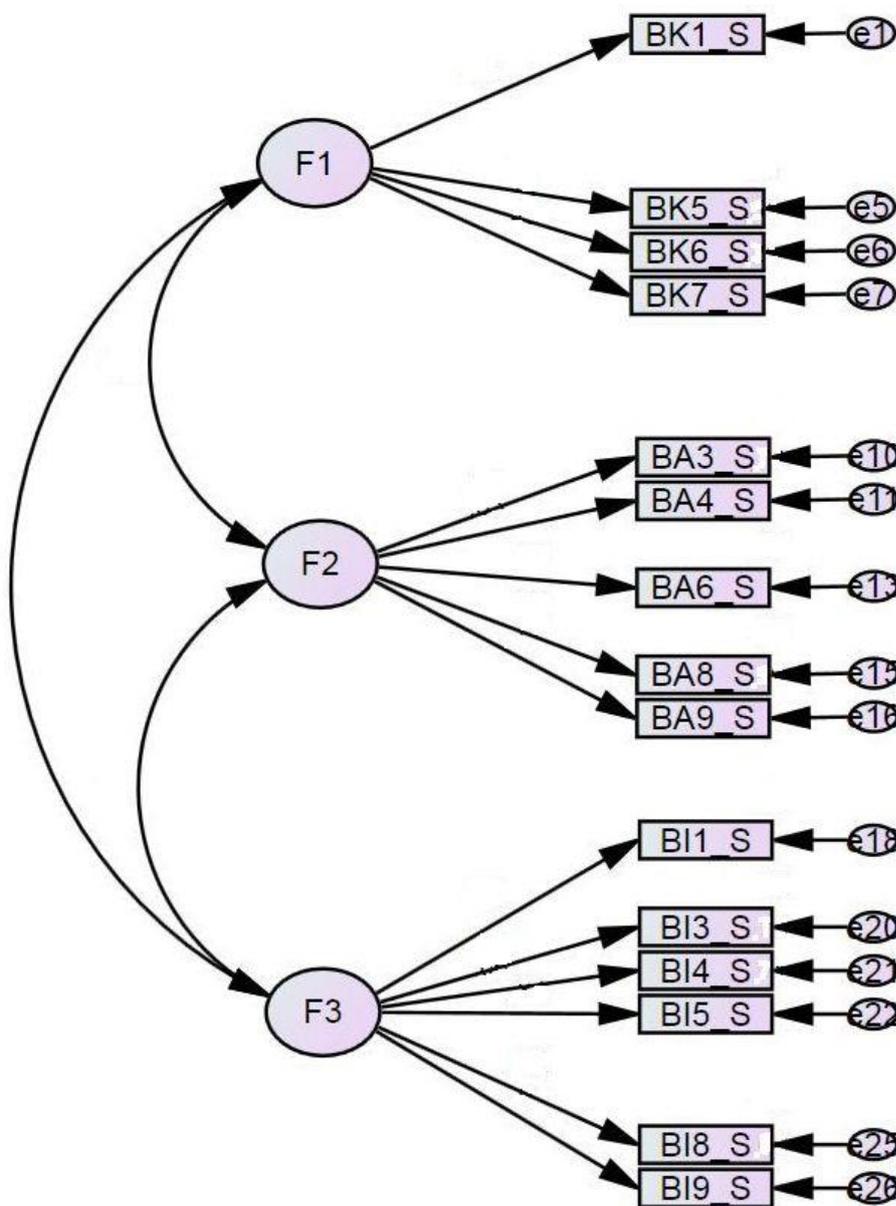


Figure 3. The path diagram of the three-factor model for the TESI self-efficacy (For example; BK1\_S means Item 1 in technology embedded scientific conceptualization; BA3\_S means Item 3 in technology embedded scientific investigation; BI1\_S means Item 1 in technology embedded scientific communication).

technology-embedded scientific conceptualisation (see Table 1) may result from the capacity of the innovative technologies used in the project. These technologies, (probes and sensors, TI, CBL, GPS and so on) may have helped them investigate the related concepts in a practical manner. For example, given the statement “the more table salt is dropped into pure water, the more the solution’s electrical conductivity increases”, TI-84, CBL and conductivity sensor from the innovative technologies enabled the SSSTs to test this statement by monitoring the electrical conductivity change. Such a claim is consistent with conceptual understanding studies (e.g. Karlı & Çalik, 2012; Çalik, Okur & Taylor, 2011; Ebenezer, 2001; Hoban, Loughran & Nielsen, 2011). In other words, because the TESI model assisted the SSSTs in extending and elaborating their subject matter of knowledge of related concepts and scientific conceptualisation, such a procedure may have impacted and enhanced their self-efficacy. Likewise, Ebenezer et al. (2012) addressed teacher growth and significant changes in students’ perceptions of their innovative technologies fluency. The current study, in turn, indicates that intensive professional development opportunities, viz. the ‘Environmental Chemistry’ elective course based on the TESI model, have the potential to produce significant increases in the SSSTs’ self-efficacy.

An increase in SSSTs’ self-efficacy for the technology-embedded scientific investigation (see Table 1) may come from the structure of the ‘Environmental Chemistry’ elective course (see syllabus at intervention sub-section). Based on the TESI model, the author employed the ‘Environmental Chemistry’ elective course as a driving factor. Within the course, the author and his scholars mentored the SSSTs to make practical use of the innovative technologies and to transfer skills gained in practice on consultation days. The SSSTs’ environmental research reports may also have explicitly influenced their self-efficacy. In this process, the SSSTs spent considerable time on several issues-- laboratory experiences for the research reports, analysis of graphical data, inquiring into the results and tentative claims and exploring new questions (Lapp & Cyrus, 2000; Schultz, 2003). In brief, a dual situated structure balancing theoretical knowledge with practical skill (e.g. Calik, 2011; Ültay & Çalik, 2012; Çalik et al. 2012) may very likely have affected their self-efficacy of the TESI model and its three hallmarks.

An improvement in the SSSTs’ self-efficacy for the technology-embedded scientific communication (see Table 1) may stem from the structure of the TESI web-site in which the SSSTs communicated with their peers, scholars and lecturer; and uploaded all related documents, such as animations, simulations, videos, cartoons (see Figure 2). As seen in the syllabus of the ‘Environmental Chemistry’ elective course, the author

always tends to create a discussion board for topics/issues in the course. Such a unique learning environment, which differs from the other pre-service courses, may have engendered an increase in the SSSTs’ self-efficacy. Overall, the TESI model aided the SSSTs to participate in interactive scientific argumentation (Duschl & Osborne, 2002) so that this procedure may have contributed to their self-efficacy improvement.

Confirmatory factor analysis via AMOS 18.0 (see Table 2) revealed that the proposed TESI model was acceptable and feasible for the related context. Also, interactions amongst the three hallmarks of the TESI model resulted in increasing the SSSTs’ self-efficacy. If the SSSTs are well equipped with Technology-Embedded Scientific Conceptualisation, they are able to properly investigate researchable questions and to conduct scientific investigation. In a parallel fashion, they are also able to adequately communicate research process, research results, and knowledge claims. Because this current study only describes a small part of an 18-month extensive project entitled “Technology-Embedded Scientific Inquiry (TESI): Modelling and Measuring Pre-Service Teacher Knowledge and Practice”, several instruments (i.e. TESI-classroom observation protocol, interviews, TPACK, Environmental Chemistry Conceptual Understanding Questionnaire, environmental research papers etc) used for data triangulation were reserved for the studies in progress. Therefore, this may be seen a limitation of the present study. Furthermore, during the project period, the subject-specific national examination (Ayas, Özmen & Çalik, 2010; Çalik et al., 2012) acted as a robust barrier to get better results and undermined the SSSTs’ self-efficacy. For this reason, a longitudinal study with the science student teachers is suggested to get more detailed information concerning the applicability of the TESI model and TESI self-efficacy.

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