Developing an Instrument to Measure Teachers' Self-Efficacy of Teaching Innovation Skills

Huda S. Al-Azmi

Abstract—There is a growing consensus that adoption of teachers' self-efficacy measurement tools help to assess teachers' abilities in specific areas in order to improve their skills. As a result, different instruments to assess teachers' ability were developed by academics and practitioners. However, many of these instruments focused either on general teaching skills, or on the other hand, were very specific to one subject. As such, these instruments do not offer a tool to measure the ability of teachers in teaching 21st century skills such as innovation skills. Teaching innovation skills helps to prepare students for lives and careers in the 21st century. The purpose of this study is to develop an instrument measuring teachers' self-efficacy of teaching innovation skills related to the classroom context and evaluating the teachers' beliefs regarding their ability in teaching innovation skills. To reach this goal, the 16-item instrument measures four dimensions of innovation skills: creativity, critical thinking, communication, and collaboration. 211 secondary-school teachers filled out the survey to quantitatively analyze the quality of the instrument. The instrument's reliability and item analysis were measured by using jMetrik. The results concluded that the mean of self-efficacy ranged from 3 to 3.6 without extreme high or low self-efficacy scores. The discrimination analysis revealed that one item recorded a negative correlation with the total, and three items recorded low correlation with the total. The reliabilities of items ranged from 0.64 to 0.69 and the instrument needed a couple of revisions before practical use. The study concluded the need to discard one item and revise five items to increase the quality of the instrument for future work.

Keywords—Critical thinking, collaboration, innovation skills, self-efficacy.

I. INTRODUCTION

INNOVATION skills have become an important attribute in the 21st century. Teaching innovation skills helps to prepare students for a more complex life and work environment. Teachers should support students' innovation skills by focusing on creativity, critical thinking, communication, and collaboration. Teachers who have high self-efficacy in teaching innovation skills tend to achieve desired results in improving students' innovation skills. So, the purpose of this project is to develop a new instrument measuring teachers' self-efficacy of teaching innovation skills in the classroom context and evaluating the teachers' beliefs regarding their ability in teaching innovation skills. This instrument uses a criterion-referenced measure to help educators to group the results into categories such as below basic, basic, and proficient. Thus, identifying the level of teachers' self-efficacy in innovation skills and enabling educational policy-makers to focus on the weakness points to provide more training for

Huda Al-Azmi is with the Kuwait University, Kuwait (phone: +965 55148999, e-mail: ahuda1@vt.edu).

those who achieved low scores in self-efficacy. Principals, professors, and educational policymakers can use these measurements to improve teacher education programs and provide them the appropriate workshops or courses. This instrument focused on four innovation skills (4Cs): creativity, critical thinking, communication, and collaboration. A problem with existing research is that there is no instrument focused on teaching modern-day skills such as innovation skills. Reference [1] developed a teachers' sense of efficacy scale that focused on three main areas: efficacy in student engagement, efficacy in instructional strategies, and efficacy in classroom management. This instrument focused on instructional strategies in general without any mention of teaching critical thinking skills or creativity. Another problem with the existing research on teacher self-efficacy is that there is no agreement about how to measure the construct. Discrepancies between researches occur because teachers have varying skills and abilities, perceive different aspects of the work situation, and take into consideration different factors.

II. THEORETICAL FRAMEWORK

Self-efficacy plays a critical role in how we think, feel, and behave. According to [2], self-efficacy is the belief in one's abilities to achieve successful in specific tasks. In other words, self-efficacy is a person's belief in his or her ability to succeed in a particular situation. Self-efficacy impacts the learning performance of an individual, the judgment of one's ability to achieve success in completing tasks and how people can interact within a learning environment.

Many researchers have tried to develop an instrument that specifically measures teachers' self-efficacy [1], [3], [4]. Each of these researchers focused on some aspects related to teaching efficacy. Reference [1] emphasized teachers' efficacy in classrooms. They paid attention to teachers' skills in student engagement, instructional strategies, and classroom management. Reference [3] focused on science teachers' efficacy. Their measurement was nearly the same [1] regarding teachers' skills but their instrument also discussed the teachers' assessment skills. There is no (golden standard) to measure teachers' self-efficacy.

This study seeks to develop a new teachers' self-efficacy instrument by measuring teachers' beliefs in their ability to teach students innovation skills (21st century skills). This instrument will depend on the P21 framework created by the Partnership for 21st Century Learning (P21). This framework provides practical guidance on integrating 21st-century skills into learning programs and experiences for the youngest learners. It is hoped that educational policy-makers and

teacher education programmers can understand the teachers' self-efficacy needs to improve their weaknesses, and provide them training courses and workshops.

III. CONSTRUCT MAP

Constructing a teachers' self-efficacy in a teaching innovation skills instrument is derived from Bandura's social cognition theory, which is the belief in one's ability to perform his/her behavior to achieve the desired outcome [5]. A central idea posed in social cognitive theory is that successful experiences increase self-efficacy but repeated failures lower self-efficacy. This means that people become more motivated to achieve their work if they feel confident in performing. Teachers who believe that they can perform well will be more likely to face difficult tasks rather than avoid them. Teachers with high levels of self-efficacy are able to overcome difficulties and challenging tasks, while teachers with low levels of self-efficacy avoid challenging tasks because they are

not confident in their abilities to face them. Self-efficacy beliefs determine how people might feel, think, be motivated, and therefore, how they act and behave. If individuals believe that they cannot achieve or meet expectations, they will make little to no effort to complete a task or an assignment. Reference [2] states that self-efficacy beliefs "influence the courses of action people choose to pursue, how much effort they put forth in given endeavors, how long they will persevere in the face of obstacles and failures, their resilience to adversity, whether their thought patterns are self-hindering or self-aiding, how much stress and depression they experience in coping with taxing environmental demands, and the level of accomplishments they realize". In addition, in order to generate taxonomy for the development of this instrument, the definitions of many scholars who identified and explained teachers' efficacy were explored [6]-[10]. For a pictorial depiction of the construct map, see Fig. 1.
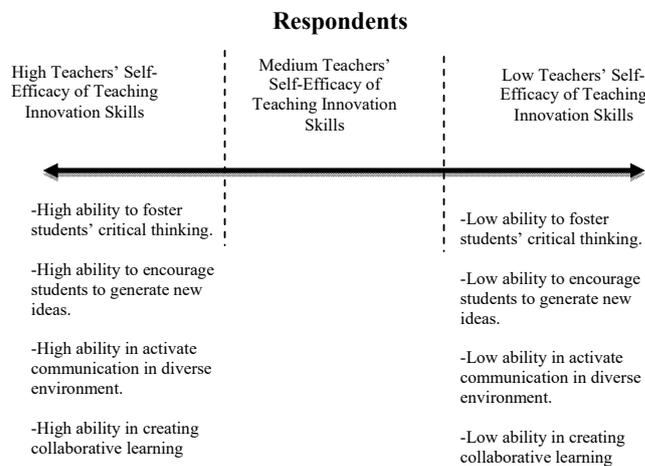

Fig. 1 Construct map of teachers' self-efficacy of teaching innovation skills

Teacher efficacy is defined as the confidence of teachers in their abilities to promote students' learning and success [6]. Reference [8] clarified that teachers with high levels of efficacy always set high goals, embrace challenging tasks, and try to use a new strategy when they find that one approach does not achieve their goals. In the results, teachers with a high sense of efficacy are more likely to achieve good results in student learning. Similarly, [9] illustrates that teachers with a high sense of efficacy exert more efforts and always achieve positive effects on students' learning and achievement. In addition, they also are more likely to have a positive influence on difficult students.

Reference [7] highlighted five behaviors found to be related to teachers' sense of efficacy. Firstly, teachers who have a high sense of efficacy have a greater level of planning and organization. Secondly, they generate new ideas and are more likely to use new methods or strategies to meet students' needs and interests. Thirdly, they are more persistent and tackle problems or challenges that hinder their goals. Fourthly, they

also are more flexible in dealing with students' mistakes. Finally, they can achieve a positive influence on difficult students or special-needs students. Teachers with a high sense of efficacy always feel they can positively influence students learn, even those who may be difficult or unmotivated [10].

IV. INTERNAL VALIDITY

Teachers' self-efficacy in teaching innovation skills encompasses a number of variables. The Partnership for 21st Century Skills is a national organization in the US, emphasized on integrating technology in schools, and improving learning skills. It created a P21 framework to describe the skills and knowledge that teachers have to focus on to prepare students to succeed in work and life. According to Partnership for 21st Century Skills [11], schools must prepare students with essential skills for success, such as creative thinking, problem solving, and communication skills within the context of core knowledge instruction. Partnership for 21st Century Skills [11] argues that there are four

correlated factors considered as the measurement of teachers' self-efficacy in innovation skills:

- *Creativity:* Teachers have to foster students to think in creative ways. For example, a teacher with high self-efficacy in creativity is able to encourage students to think and work creatively. Teachers use a range of techniques and methods to encourage students to generate new ideas. They are also open and responsive to new and diverse perspectives.
- *Critical-thinking skills:* Teachers with high self-efficacy in innovation skills are able to encourage students to think critically. Teachers have to be highly confident in fostering judgments and decisions. For example, they are always able to encourage students to analyze, compare, contrast, and solve problems.
- *Communication:* Teachers encourage students to communicate with others in oral or written ways. They also are able to use technology to communicate with students.
- *Collaboration:* Teachers must be able to foster collaborative learning by encouraging students to work in pairs or within groups. They use cooperative learning techniques, and encourage students to respect others.

V. External Validity

Previous research has found that work adjustment, job satisfaction, and stress reduction have a positive effect on self-efficacy [12]. Work adjustment is a relationship between an individual or teacher and his or her work environment. People who have a positive relationship with their work environment will increase their self-efficacy. Moreover, people who also feel positive emotion toward their work environment will have a high level of self-efficacy. Stress also affects self-efficacy; people who have low levels of stress will achieve high levels of self-efficacy. Finally, to provide evidence for criterion validity, we have to expect that the teachers' self-efficacy of assessment and teaching skills score will be correlated with stress, job satisfaction, and job adjustment.

VI. Instrument Development Procedure

Operational definitions of teachers' self-efficacy in teaching innovation skills include indicators such as: creativity skills, critical-thinking skills, communication skills, and collaboration skills. More specifically, Partnership for 21st Century Skills [11] clarified that there are many activities that foster these skills, grouped into two levels: (a) thinking level, which refers to all thinking process that foster the skills, and (b) action level, which indicates how teachers foster students to master their skills in practical ways through projects and activities.

A. Frame of Reference

This proposed measure of teachers' self-efficacy construct is a criterion-referenced measure. This measure is designed to measure the construct of teachers' self-efficacy in innovation skills. The teachers' self-efficacy scores will be compared with an established criterion or standard. This instrument uses Likert-scale items; teachers will complete the survey and respond by specifying their level of agreement to a statement, which is then transposed to a number to ease the measurement and analytics process. Reference [13] indicated that creating observable criteria for instruments on the scale improves reliability. In this instrument, the criterion has been determined prior to completing the survey with a scale from 1-5. The goal of the instrument is to measure the differences in self-efficacy levels between teachers according to established criteria. The criterion-referenced test is the most appropriate design to execute this goal through the purposed instrument.

B. Item Format

Items in this instrument will be formatted as a Likert scale with 16 items. Similar to traditional Likert scales, this scale will provide teachers with five options ranging from strongly agree to strongly disagree. Each item will be a statement that will be ranked from 1 to 5 (1= highly agree, 2= agree, 3= neutral, 4= disagree, 5= highly disagree). The use of these scales enhances substantive validity, as it will be possible to simply average a respondent's score across both dimensions (thinking and action) with positive value indicating high self-efficacy. The items are specifically designed to measure the teachers' self-efficacy in teaching innovation skills. These skills are divided into four types, and each type has two dimensions: thinking and action. The scores will indicate how much self-efficacy that teachers have obtained based on their beliefs about their abilities regarding the various components of the construct. Table I shows the measurement blueprint.

TABLE I
MEASUREMENT BLUEPRINT: DIMENSIONS OF TEACHERS' SELF-EFFICACY IN
TEACHING INNOVATION SKILLS (4CS)

Dimensions	Creativity	Critical Thinking	Communication	Collaborative
Thinking Level	2	2	2	2
Action Level	2	2	2	2

The proposed instrument is scored on a scale from 1 to 5, as aforementioned. These scores are based on a teacher's responses to the Likert scale instrument designed to measure the self-efficacy construct. This instrument measures teachers' self-efficacy in four teaching skills as key components of innovation skills. Teachers' responses will be assessed according to their beliefs about their abilities to teach students four innovation skills: creativity, critical thinking, communication, and collaboration skills. The items included in the instrument are divided into two levels of thinking level and action level for a more accurate measurement. These items are designed to be general to implement the instrument for all teachers across various disciplines. In this instrument, the content sampling will include the self-reporting of selected teachers working at schools supervised under the Kuwait Ministry of Education. The test blueprint follows the concept map and internal model, which the existing literature review used as a foundation to construct a 16-item instrument that will be used in the pilot testing.

C. Pilot Testing

A pilot test was conducted to measure the teachers' self-efficacy in innovation skills. The survey was offered to teachers in public schools in the State of Kuwait. A convenience sample of participants (n = 211) completed the survey, which consists of 16 items. Participants responded to the items using a 5-point Likert scale (1= strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; and 5 = strongly agree). The survey was administered through Qualtrics, an online resource that allowed for survey distribution and data collection. There were a total of 211 anonymous respondents within the timeframe allotted (6 days), and no time restrictions were placed on the survey. The results from the pilot test were placed into an Excel spreadsheet and imported into jMetrik, a computer program used for psychometric analysis, where the item analysis was performed.

VII. RESULTS

JMetrik was used to analyze each item in the instrument to evaluate the strengths, weakness, and potential areas for improvement. In the Likert instrument, the item difficulty did not apply because there is no correct answer for such a question. In the survey, people were asked to respond on a scale of 1 - 5 (strongly agree, agree, neutral, disagree, or strongly disagree), and any response was acceptable. For this reason, the analysis focuses on the overall item rather than the distractors (unselect the check-box for all response options). Thus the output only displays statistics for the whole item. The item difficulty was considered as the mean of teachers' responses from 0 to 4.

A. Reliability

Reliability is a significant indicator to measure the quality of instrument. Table II displays the overall item reliability, the coefficient alpha. The overall reliability estimate of the measurement is 0.6744, which indicates 67% consistency in the scores produced by the instrument. The reliability of the instrument is low because for research purposes, a minimum reliability of 0.70 is required. Some researchers feel that it should be higher. In this instrument, the reliability is low, and items need revision or deletion to increase the reliability.

TABLE II
RELIABILITY ANALYSIS

Method	Estimate	95% Conf. Int.	SEM
Guttman's L2	0.7337	(0.5851, 0.8467)	2.7286
Coefficient Alpha	0.6744	(0.5082, 0.8183)	2.9707
Feldt-Gilmer	0.6966	(0.5273, 0.8253)	2.9125
Feldt-Brennan	0.6948	(0.5245, 0.8243)	2.9212
Raju's Beta	0.6844	(0.5082, 0.8183)	2.9707

A further analysis of Table III suggests that the reliability of the instrument would increase if Q9, Q11, Q12, Q15, and Q16 were removed. Removing item Q9 will increase reliability from 0.67 to 0.70, removing Q11, Q12, and Q15 will raise reliability from 0.67 to nearly 0.70, and Q16 increases reliability from 0.67 to 0.71.5.

TABLE III
RELIABILITY IF ITEM DELETED

Item	L2	Alpha	F-G	F-G	Raju	L2
Q1	0.707	0.650	0.665	0.665	0.650	0.707
Q2	0.711	0.656	0.672	0.672	0.656	0.711
Q3	0.704	0.668	0.662	0.662	0.648	0.704
Q4	0.737	0.684	0.696	0.696	0.684	0.737
Q5	0.700	0.668	0.664	0.664	0.648	0.700
Q6	0.720	0.666	0.681	0.681	0.666	0.720
Q7	0.718	0.664	0.678	0.678	0.664	0.718
Q8	0.707	0.669	0.663	0.663	0.649	0.707
Q9	0.739	0.704	0.701	0.701	0.694	0.739
Q10	0.706	0.650	0.663	0.663	0.650	0.706
Q11	0.738	0.697	0.714	0.714	0.697	0.738
Q12	0.746	0.695	0.710	0.710	0.695	0.746
Q13	0.723	0.675	0.687	0.687	0.675	0.723
Q14	0.704	0.648	0.663	0.663	0.648	0.704
Q15	0.734	0.708	0.698	0.698	0.687	0.734
Q16	0.740	0.715	0.713	0.713	0.695	0.740

B. Item Analysis

In the item difficulty, the scores closest to 4 indicate high self-efficacy and the items closest to 0 indicate low self-efficacy (see Table IV). As this instrument uses a Likert scale, all responses are correct and reflect the amount of self-efficacy across different items. In this case, the mean of self-efficacy with item difficulty was analyzed as the mean of self-efficacy. The mean of self-efficacy ranged from 2.8571 to 3.6857. There were no extreme high or low self-efficacy scores. In general, the mean of self-efficacy ranged from 3 to 3.6. The item numbers 3, 11, and 16 achieved a medium score in the mean of self-efficacy which ranged from 2.6 to 2.8 (it is slightly high).

On the other hand, discrimination is defined as the strength of the relationship between the item and the total test. It is used to depict the degree to which the item rank orders examinees in the same sequence that other items do. An item-total score correlation that is near zero or negative typically indicates a bad item. In this instrument, most items have good correlation with the total, which ranged from 0.3 to 0.6. In the instrument, one item recorded a negative correlation with the total (Q 9), which recorded -0.2070. Additionally, three items recorded low correlation with the total but are still positive (Q 4, Q11, Q12).

VIII. DECISION

After conducting an item analysis on this survey, it is clear that this survey requires major revisions before it can be administered for an actual study. For example, the overall reliability of this survey is quite low (α = 0.6744). As this survey uses a Likert scale, the difficulty of items did not apply because all the responses are correct. Recommendations to revise or discard an item were determined as follows: (1) items that increased Cronbach's alpha if deleted but did not have a negative total item correlation were suggested for revision; (2) items with a negative total item correlation were discarded. The results of item analysis recommendations for each item are discussed in the section below and shown in

Table IV.

Depending on the analysis, five items requiring revision, and one to discard. In item number 9, "I am able to encourage students to articulate their thoughts in oral, written and nonverbal communication skills in a variety of forms and contexts", the decision is taken to discard this item, because the correlation with the total is negative, and Cronbach's alpha will increase to 0.7049. The (negative of correlation with total) means that this item has a low level of decision consistency. In addition, deleting this item will raise the reliability from 0.67 to 0.70. This item may need to be re-written because the oral, written, and nonverbal skills are specific issues and need separate written items.

Item number 4 "I am able to create activities in order to meet students' interests and needs", item number 11 "I am able to use technology to foster communication between students, or between students and teacher", item 12 "I am able to give each student feedback in each exercise or assignment", item 15 "I am able to encourage students to work in pairs or groups" and item 16 "I am able to use cooperative learning (it is teaching strategy encourages students to work in groups with using variety of activities to promote of understanding of a subject) in my classroom" need revisions. Deleting these items will increase the reliability, but they have a positive correlation with the total. So, these items will be revised as follow:

- Item 4 "I am able to create activities in order to meet students' interests and needs." will be changed to "I am able to use multiple teaching strategies in my classroom" because "meet students' interests" may not be clear, but using multiple teaching strategies means that the teacher can meet students' interests.

- Item 11 "I am able to use technology to foster communication between students, or between students and teacher." will be changed to "I use technology to foster communication between students" because the item indicates both communication "between students" and "between students and teachers" and these may need to be separate items. In this case, this item may need to narrow to "between students" or add another item to indicate communication between students and teachers.

- Item 12 "I am able to give each student feedback in each exercise or assignment." will be changed to "I am able to give students feedback in each assignment" because the item indicates both "exercise" and "assignment," yet exercise refers to classroom work, while assignments are homework.

- Item 15 "I am able to encourage students to work in pairs or groups." will be changed to "I am able to create group exercises in classroom" because the term of "encourage" is not clear or measurable.

- Item 16 "I am able to use cooperative learning (it is a teaching strategy that encourages students to work in groups using a variety of activities to promote their understanding of a subject)." I will change it to "I am able to create group activities" because the item is too long and confusing.

TABLE IV
THE DECISION TO REVISE OR DISCARD ITEMS

ID	item	Correlation with Total	Alpha Reliability if item deleted	Decision
Q1	I am able to ask students open-ended questions (questions that need more than one word answers like suggestions or opinions).	0.5702	0.6508	Keep
Q2	I am able to encourage students to generate creative ideas and solutions to solve specific problems.	0.4435	0.6568	Keep
Q3	I am able to create students group projects depending on multiple abilities or interests.	0.4531	0.6683	Keep
Q4	I am able to create activities in order to meet students' interests and needs.	0.1924	0.6549	Revision
Q5	I am able to help students to analyze, evaluate evidence or alternative points of view, arguments, claims and beliefs.	0.4783	0.6683	Keep
Q6	I am able to foster students' thinking to compare and contrast between two things.	0.3668	0.6667	Keep
Q7	I am able to create solving problems projects (for example: I can group students and give each group problem to analyze this problem by identifying reasons, results, and then create solutions to solve it).	0.3905	0.6649	Keep
Q8	I am able to create activities that need synthesis and make connections between information and arguments.	0.5021	0.6698	Keep
Q9	I am able to encourage students' to articulate their thoughts in oral, written and nonverbal communication skills in a variety of forms and contexts.	-0.2070	0.7049	Discard
Q10	I am able to encourage students' to express their thoughts to others, and listen effectively to decipher meaning.	0.4204	0.6505	Keep
Q11	I am able to use technology to foster communication between students, or between students and teacher.	0.1493	0.6975	Revision
Q12	I am able to give each student feedback in each exercise or assignment.	0.1462	0.6958	Revision
Q13	I am able to encourage students to share their thoughts with peers.	0.2556	0.6751	Keep
Q14	I am able to encourage students to write conclusion after discussion with other students and listen to different thoughts.	0.5495	0.6489	Keep
Q15	I am able to encourage students to work in pairs or groups.	0.3763	0.7087	Revision
Q16	I am able to use cooperative learning (it is teaching strategy encourages students to work in groups with using variety of activities to promote their understanding of a subject) in my classroom.	0.3604	0.7138	Revision

IX. CONCLUSION

First, the results from the use of the instrument revealed the need to discard one item and revise five others. These results provide insightful information for future work to increase the quality of this instrument. Second, reapplication of the instrument and the reliability and item analysis will be measured to make sure that the reliability is increased (not less

than 0.70). There are a couple of recommendations that may increase the quality of the instrument: (a) increase the sample of the study to 350-500, (b) use advanced statistical analyses such as the Rush model and factor analysis to reliably analyze the quality of the instrument and the relationships between dimensions. A significant growth will be expected when considering the previous recommendations for future application.

APPENDIX

TABLE V

TEACHERS' SELF-EFFICACY OF TEACHING INNOVATION SKILLS (4CS) SURVEY

Components	Level	item	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Creativity	Thinking	I am able to ask students open-ended questions (questions that need more than one word answers like suggestions or opinions). I am able to encourage students to generate creative ideas and solutions to solve specific problems.					
	Action	I am able to create students' group projects depending on multiple abilities or interests. I am able to create activities in order to meet students' interests and needs.					
Critical Thinking	Thinking	I am able to help students to analyze, evaluate evidence or alternative points of view, arguments, claims and beliefs. I am able to foster students' thinking to compare and contrast between two things.					
	Action	I am able to create solving problems projects (for example: I can group students and give each group problem to analyze this problem by identifying reasons, results, and then create solutions to solve it). I am able to create activities that need synthesis and make connections between information and arguments.					
Communication	Thinking	I am able to encourage students' to articulate their thoughts in oral, written and nonverbal communication skills in a variety of forms and contexts. I am able to encourage students' to express their thoughts to others, and listen effectively to decipher meaning.					
	Action	I am able to use technology to foster communication between students, or between students and teacher. I am able to give each student feedback in each exercise or assignment.					
Collaboration	Thinking	I am able to encourage students to share their thoughts with peers. I am able to encourage students to write conclusion after discussion with other students and listen to different thoughts.					
	Action	I am able to encourage students to work in pairs or groups. I am able to use cooperative learning (it is teaching strategy encourages students to work in groups with using variety of activities to promote their understanding of a subject) in my classroom.					

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