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Lithuanian Science Teachers' Self-confidence in Teaching and Their Innovative Work Activities

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ABSTRACT
The study deals with Lithuanian science teachers' self-confidence in teaching science and its role in teachers' innovative activities on the basis TIMSS 2015 data set. The latent construct of science teachers' self-confidence in teaching science was examined using confirmatory factor analysis (CFA). Seeking to disclose the influence of science teachers' self-confidence in teaching science on their innovative work activities, structural equation modeling (SEM) was used. The results of our research revealed that the self-confidence of Lithuanian science teachers in teaching science is more associated with an idea application activity, i.e., applying specific innovation in practice, and less – with an idea-generating and sharing activity. The analysis of paths coefficients confirmed that science teachers' innovative activities (working together, trying out new ideas, learning more about teaching, encouraging students to express their ideas in a classroom, asking students to decide their problem-solving procedures, and sharing new ideas) is directly and positively associated with science teachers' self-confidence in teaching science.

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Introduction

Educational innovation plays an important role in creating a sustainable, and progressive society (Ormancı, 2020; Serdyukov, 2017). Innovation comes with challenges and uncertainties Rogers (2003). Innovations require a person to have the capabilities to solve difficult tasks and to concentrate on successful outcomes (Kocabaşoğlu, & Şahin, 2021; Pishchanska et al., 2021; Runhaar et al., 2016). Individuals with high self-confidence in their capabilities approach difficult challenges and uncertainties (Mahon et al., 2019).

Realizing an educational innovation requires understanding the meaning of innovation. According to Brewer and Tierney (2012), innovation has two components: the new idea and the change which results from the adoption of a new idea. The ability to generate new ideas is not enough for the successful implementation of innovation in practice. People who are full of new ideas often do not understand how to implement new ideas in practice (Levitt, 2002).

For this reason, researchers address the phenomenon of innovative work behavior which involves creating and implementing something new to the existing work (Aziah & Al Amin, 2018; Chang, 2018; Pudjiarti & Hutomo, 2020). Innovative work behavior manifests itself in a variety of activities such as generating, promoting, and realizing new ideas (Aziah & Al Amin, 2018; Sun &

Huang, 2019; West & Farr, 1990). Innovative work activity requires an ability to think and do things differently while implementing innovations (Pudjiarti, & Hutomo, 2020; Zhu et al., 2013).

Seeking to have innovative science teaching in the science classroom, it is important to uncover factors that determine the innovative work behavior of teachers (Adu Gyamfi, 2020; Martin-Gamez et al., 2016). Thurlings et al. (2015) performed a systematic literature review in order to highlight the factors affecting the innovative behavior of teachers in their work and revealed three groups of factors influencing the teachers' innovative behavior: demographic, individual, and organizational. According to Thurlings et al. (2015), self-confidence belongs to the group of individual factors. Self-confidence is an individual property of a person. To be self-confident is to have confidence in yourself (Ashourizadeh et al., 2014). If persons know what they are doing, they have every reason to be self-confident. Self-confidence is a "state of being certain about the success of a particular behavioral act" (Stankov et al., 2012, p. 747). The self-confidence of teachers is linked to innovation because innovation is associated with difficult tasks viewed as challenges in education (Sheldrake, 2016; Viljaranta et al., 2014).

There is a high number of studies dealing with self-efficacy and innovative behavior as well as how teachers' self-confidence influences the teaching and learning process (Gol & Aaleabbas, 2016; Jansen, Scherer, & Schroeders, 2015), however, there is a lack of research on self-confidence in teaching science of teachers and the relation between the self-confidence in teaching science and different dimensions of innovative work behavior in the classroom through such activities as idea generation, idea promotion, and idea realization.

The last three decades have demonstrated growing calls for innovations associated with science teaching methods. In the light of science education reforms (National Research Council [NRC], 1996; NRC, 2000; NRC, 2012) teaching methods have focused on innovations that have alternately been called scientific inquiry, discovery, and constructivist approaches (Furtak & Kunter, 2012). How these challenges are reflected in educational practice is revealed through systemic measurement of innovations: the New Consortium Media (Adams Becker et al., 2018), Measuring Innovation in Education monitoring (OECD, 2019), and An innovation survey (Halász, 2018).

Research on innovations in science education discuss the application of new technology (Arıcı et al., 2019; Liu et al., 2017; Osunkwo & Enyaosah, 2016; Ruzman & Rosli, 2020), a need to infuse arts and social-emotional learning content into science education (Bardone et al., 2017); a need to infuse social-emotional principles (Garner et al., 2018), to promote social creativity towards novel student-based solutions and innovations in science education (Aksela, 2019), a need to use innovative models to improve critical thinking skills and self-efficacy of pre-service chemistry teachers (Rusmansyah et al., 2019).

The innovative work behavior is reflected by a series of activities in which individuals generate novel ideas, solve practical problems at work, and achieve positive effects (Sun & Huang, 2019). The dimensions of innovative behavior seem clear enough: generation, development, and implementation of innovative ideas. However, there is no consensus in the scientific literature on the concept and dimensions of innovative work behavior. Scholars (Janssen, 2003; Borasi & Finnigin, 2010; De Jong & den Hartog, 2010; Noefer et al., 2009; So, 2013) highlighted different dimensions of innovative work behavior. De Jong and den Hartog (2010) identified four dimensions of innovative work behaviors: idea generation, idea exploration, idea championing, and idea implementation. Janssen (2003) revealed three dimensions of innovative work behavior, such as idea generation (problem recognition), idea promotion (introduction and dissemination), and idea realization (application). Noefer et al. (2009) did not distinguish the second dimension of idea promotion. Borasi and Finnigin (2010) focused on the first and the third dimension of innovative behavior. So (2013) exclusively focused on the first dimension (idea generation).

The spectrum of factors influencing the teachers' innovative work behavior is very wide: from cultural to the individual (O'Keeffe et al., 2019). Self-confidence refers to an individual's cognitive point of view regarding their abilities and capabilities (Gol & Aaleabbas, 2016). Within the educational research, teachers' self-confidence has been defined as the teachers' cognitive assessment of their professional abilities to execute the educational process (self-concept) and the teachers' belief to accomplish an innovative teaching task in the future (self-efficacy) (Sheldrake, 2016; Tschannen-Moran et al., 1998; Yeşilyurt, 2013).

Establishment of Hypotheses

Teachers' self-confidence is analyzed from various points of view: a comparative analysis of pre-service and in-service teachers' confidence (Megan, 2016); self-confidence and science knowledge (Appleton, 1992; Harte & Reitano, 2015; Malandrakis, 2018); factors of primary school teachers' confidence (Yates, 1990); communication and confidence (Train & Miyamoto, 2017); pre-service teacher anxiety toward teaching science, including low self-efficacy (Noble, 2016; Yürük, 2011), engaging pre-service teachers in various professional development opportunities to build confidence (DeCoito, 2006; Kenny, 2010); teachers and students' confidence and learning mathematics concepts (Barrow et al., 2018).

Trying to better understand and analyze the components of innovative work behavior (expressed through innovative activities) and their relation to self-confidence, we refer to Rogers' Diffusion of Innovations theory (RDI), which sees the innovation process as composed of five stages: the Knowledge, the Persuasion, the Decision, the Implementation, and the Confirmation (Rogers, 2003). The first stage is cognitive-centered and related to the generation of new ideas (Rogers, 2003). To try out a new idea, teachers seek information about the innovation, look for how to use an innovation correctly, and discuss how and why an innovation works. The Knowledge stage is more cognitive, seeking awareness about the existence of innovation (Şahin, 2006). At the Knowledge stage, the self-confidence in teaching science is most strongly affected by mastery experience. Teachers need to estimate their past experience with similar experiences deriving from innovation problems (Usher & Pajares, 2009). Thus, we hypothesized:

H$_1$. Self-confidence in teaching science will be positively associated with science teachers' activity of working together to try out new ideas.

Idea championing becomes relevant once an idea has been generated (De Jong & den Hartog, 2010). Teachers are championing new ideas at the Persuasion and Decision stage. The Persuasion stage of RDI theory is cognitive and affective centered. In this step, the degree of uncertainty rests on new ideas, and social reinforcement from other colleagues is needed.

Scholars analyzed teachers' reactions to innovation challenges based on concern (the feelings, preoccupation, thought, and consideration) stages about the innovation (Hall & Hord, 2020; Teerling et al., 2020). They revealed that the emotional factors appear to be relevant as predictors of persons' attitudes toward the innovation (Teerling et al., 2020).

Championing includes finding encouragement and support from colleagues, by expressing confidence about the success of the innovation (Howell et al., 2005). To reduce the level of uncertainty, teachers visit another classroom to learn more about teaching, seeking to see how innovation works. Teachers usually seek the confirmation of information about innovations from colleagues whose subjective opinions about innovation are most convincing (Sherry, 1997).

Encouragement and support derive from vicarious experience and social persuasion (Usher & Pajares, 2009) at the Persuasion and Decision stage. Vicarious experience is developed from the observation of colleagues applying new ideas and teachers use this experience as a source of information for their own ability to apply new ideas in science education. Social persuasions refer to encouragement from other teachers, and outside experts (Sherry, 1997). Vicarious experiences and social persuasion can enhance teachers' self-confidence in teaching science (Usher & Pajares, 2009). Championing of new ideas ends with the Decision stage. At the decision stage teachers choose to adopt or reject the innovation by reacting in an affective and cognitive way (Teerling et al., 2020). We hypothesized:

H$_2$. Self-confidence in teaching science will be positively associated with science teachers' activity of championing new ideas.

Championed ideas need to be implemented (De Jong & den Hartog, 2010). RDI states that at the Implementation stage, innovation is put into education. Teachers need to design their teaching and learning process in a new way that can attract students' interests and attention, offer them the best learning experience (Aziah & Al Amin, 2018; Chang et al., 2013). The implementation of innovations occurs by encouraging students to solve new problems by creating opportunities to express new ideas in the science classroom.

Understanding teachers' self-confidence in teaching science continues to be a central concern regarding the implementation of innovations in science education. Psychologists (Bandura, 1994; Ng & Lucianetti, 2016) claim that persons with high assurance in their abilities are willing to approach difficult tasks, meanwhile, the individuals who doubt their capabilities, dwell on their deficiencies rather than concentrate on how to perform successfully (Bandura, 1997; Ng & Lucianetti, 2016). Teachers' self-confidence derives from mastery experience, vicarious experience, and social persuasion at different stages of innovative behavior (Ng & Lucianetti, 2016).

Self-confidence in teaching and implementation of innovation can work in a positive cycle: the more self-confident a person is in his innovative work abilities, the more likely they are to succeed in the application of innovation (Ng & Lucianetti, 2016). The application of innovation, in turn, gives them more self-confidence in themselves (Çakıroğlu, 2008; Gan & Gal, 2018; Hsiao et al., 2011; Stylianidou et al., 2005). The foregoing insights about self-confidence in teaching and innovative work activity lead us to develop the following hypotheses:

H_3. Self-confidence in teaching science will be positively associated with science teachers' activity of asking students to decide their problem-solving procedures.

H_4. Self-confidence in teaching science will be positively associated with science teachers' activity of encouraging students to express their new ideas in the classroom.

The new idea is not finally approved at the Implementation stage because some degree of uncertainty is involved (Rogers, 2003). The degree of uncertainty disappears at the last Confirmation stage when teachers look for support for innovation in education. At the confirmation stage, teachers seek "supportive messages that confirm their decision" (Şahin, 2006, p. 17). The 'supportive messages' are the tools of social persuasion. Scholars revealed that the persuasion of self-efficacy is positively related to growth in idea dissemination (Battistelli et al., 2019; Ng & Lucianetti, 2016). Whereas self-efficacy is the dimension of self-confidence (Bong & Skaalvik, 2003), we developed the last hypothesis:

H_5. Self-confidence in teaching science will be positively associated with science teachers' activity of sharing what they have learned about their teaching experiences.

TIMSS 2015 (Trends in International Mathematics and Science Study) provides a unique opportunity to analyze the association between self-confidence in teaching science and innovative work behavior. TIMSS 2015 focuses on the self-confidence to teach the science topics (Martin et al., 2016). Given the opportunities offered by TIMSS 2015 and the lack of research on science teachers' innovative work behavior and its determinants, especially on individual ones, we set the purpose of this paper: to reveal the associations between Lithuanian science teachers' self-confidence in teaching science and their innovative work activities using secondary TIMSS 2015 data analysis.

Methods

Study Location, Population, and Sample Size

We performed a secondary data analysis of TIMSS 2015 data of Lithuania in 2020. The science achievement of students from Lithuania is a little higher than the TIMSS 2015 survey average (Martin et al., 2016). Primary data were downloaded from the TIMSS 2015 database (http://www.timss.org/).

The research sample of TIMSS 2015 research (the confidence interval being 5%, and the confidence level being 95%) was reliable as it involved 937 (825 female, 112 male) science teachers from Lithuania. The science teachers were selected based on probability cluster sampling. The reliability and representativeness of the sample presuppose the generalization of the survey data.

It should be noted that 41% of Lithuanian science teachers involved in the survey had a master's degree or higher (international average - 28%), and 58% of teachers had a bachelor's degree or equivalent (international average - 64%). One percent of the Lithuanian science teachers had higher non-university or higher education (international average - 7%). It has to be stated that in Lithuania 71% of science teachers had 20 years or more of work experience. At the international level, science teachers had an average of 15 years of teaching experience. Comparing the education and work experience of Lithuanian science teachers with international ones, it is noticeable that a higher percentage of teachers in the country had a master's degree or higher. In addition, Lithuanian science teachers have a slightly higher experience of pedagogical work compared to the international context.

Research Instrument and Primary Data

TIMSS 2015 is a large-scale study in which domain-specific self-confidence and innovative work activities of science teachers are measured by items that correspond to the validity and reliability of the construct innovative work behavior and self-confidence. Analyzing science teachers' self-confidence in teaching science we used 17 questions for the analysis which in the TIMSS 2015 questionnaire was worded as follows: "In teaching science to this class, how would you characterize your confidence in doing the following?" The answers to this question revealed teachers' self-confidence in teaching activities in the science classroom (Table 1).

Table 1

The Questions from TIMSS 2015 about the Science Teachers' Self-confidence in Teaching Science

Code of question	Science teachers' self-confidence in teaching
BTBS 17A	Inspiring students to learn science
BTBS 17B	Explaining science concepts or principles by doing science experiments
BTBS 17C	Providing challenging tasks for the highest achieving students
BTBS 17D	Adapting my teaching to engage students' interest
BTBS 17E	Helping students appreciate the value of learning science
BTBS 17F	Assessing student comprehension of science
BTBS 17G	Improving the understanding of struggling students
BTBS 17H	Making science relevant to students
BTBS 17I	Developing students' higher-order thinking skills
BTBS 17J	Teaching science using inquiry methods

Science teachers' self-confidence in teaching science (STS) is a latent or unobserved variable (Figure 1). We examined convergent validity of latent variable (STS) by the Average Variance Extracted (AVE) and Composite Reliability (CR): AVE = .723 > .50; CR = .916 > .70. The convergent validity and composite reliability of our latent construct (SCS) are appropriate (Fornell & Larcker, 1981).

The normality of the data (Table 2) was checked. We hold that the values for asymmetry (skewness and kurtosis) between -2 and +2 are considered acceptable in order to prove normal univariate distribution (George & Mallery, 2010). Asymmetry coefficients indicate that the data satisfies the condition of normality (Table 2). The Cronbach alpha coefficient for the ten items (17A - 17J) is .914. suggesting that the items have relatively high internal consistency.

Table 2

Normality of Science Teachers' Self-confidence in Teaching Science Data: Asymmetry Coefficients Test

	Question code (BTBS)									
	17A	17B	17C	17D	17E	17F	17G	17H	17I	17J
Skewness	.221	.371	.478	.113	.201	.187	.204	.358	.269	.130
Kurtosis	-.329	-.438	.273	-.247	-.596	-.040	-.423	-.705	-.043	-.365

TIMSS 2015 Instrument for science teachers allowed carrying out an empirical analysis of science teachers' innovative work activities. TIMSS 2015 questions (BTBG 09E; BTBG 09D; BTBG 09C) about the innovative work behavior of science teachers are formulated by emphasizing teachers' communication in science education (Figure 1). It increases the content validity of questions about science teachers' innovative work activity because the RDI highlights the role of communication channels in innovative work (Rogers, 2003). The questions about science teachers' innovative work activities correspond to different stages of RDI (Table 3). We checked the internal consistency and asymmetry coefficients of these questions. They suggest that the items have good internal consistency and normality (Table 4).

Figure 1

Conceptual Framework of Science Teachers' Self-confidence in Teaching Science and Innovative Work Behavior

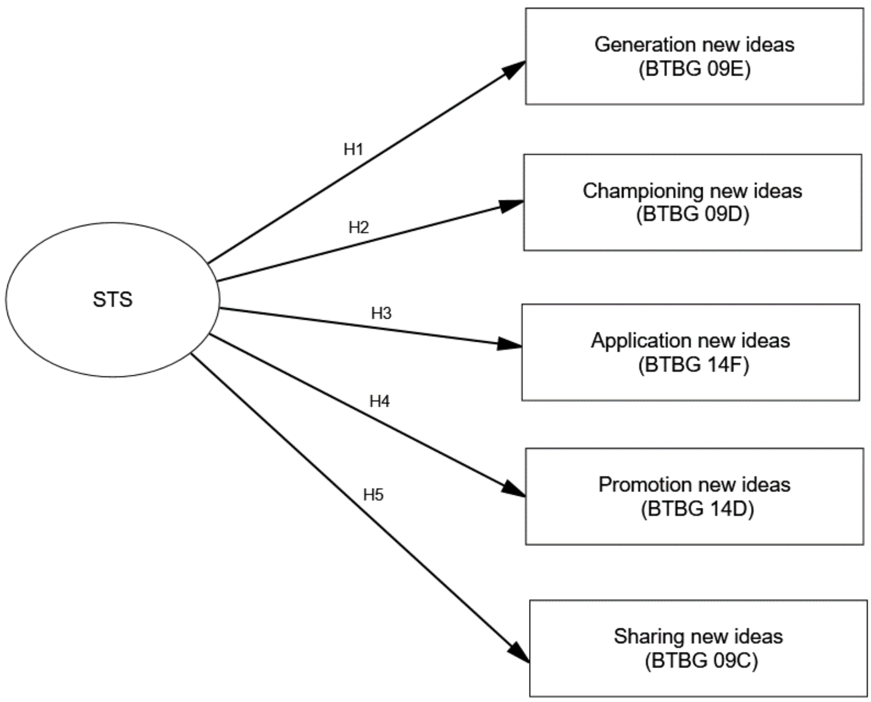

Table 3

The Questions about Science Teachers' Innovative Work Activity in Classroom

Innovative work activity according to RDI	Question code	Question: How often do you have the following types of interactions with other teachers?
Generation	BTBG 09E	Work together to try out new ideas
Championing	BTBG 09D	Visit another classroom to learn more about teaching
Application	BTBG 14F	Ask students to decide their own problem-solving procedures
Promotion	BTBG 14G	Encourage students to express their new ideas in the classroom
Modification and sharing	BTBG 09C	Share what I have learned about my teaching experiences

Table 4

Normality of Science Teachers Innovative Work Activity Data: Asymmetry Coefficients Test

	Generation BTBG 09E	Championing BTBG 09D	Application of BTBG 14F	Promotion of BTBG 14G	Sharing BTBG 09C
Valid	937	937	937	937	937
Skewness	-.261	-.621	-.628	-.476	1.463
Kurtosis	-.516	.915	.443	-.515	1.131

Data Analysis

The selected data were analyzed using confirmatory factor analysis (CFA) and structural equation modeling (SEM). Confirmatory factor analysis (CFA) extended the possibility to reveal the relationships between the latent variable (STS) and measuring variables (BTBS 17A – BTBS 17J). We used structural equation modeling (SEM) seeking to reveal the association of science teachers' self-confidence in teaching science with their innovative work behavior we tested five science teachers' activities (BTBG 09C; BTBG 09CD; BTBG 09 E; BTBG 14D; BTBG 19F) (Figure 1). The associations among variables were examined with the use of SPSS 21 and the structural equation modeling software AMOS 16.

Findings

Results of CFA

The latent construct of science teachers' Self-confidence in Teaching Science (STS) was examined using CFA. Initially, the fit of the data to the model was checked (Bentler, 1990).

The fitness of items of latent factor science teachers' self-confidence in teaching science revealed a sufficient fit and confirmed ten questionnaires structure (Table 5). CFA confirmed that the structural model fits the data well.

Table 5

The Fitness of Items of Latent Factor Science Teachers' Self-confidence in Teaching Science

	Absolute fit index			Relative fit index		
	χ^2/df	RMSEA	GFI	IFI	TLI	CFI
Assumed model	2.212	.036	.977	.991	.987	.990
Acceptance value	1-5	<.08	>.80	>.90	>.90	>.90

Standardized and Unstandardized coefficients for observed variables and the latent factor (STS) were deducted (Table 6). The unstandardized beta (B) for the variable Inspiring students to learn science: would mean that for every one-unit increase in the variable Inspiring students to learn science, the dependent variable (STS) increases by 1.012 units (Table 6). Similarly, for the variable Explaining science concepts or principles by doing science experiments: for every one-unit increase in the variable Explaining science concepts or principles by doing science experiments, the dependent variable (STS) increases by 1.017 units.

The CFA results revealed that science teachers' self-confidence in teaching science, using inquiry methods is mostly associated with science teachers' confidence in teaching science because unstandardized beta is highest (Table 6).

Science teachers' self-confidence in adapting the teaching to engage students' interests has the strongest relationship with the latent variable of science teachers' confidence in teaching science (β = .845) (Table 6).

Table 6

Results of CFA: the Latent Construct is Science Teachers' Self-confidence in Teaching Science (STS)

Observed variable	B	β	S.E.	p label
Inspiring students to learn science	1.012	.817	.037	<.001
Explaining science concepts or principles by doing science experiments	1.017	.777	.037	<.001
Providing challenging tasks for the highest achieving students	1.039	.793	.033	<.001
Adapting my teaching to engage students' interest	1.042	.845	.034	<.001
Helping students appreciate the value of learning science	.997	.774	.034	<.001
Assessing student comprehension of science	1.018	.825	.036	<.001
Improving the understanding of struggling students	1.015	.791	.034	<.001
Making science relevant to students	1.002	.818	.040	<.001
Developing students' higher-order thinking skills	1.034	.743	.039	<.001
Teaching science using inquiry methods	1.046	.768	.037	<.001

The observed variable of Developing students' higher-order thinking skills has the lowest relationship with the latent variable (science teachers' self-confidence in teaching science) (β = .743) (Table 6). The development of higher-order thinking (HOT) is a complex and complicated educational process when students have to understand facts, infer them, connect them, and apply them as we seek new solutions to raised problems (Ramadhan et al., 2019). The development of students' HOT requires a teacher's ability to apply various teaching techniques. Therefore, it is clear that science teachers have the least self-confidence in Developing students' higher-order thinking skills (β = .743) (Table 6).
The results of CFA revealed that the relation of the predictor (observed) variables (BTBS 17A – BTBS 17J) to the dependent (latent) variable (STS) is statistically significant in all cases (Table 6). The strongest relation was detected between science teachers' self-confidence in teaching science and teaching science using inquiry methods, the lowest – helping students appreciate the value of learning science.

Results of SEM

The hypothesis testing was performed using SEM. According to the theoretical model (Figure 1), science teachers' innovative work behavior manifests in innovative activities: generation of new ideas in education, development of new ideas in education, application of new ideas in education, promotion of new ideas in education, modification, and sharing new ideas (Rogers, 2003).

The result of descriptive statistics (mean, SD) revealed that the highest mean is for the activity of developing new ideas ($\bar{x}_D = 2.68 \pm .661$) and the lowest is for the activity of promoting new ideas in the science classroom ($\bar{x}_P = 1.89 \pm .797$) (Table 7). A strong, statistically significant correlation was found between the generation new idea and development of an idea ($r = .588^{**}$, $p < .01$), between the generation new idea and share new idea ($r = .452^{**}$, $p < .01$). The Spearman's correlation coefficients among science teachers' innovative work activities indicate that not all of the variables are significantly positively correlated with each other (Table 7).

Seeking to disclose the direct effect of science teachers' self-confidence in teaching science on their innovative work activity structural equation modeling (SEM) was used. The structural model (Figure 1) displays the interrelations among exogenous (unobserved) variable (science teachers' self-confidence in teaching science (STS)) and endogenous (observed) variables (science teachers' innovative work activities) in the proposed model as a succession of structural equations. The direct effects among exogenous variable (STS) were investigated on an endogenous variable (generation, championing, application, promotion, sharing of new ideas) (Figure 1). SEM allowed us to test five hypotheses (H_1-H_5) regarding how exogenous variable is theoretically linked to endogenous variables in a direct effect. The results of the hypothesis testing revealed that all pathways are statistically significant (Table 8).

Table 7

The Means, Standard Deviations, and Correlation of Science Teachers' Innovative Work Activity

Innovative work activity	Means	SD	Generate	Develop	Applying	Promote	Share
Generation of an idea	2.68	.661	1				
Development of an idea	2.81	.648	.588**	1			
Applying an idea	2.44	.764	.240**	.224**	1		
Promoting an idea	1.89	.797	.119**	.106**	.253**	1	
Share an idea	2.33	.678	.452**	.463**	.186**	.155**	1

Note. N = 937. Pearson Correlations (2-tiled) *p < .05. **p < .01. ***p < .001

Table 8

The Associations Between the Science Teachers' Self-confidence in Teaching Science and Their Innovative Work Activities: Paths Coefficients and Statistical Significance

Hypothesis and paths	Paths' coefficients (β)	p label	R^2	Results
H_1. (STS) → Work together to try out new ideas	.376	.001	.142	Support
H_2. (STS)→ Visit another classroom to learn more about teaching	.386	.001	.149	Support
H_3. (STS)→ Ask students to decide their own problem-solving procedures	.524	.001	.275	Support
H_4. (STS)→ Encourage students to express their ideas in class	.557	.001	.310	Support
H_5. (STS)→ Share what I have learned about my teaching experiences	.349	.001	.122	Support

The findings of our quantitative study (p-value) revealed that science teachers' self-confidence in teaching science has a direct effect on their innovative work activities: generation of new ideas in education; development of new ideas in education; application of new ideas in education; promotion of new ideas in education; modification and sharing new ideas (Table 8).

We performed hypotheses testing by the aspect of R-squared (R^2). Our model has statistically significant independent variables but a low R-squared value. This combination indicates that the independent variables are correlated with the dependent variable, but they do not explain much of the variability in the dependent variable. The coefficient of determination (R^2) value for variable science teachers' activity of asking students to decide their problem-solving procedures was .275. This means that 27.5% of teachers' activity of asking students to decide their problem-solving procedures variable values was directly affected by science teachers' self-confidence in teaching science. The remaining changes are influenced by other factors. Science teachers' activity of encouraging students to express their ideas in class was .310 (Table 8). This is the greatest value of R^2. This means that 31.0% of teachers' activity of encouraging students to express their ideas in the classroom was directly affected by science teachers' self-confidence in teaching science. The remaining 69.0% of changes are influenced by other factors.

It should be noted that the values of R^2 are smaller than the factor Work together to try out new ideas (R^2 value is .142), and of the factor Share what I have learned about my teaching experiences (R^2 value is .122) (Table 8). A low R^2 does not negate the importance of any significant variables. Even with a low R^2, statistically significant p-values continue to identify relationships and coefficients have the same interpretation (Frost, 2020).

We analyzed the paths coefficients of different hypothesis testing (Table 8). SEM results show that paths coefficients for the path Idea generating, and the path Idea sharing are almost twice lower as for the path Idea applying variables differ almost twice (Table 8). This suggests that teachers 'self-confidence in teaching science is associated with their innovative work activity differently.

SEM results revealed the importance of self-confidence in teaching science at the implementation phase of educational innovation. Analysis of paths coefficients indicates that science teachers' innovative work activity of encouraging students to express their ideas in class (EIC) is directly affected by STS. We regress science teachers' innovative work activity of encouraging students to express their ideas in the classroom on STS variables and obtain R^2= .310. $\beta_{EIC\text{-}STS}$ = .557. We also regress science teachers' innovative work activity of asking students to decide their problem-solving procedures (PSP) on STS variables – R^2= .275. $\beta_{PSP\text{-}STS}$ = .524. It can be argued that science teachers' self-confidence in teaching science is more associated with science teachers' innovative work activity of encouraging students to Express their Ideas in the Classroom (EIC) i.e., the activity of asking students to decide their own Problem-Solving Procedures (PSP). SEM results about the implementation phase of educational innovations complement theoretical insights into associations between self-confidence in teaching science and innovative work activities of science teachers and invite further research and discussion of these associations in the light of fundamental ways of learning (general to specific or specific to general) based on different content of the subject.

Discussion

In the current study, we analyzed the association of science teachers' self-confidence in teaching science with their innovative work activities. We investigated teachers' innovative work activities by carrying out a secondary analysis of TIMSS 2015 data of Lithuania. The theoretical background of the investigation is supported by RDI (Rogers, 2003). Serdyukov simplifying RDI posits that "innovation requires three major steps: an idea, its implementation, and the outcome that results from the execution of the idea and produces a change" (2017, p. 8). The results obtained in the study are in accordance with all our hypotheses. We revealed that self-confidence in teaching science is positively associated with science teachers' activity of working together trying out new ideas (H_1), science teachers' activity of championing new ideas (H_2), science teachers' activity of asking students to decide their own problem-solving procedures (H_3), with science teachers' activity of encouraging students to express their new ideas in the classroom (H_4) and with science teachers' activity of sharing what they have learned about their teaching experiences (H_5). The SEM result (Table 8) shows that science teachers' self-confidence in teaching science is more associated with their innovative work activity at the second – idea implementation step.

The educational discourse on innovative work behavior suggests that self-confidence is usually specific to academic subjects (Sheldrake, 2016; Viljaranta et al., 2014). TIMSS 2015 data allowed to investigate science teachers' self-confidence in teaching science. Science teaching is a process of coming to understand the world (Agarwal & Roediger, 2018). The process of world understanding is based on knowledge construction in one form or another by doing science experiments, providing challenging tasks, and other educational activities (Table 6). We revealed that the activity using inquiry methods is mostly related to science teachers' self-confidence in teaching science.

Teachers' self-confidence and innovative behavior are determined not only by the academic subject but also by other factors. Our study complemented the study of other authors on the influence of individual factors on teachers' innovative behavior (Chang, 2018; Hsiao et al., 2011). Researchers (Hsiao et al., 2011) investigated the influence of self-efficacy on teachers' innovative work behavior (idea generation, idea promotion, idea realization) and revealed that there is a strong positive relationship between teachers' self-efficacy and innovative work behavior. Self-confidence is a construct of broader content that includes both: self-concept and self-efficacy (Sheldrake, 2016). Thus, the presented research makes a new contribution to the knowledge about the influence of broader content individual factor — self-confidence in teaching science — on teachers' innovative work behavior.

A thorough analysis of the studies in this field indicates that most of the research is centered on self-efficacy and self-confidence, yet not linking the latter dimension with the innovative activities of teachers. One of the studies conducted by Howitt (2007) allowed to identify significant factors which influence the self-confidence of science teachers, and these factors are related to professional content knowledge, teaching practice, learning environment, and others, however, what is important to stress is that none of these factors are dominant or are not the main contributor to the self-confidence of science teachers.

We analyzed the association of science teachers' self-confidence in teaching science with their innovative work activities at the individual level. At the individual level innovation occurs in terms of the implementation of 'small scale' ideas that are related to improvements in daily work processes and activities (Axtell et al., 2000). Though, the field of innovation ranges from the organizational level to the individual level (Axtell et al., 2000; Deary et al., 2007; Meyera et al., 2019; Rohde & Thompson, 2007). It would make sense to repeat our study at the level of the organization.

At the organizational level, different types of innovators emerge: Innovators, Early adopters, Early majority, Late majority, and Laggards (Rogers (2003). Rusek et al. (2017) analyzed how ICT is used in chemistry education and revealed that Innovators represent 23% of the pre-service chemistry teachers, and only 3% of respondents are laggards – the most traditional, conservative group. It is appropriate to study the relationship between the innovative work behavior of science teachers and self-confidence in teaching science in the diametrically opposite groups: Innovators and Laggards.

Our research was constrained by some limitations. The measurement of innovative behavior is challenging. "Both scientists and practitioners emphasize the importance of innovative work behavior (IWB) of individual employees for organizational success, but the measurement of IWB is still at an evolutionary stage" (De Jong & den Hartog, 2010). We do not use a special questionnaire to investigate the innovative work behavior of science teachers. We conducted a secondary analysis of science teachers' innovative behavior using the TIMSS 2015 questionnaire. We were going to conduct research with the TIMSS 2019 Lithuanian database. However, the TIMSS 2019 questionnaire did not include questions on teachers' self-confidence and innovative work activity (generation, championing, sharing new ideas).

The results of the study indicate the need for further research on innovative work activities and self-confidence in the teaching of teachers on the TIMSS 2015 data from different countries. TIMSS 2015 data could be more explored while investigating self-confidence in teaching science and innovative work behavior not only of science but math teachers. Research on the role of the human factor in educational innovation would have important theoretical and applied implications.

Conclusion and Implication

Innovation in science education is the normal and continuing process in the curriculum, and teaching methods. In the light of the last science education reforms, teaching methods have focused on educational innovations such as scientific inquiry, discovery, and problem-solving activities. These constructivist approaches require science teachers to new innovative work behavior. Science teachers implement new learning strategies through various innovative work activities.

Statistical analysis (CFA) of various educational activities revealed that science teachers' self-confidence in teaching science using inquiry methods is mostly associated with science teachers' self-confidence in science teaching. Science teachers' activity helping students appreciate the value of learning science is at least associated with their confidence in teaching science.

SEM results confirmed that self-confidence in teaching science of teachers has a stronger direct effect on an idea application ability and less effect on an idea-generating and sharing abilities.

The analysis of paths coefficients confirmed that science teachers' innovative activity (working together to try out new ideas, learning more about teaching, encouraging students to express their ideas in a classroom, asking students to decide their own problem-solving procedures, and sharing new ideas) is directly and positively associated with science teachers' self-confidence in teaching science.

Analysis of paths coefficients confirmed that science teachers' innovative work activity of encouraging students to express their ideas in class and innovative work activity of asking students to decide their own problem-solving procedures is directly and positively associated with science teachers' self-confidence in teaching science.

A successful application of innovation in science education not only depends on technology but also human factors. This study has highlighted the importance of the human factor in implementing innovations in science education. The link between self-confidence in teaching science and innovative work behavior of science teachers should be taken into account both in the training of science teachers and in the development of in-service teacher training programs by offering more psychological content.

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