

Development questionnaire about High school students learning science and technology in the 21st century

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Abstract:

This study revised three surveys. The development of questionnaires was focused on three major themes: 21st century learning ability, Teacher Authority Survey (TAS), and Self-efficacy. Firstly, 21st century learning ability is the relationships among students' perceptions for collaborative learning, critical thinking, self-directed learning, creative thinking, meaningful use of Information and communication Technology (ICT), problem solving, knowledge creation efficacy, design disposition, teacher authority, and learning achievements. And, secondly, name Learning in schools and the preferred version of TAS questionnaire, and utilize both of them to elicit high school students' conceptions of learning and preferences of teacher authority in classroom. The study aims to develop a questionnaire to explore High school students' learning science and technology in the 21st century.

Keywords: 21st century learning ability, TAS, Self-efficacy, ICT

1. Introduction

The implications of the implementation of 21st century competences in national curriculum policies have been discussed and recommendations are provided in many previous studies. Several (international) organizations and scholars have attempted to promote the integration of 21st century competences in national curriculum policies by providing descriptions of the competences that are regarded as important issues for the knowledge society. These descriptions are usually accompanied by specifications of the types of teaching, learning, and assessment approaches associated with the implementation of these competences in school curricula (Joke Voogt & Natalie Pareja Roblin, 2012). Globalization has changed the way in which most people live, work and study in the 21st century. Students and teacher educators, such as other professionals, have to embrace these changes to be effective in their jobs and the ongoing change is the use of Information Communication Technologies (ICT) for lifelong learning.

There is a relationship between learning in school and learning by preferences for teacher authorities among high school students in Taiwan. The relationships between learning context and learners during the learning process have attracted more and more attentions in educational researchers. In Biggs' 3P model of student learning (2001), learning contexts and learners are presages of learning outcomes.

There are two factors that influence of learning process: (1) The factors of learning context, such as Assessment, Climate, Teaching parameters, and Teacher authority; and (2) the factors of learners, such as Attitude, Motive, Conception, and Belief. If we take learners as the kernel of the whole learning process, there exist two perspectives to investigate the relationships between learning context and learners, from the inside out and from the outside in.

Based on Biggs' 3P model of student learning (2001), there are two cognitive and affective flow of learning, which is from outside in (Cognitive dimension, situated views of cognition and perceptions of contexts) and is from inside out (Affective dimension, Conception of learning, and Differentiated instruction).

In the other research by Lee, Chang, and Tsai (2009) found that teacher authorities in the science learning environment may have a potential impact on students' learning outcomes, including

achievement and attitudes. Tsai (2004) suggested that conceptions of learning represent students' beliefs about school knowledge and learning in general. Both factors are important factors to determine student performance. Based on previous studies, researchers want to know the relationship between two independent variables.

2. Method

The development of questionnaires was focused on three major themes: 21st century learning ability, Teacher authorities, and Self-efficacy.

2.1. 21st century learning ability

From the article (A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies, Joke Voogt & Natalie Pareja Roblin, 2012) found that there are strong agreements on the need for competences in the areas of communication, collaboration, Information and communication technology (ICT), which was related to competences, and social and/or cultural awareness. Creativity, critical thinking, problem-solving, and the capacity to develop relevant and high quality products are also regarded as important competences in the 21st century by most frameworks.

The 21st century competences needed in the knowledge society can be regarded as the overall rationale and goals for learning. Therefore, eight themes describing 21st century learning ability is developed. Totally, there were 48 items in the questionnaire and it was designed to measure students' perceptions of learning environment.

2.1.1 Collaborative learning

Knowledge converges in collaborative case-based learning. Methods of case-based learning have repeatedly been proposed for implementation in teachers' education. It is because learning with cases and problems is ascribed to high potential for promoting analytical, problem-solving skills, and for overcoming inert knowledge (e.g., Levin, 1999 and Merseth, 1996).

In collaborative learning, as can be seen in Table 1. For example, learners are supposed to develop a similar understanding of which aspects or situational cues of the given case are important. Then, apply appropriate principles to them (see Choi & Lee, 2009). As O'Neill, Scott and Conboy (2011) pointed out that several studies have demonstrated the superiority of collaborative learning over traditional modes of learning. These authors indicate that working in groups is not just a valuable way of learning but also develops the abilities for cooperative work, which are essential in the modern working place.

Table 1: Collaborative learning

Theme 1	Description	
	Learner-centered aspect: Learning in school...	
Collaborative learning	1	In this class, my classmates and I actively work together to complete tasks.
	2	In this class, my classmates and I actively discuss different views we have about things we are learning.
	3	In this class, I get helpful comments about my work from my classmates.
	4	In this class, my classmates and I actively work together to learn new things.
	5	In this class, my classmates and I actively share and explain our understanding.

2.1.2 Critical thinking

Mentioned in Table 2 critical thinking, or capacity to apply rigorous logical processes in judging the merits of evidence, is clearly relevant to scientific inquiry and learning of science. It also has been defined in various ways by others. For example, Lipman defines critical thinking as “skillful, responsible thinking that facilitates good judgment because it relies upon criteria, is self-correcting and is sensitive to context” (Lipman, M. Educ. Leadership 1988). Siegel states that “a critical thinker is one who appreciates and accepts the importance and convicting force of reasons” (Siegel, H. Synthese 1989).

Ennis’s definition may be most widely used; he stated critical thinking as “reasonable reflective thinking that is focused on deciding what to believe or do” (Ennis, R. H1987). It is clear that the process of deciding what to believe or to do depends on the learner’s epistemological commitments—that is, his or her standards of judging knowledge—and the use of reflective thinking depends on his or her metacognitive processing. Hence Kuhn asserted that critical thinking should be viewed as metacognition rather than cognition (Kuhn, D. Educ. Res. 1999).

The critical inquiry starts with a triggering phase involving an issue, a dilemma, or a problem. The participants then engage in a process of social exploration of ideas. (Chin-Chung Tasi, 2010) These interactions allow participants with various perspectives to contribute their ideas in an environment where social status (e.g., academic level) and other social, cultural, and academic contextual factors become less important. And, critical thinking may become more important.

Table 2: Critical thinking

Theme 2	Description	
	Learner-centered aspect: Learning in school...	
Critical thinking	1	In this class, I think about whether or not what I learnt is true.
	2	In this class, I have opportunities of judging the value of new information or evidences presented to me.
	3	In this class, I think about other possible ways of understanding what I am learning.
	4	In this class, I evaluate different opinions to see which one makes more sense.
	5	In this class, I decide what kind of information can be trusted.
	6	In this class, I distinguish what are supported by evidence and what are not.

2.1.3 Self-directed learning

Self-directed learning requires self-assessment of learning needs and performance. Modern learning principles suggest that learning strategies should be self-directed rather than teacher-directed, and should encourage independent decision making as well as make students become aware of their own deficiencies (Knowles 1984; Rolfe & Sanson-Fisher 2002; Sanson-Fisher et al. 2005). The aim of this in Table 3 study was to gain insight into how learners process external information and apply their interpretation of this information to their self-assessment and learning during a structured educational activity.

Table 3: Self-directed learning

Theme 3	Description	
	Learner-centered aspect: Learning in school...	
Self-directed learning	1	In this class, I set goals for my studying.
	2	In this class, I make plans for how I will study.
	3	In this class, I check my progress when I study.
	4	In this class, I think about different ways or methods I can use to improve my study.
	5	In this class, I reflect about the ways I study.
	6	In this class, I adjust the ways I study based on my progression.

2.1.4 Creative thinking

An innovative approach to measuring knowledge convergence was introduced. Table 4 gives an example. In a complex and rapidly changing globalized world, it is critically important that teachers and teacher educators engage in debate, decision making, new knowledge creation, and action for change.

Table 4: Creative thinking

Theme 4	Description	
	Learner-centered aspect: Learning in school...	
Creative thinking	1	In this class, I generate many new ideas.
	2	In this class, I create different solutions for a problem.
	3	In this class, I suggest new ways of doing things.
	4	In this class, I design objects that may be helpful.
	5	In this class, I produce ideas that are likely to be useful.
	6	In this class, I develop innovative ideas.

2.1.5 Meaningful use of ICT

Information and communication Technology (ICT) is in the core of each of the frameworks. Not only the development is regarded as an argument for the need of new competences by all frameworks, but it is also associated to a whole new set of competences about how to effectively use, manage, evaluate, and produce information from different types of media. (Joke Voogt & Natalie Pareja Roblin, 2012)

Interest in social networking practices and their educational implications are growing as a new field of digital media. Also, learning brings together learning scientists, educational technologists, instructional designers, literacy theorists, and media scholars to explore, debate, and envision systemic change for education in the digital age (Greenhow & Burton, 2011). As Cho, Gay, Davidson and Ingraffea (2007) indicated, a growing body of research has demonstrated that a social network is a central element in collaborative learning environments.

Table 5 presents an overview of the various frameworks analyzed. Computer-supported learning environments enable learners to work with video cases in new and innovative ways, such as annotating case videos (Fu, Schaefer, Marchionini, & Mu, 2006). Recent studies that compared annotation-based environments with discussion boards have provided some evidence. It is that the ability to easily link annotations to specific passages of a primary document can positively influence the quality of subsequent discussion through an increase of task-directedness and deeper elaboration of content (e.g., Wolfe, 2008)

Table 5: Meaningful use of ICT

Theme 5	Description	
	Learner-centered aspect: Learning in school...	
Meaningful use of ICT	1	In this class, I construct ICT-based materials (e.g. PowerPoint slides, word documents, mindmaps) to represent my understanding.
	2	In this class, my classmates and I actively communicate online (e.g. LMS, Discussion Forum, Facebook, Wiki etc.) to learn new things together.
	3	In this class, I find out useful information on the Internet to help my learning.
	4	In this class, I use the computer to organize and save the information for my learning.
	5	In this class, I use the computer to record my ideas for my learning progress.
	6	In this class, I use the computer to remix/re-organize information from other resources.

2.1.6 Problem solving

The key question tackled in Table 6. This field concerns how to identify and create the most favorable conditions for effective learning and development; thus, prepare learners to cope with challenges, such as deeply understanding concepts, theories and principles; making causal reasoning; solving complex problems; and exercising critical and creative thinking.

Table 6: Problem solving

Theme 6	Description	
	Learner-centered aspect: Learning in school...	
Problem solving	1	In this class, I am challenged by many real-world problems.
	2	In this class, I learn about real-life problems that people have.
	3	In this class, I investigate the reasons that give rise to real-world problems.
	4	In this class, I apply the knowledge I have to solve real-life problems.
	5	In this class, I practice solving real-world problems.
	6	In this class, I think about whether my solutions to real-world problems are good.

2.1.7 Knowledge creation efficacy

The center of this analytical framework is a shift from shared understanding to an individual's independent construction of knowledge in multiple-week discussions. (Chin-Chung Tasi, 2010) In online knowledge building, making judgments with supporting examples or with justifications of new information is viewed as in-depth processing during online discussions (Hara et al. 2000).

The aim of it in Table 7 study was to gain the rich variety of information on the Internet, which may also help students develop the metacognitive skill of information organization; that is, keep track of sources of information and merge them with newly identified information on the Internet.

Table 7: Knowledge creation efficacy

Theme 7	Description	
	Learner-centered aspect: Learning in school...	
Knowledge creation efficacy	1	I am able to connect different ideas to form new ideas.
	2	I am able to build explanations/theories about things related to the issues that I am learning.
	3	I am able to create useful ideas that may help to address problems in our society.
	4	I am able to design things that may be useful.
	5	I am able to create useful knowledge on my own.
	6	I am able to generate new ideas about what I am learning.
	7	I am able to find answers to questions that I want to understand.

2.1.8 Design disposition

As can be seen in Table 8, develop a positive disposition to learn and make use of higher-order thinking skills.

Table 8: Design disposition

Theme 8	Description	
	Learner-centered aspect: Learning in school...	
Design disposition	1	I am comfortable with the presence of uncertainty.
	2	I am open to new ideas about how things can be done.
	3	I am comfortable to explore conflicting ideas.
	4	I am comfortable to deviate from established practices.
	5	I am comfortable with occasional failures from trying out new

		approaches for teaching.
	6	I am constantly seeking to turn constraints into opportunities.

2.2. TAS

This questionnaire was modified from the ESCLEI used in our previous study (Chang et al., 2006; Lee & Chang, 2004), and the description of items on the TAS was revised to encompass teacher authority in particular.

Oyler (1996) stated that teacher authority can be analyzed from both the process dimension and the content dimension. Thus, the items of the TAS were revised from the items of the ESCLEI with the description regarding the course content and the processes in the classroom.

In order to assess students' perceptions of and preferences for teacher authorities in the classroom, researchers adapted from The Teacher Authority Survey (TAS). This questionnaire was modified from The Teacher Authority Survey (TAS) (Lee, Chang, & Tsai, 2009), and the description of items on the TAS was modified to cover teacher authorities in particular situation. The Teacher Authority Survey (TAS) has 20 items and it was designed to measure students' perceptions of learning environment with a focus on learner-centered and teacher-centered components that cover curriculum content, teaching process, and assessment.

2.3. Self efficacy

2.3.1. Definition of Self efficacy

Self-efficacy is individual belief on their self to do certain task (Bandura, 1997). Dale Schunk (2001) states self-efficacy will influence their task preference. For example, individual with low self-efficacy avoid hard task especially challenging task; however, individual with high self-efficacy have great desire to motivate their self to do challenging task. Bandura (1997) explain self-efficacy will be different in every task and self-efficacy will influence task preference, effort, perseverance, endurance, and achievement.

2.3.2. Influencing factor of self-efficacy

Bandura (1997) explained there are three major factors that influence self-efficacy which are:

1. Mastery experiences

Successful experience will increase self-efficacy and failure will reduce self-efficacy. If people gain successful experience because of outside factor, such as luck or helped by other, there will be no enhancement of self-efficacy; however, if people gain successful experience because of self-efficacy, such as hardworking, there will be some enhancement of self-efficacy.

2. Vicarious experiences

Others' successful experiences that have similarity with the individual will increase self-efficacy, especially to do a similar task. In this case, self-efficacy is gained by social model. However, vicarious experience will be no effect if the model has no similarity to the individual.

3. Social persuasion

Verbal encouragement from someone who are capable to persuade others and be trusted by others will increase the individual's self-efficacy.

2.3.3. Self efficacy measurement

Bandura (1997), measurement of self-efficacy has three dimensions:

1. Level

Level is confidence degree of the individual to execute a certain task. Difficulty degree will be evaluated by individuals' perception toward a certain task. This component has implication in choosing behavior based on difficulty level. Individual tends to avoid a task that they perceived as a difficult task. Zimmerman (2003) divided level into three levels:

- If individual think they can do the task successfully, they will do the task
- If individual think they are impossible to do the task, they will avoid doing the task
- If individual think the task is achievable for them, they will try and give the best effort to do the task.

2. Strength

Strength of self-efficacy refers to the resoluteness of one's conviction to perform a task. And, the stronger the self-efficacy expectancy, the greater the likelihood of selecting challenging tasks, striving despite obstacles, and successfully attaining their goal. The dimensions of self-efficacy suggest that an individual who has self-efficacy on a task which is limited to its specificity to a particular level should not be generalized across domains.

3. Generality

Generality of self-efficacy refers to its pervasiveness across behaviors and contexts. People may perceive themselves to be generally efficacious in a range of activities or only within a domain of functioning.

2.3.4. Domains of self-efficacy

There are four role processes of self - efficacy: (a) cognitive (b) motivational, (c) choice and (d) emotional processes (Bandura, 1999). This role of self-efficacy in the domains of cognitive, behavior and emotion can be measured by assessing cognitive self-efficacy, motivational self-efficacy, behavioral self-efficacy, and emotional self-efficacy.

1. Cognitive processes

Cognitive process will impact on choice of strategies, development of rules for predicting and influencing events, and efficiency and effectiveness in problem solving and decision-making (Maddux, 1995). Cognitive processes include one's ability to control over one's thoughts and mental processes.

2. Motivation

Perceived efficacy is crucial for the development and regulation of motivation. "Cognitive motivation based on goal intentions is mediated by three types of self - influences: self-evaluation, perceived self-efficacy for goal attainment, and ongoing adjustment of personal standards" (Bandura, 1990, p. 81). Among these three mediators of motivation, self-efficacy has a causal(?) influence on motivation.

4. Choice behavior

Perceived self-efficacy influences choice of goals, activities directed to attaining the goal, the amount of effort expended, and perseverance in the face of obstacles. High self-efficacy leads to setting higher goals and greater commitment to attaining them (Maddux, 1995).

5. Emotion

Self-efficacy beliefs impact on both the type and intensity of emotion with low self-efficacy to attain a goal leading to despondency. Positive effect state leads to enhanced self-efficacy. Emotional efficacy can be measured through measurement of cognitive and behavioral self-efficacy for controlling emotions, cognitive self-regulation, and for performing pleasant or mastery-related behaviors.

Conclusion

This study aims to synthesize literature about various frameworks that were developed to support about high school students' learning in the 21st century science and technology. Globalization and the knowledge economy have opened up worldwide agendas for national development. Following this, there is the emphasis on the social dimension. Much of social capital includes "learning skills" and "21st century skills", which broadly cover critical, creative and inventive thinking; information, interactive and communication skills; civic literacy, global awareness and cross-cultural skills. In addition, the challenges of teaching 21st century skills will also be highlighted. It departs from the conventional paradigm of socialization, but to help students develop attributes for a future society to come.

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