Pre-service chemistry teachers’ attitudes and attributes toward the twenty-first century skills

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Abstract. Teacher education has a significant role in preparing pre-service teachers with adequate 21st century skills. There has been a shift of educational standards in the 21st century learning that replaces basic skill competencies and knowledge expectation of the past. These changes need to be mastered by pre-service teachers. They will offer valuable insights for the present and future pre-service teachers when they have positive attitudes and attributes to the 21st century skills. This research aimed to analyse the pre-service Chemistry teachers’ attitudes and attributes toward the 21st century skills. Descriptive method involving 48 pre-service Chemistry teachers was used in this research. Ten skills grouped into four classes involving ways of thinking, ways of working, tools for working, and living in the world were identified using measurable dimensions: knowledge, skills, and attitudes/values/ethics. The overall findings indicated that pre-service Chemistry teachers expressed moderately positive attitude toward the 21st century skills but had lack of communication and collaboration skill in the ways of working. Each indicator of attitudes and attributes was discussed. For the future research, it is suggested to promote the 21st century skills using appropriate methods and approaches to pre-service Chemistry teachers’ in order to get more qualified education.

1. Introduction
The current Information and Communication Technology (ICT) has transformed human ways of working. Previous research has shown how social culture has evolved as a result of the increased use of digital technology [1]. This leads to the formation of new concepts of competence and skills needed. To address these challenges, schools and teachers must be transformed to facilitate students to think creatively and innovatively, have flexible problem-solving skills, and possess the necessary communication and collaboration skills in work-fields and everyday life [1–3]. A new concept of educational standards and assessment is a key strategy to complete the transformations needed. This transformation is embodied in a concept called the twenty-first century learning [1,4,5].

Teacher education has a significant role in preparing teachers and pre-service teachers with adequate twenty-first century skills [6]. Most of the researches focused on improving student performance through more rigorous content area requirement, more standardized curricula, and more homework. Relatively little attention was paid to the role of teachers or the act of teachers. The teacher is the central figure in education. The act of teaching is the critical link to schools and student improvements [7]. There has been a shift of educational standards in the twenty-first century learning that replaces basic skill competencies and knowledge expectation of the past [5]. These changes need to be mastered by teachers
and pre-service teachers. They will offer valuable insights for the present and future pre-service teachers when they have positive attitudes and attributes to the twenty-first century skills [8].

Research-based knowledge and skills about the twenty-first century skills are dynamic and evolving [9]. In parallel with the increased interest in teaching and learning of the twenty-first century skills, educational researchers have devoted significant efforts to the development of a framework for the twenty-first century skills, like Partnership for the Twenty-First Century [10], the National Research Council [11], and the Assessment and Teaching of the Twenty-First Century Skills (ATC 21) [1] [3] [10] [12–15].

The Partnership for Twenty-first Century defines skills in the twenty-first century using 3 main frameworks; they are (1) learning and innovation skills including creativity and innovation, critical thinking and problem solving, and communication and collaboration; (2) information, media and technology skills, including information literacy, media literacy, and ICT literacy; (3) life and career skills which include flexibility and adaptability, initiatives and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility [3] [10].

The National Research Council defines skills in the twenty-first century by: (1) cognitive skills, including critical thinking, non-routine problem solving, and system thinking; (2) interpersonal skills, including complex communication, social skills, teamwork, cultural sensitivity, and dealing with diversity; (3) intra-personal skills which include self-management, time management, self-development, self-regulation, adaptability, and executive functioning [3] [13].

The Assessment and Teaching of the Twenty-First Century Skills has also offered framework for different types of the twenty-first century skills. In its framework, there are ten skills grouped into four categories; they are (1) ways of thinking including creativity and innovation, critical thinking, problem solving and decision making, learning to learn, and metacognition, (2) ways of working including communication and collaboration or teamwork, (3) tools for working, including information literacy and ICT literacy, (4) living in the world including citizenship, life and career, and personal and social responsibility. This framework identifies with measurable dimensions of the skills: knowledge, skills, attitudes, values and ethics (KSAVE) [1] [3] [16] [17].

The three exemplary frameworks appear to overlap with each other. Therefore, the researcher has the right to choose to focus on the desired framework [3]. This study focuses on how attitudes and attributes of pre-service teachers, especially pre-service Chemistry teachers toward the twenty-first century skills offered by ATC21. The results of this study can be used as a basis for improving the skills of pre-service Chemistry teachers to teach in the twenty-first century, and it is suggested to promote pre-service Chemistry teachers in order to get more qualified education.

2. Method

This research used descriptive method which aimed to know the attitudes and attributes of pre-service Chemistry teachers toward the twenty-first century skills. 48 third-years pre-service Chemistry teachers, from Universitas Sebelas Maret became the participants of this research. The data collection techniques used in this research was questionnaire and interview. The questionnaire used in this study refers to four frameworks with 10 twenty-first century skills offered by ATC 21. This framework is identified using the measurable dimensions: knowledge, skills, attitudes, values and ethics (KSAVE) [1] [16]. From the framework and the dimensions, a questionnaire with 60 positive and negative statements was generated to determine the attitudes and attributes pre-service Chemistry teachers. The questionnaire presented with four-point LInkert scale (e.g., 1 = strongly disagree to 4 = strongly agree).

The interviews with pre-service Chemistry teachers were semi-structured to elicit information from each component of the attitudes and attributes. The pre-service Chemistry teachers were asked about their knowledge, thoughts, and associations (knowledge dimension), their feelings and emotional responses (attribute, values / ethics dimension), and their experience and intentions (skill dimension) toward the twenty-first skills based on ATC 21 [18].
3. Result and discussion

3.1. Pre-service Chemistry teachers' attitudes

Attitude is “a psychological tendency that is expressed by evaluating a particular entity with some degrees of favour or disfavour” [19]. The attitude object can be anything, such as Chemistry, chemists, Chemistry lesson, chemical education research and also pre-service Chemistry teacher [20]. The study of attitudes is important because of its influence over individual’s behaviour [21]. The evaluation of attitude refers to cognitive, affective, and behaviour [19]. This attitude evaluation matches the skill dimensions of ATC 21, i.e. cognitive appears to be roughly equivalent to ATC 21 knowledge dimensions, affective to attitude/ values /ethics, and behaviour to skills [1] [19]. The questionnaires were filled out by 48 pre-service Chemistry teachers to find out their attitudes toward the twenty-first century skills. The results of the shared questionnaire are presented in table 1.

Table 1. The percentage of positive responses from the questionnaires.

| No | Skill Framework | Statements | Attitude Dimensions (%) |
|----|-----------------|------------|-------------------------|
|    |                 |            | Knowledge | Attitudes | Skills |
| 1  | Creativity and innovation | Positive | 93.8 | 98 | 63.2 |
|    |                 | Negative  | 38.5 | 32.7 | 18.3 |
| 2  | Critical thinking, problem solving, and decision making | Positive | 98 | 91.6 | 73.4 |
|    |                 | Negative  | 42.8 | 28.5 | 55.1 |
| 3  | Learning to learn, metacognition | Positive | 87.8 | 100 | 75.5 |
|    |                 | Negative  | 47 | 28.6 | 85.7 |
| 4  | Communication   | Positive  | 87.7 | 53 | 83.3 |
|    |                 | Negative  | 36.7 | 89.8 | 49 |
| 5  | Collaboration   | Positive  | 97.9 | 100 | 95.9 |
|    |                 | Negative  | 22.4 | 53 | 59.2 |
| 6  | Information literacy | Positive | 95.9 | 93.8 | 93.9 |
|    |                 | Negative  | 8.1 | 34.7 | 26.6 |
| 7  | ICT literacy    | Positive  | 83.7 | 98 | 91.8 |
|    |                 | Negative  | 22.5 | 16.3 | 8.1 |
| 8  | Citizenship     | Positive  | 98 | 81.6 | 85.7 |
|    |                 | Negative  | 26.5 | 12.3 | 26.5 |
| 9  | Life and career | Positive  | 81.6 | 97.9 | 87.7 |
|    |                 | Negative  | 30.6 | 40.8 | 36.7 |
| 10 | Personal and social responsibility | Positive | 89.8 | 95.9 | 89.8 |
|    |                 | Negative  | 57.1 | 18.3 | 51 |

The percentages in table 1 represent the percentage of agreed and strongly agreed responses on the positive and negative statements of the existing skills and dimensions. Table 1 showed that pre-service Chemistry teachers have positive attitudes toward the twenty-first century skills. But there are still some skills that have a negative attitude. It is characterized by a high percentage in negative statements for each skill and dimension.

Learning to learn and metacognition skills in the skill dimensions have a high percentage of negative statement, which indicates that pre-service Chemistry teachers have proper knowledge about the skills, but not yet had the skills/ habits to apply it. The skills of learning to learn and metacognition are the
ability to set up the time to learn, autonomy, discipline, perseverance and information management in the learning process and also effective self-management to control, regulate, and monitor their use of various learning strategies [1][22].

Communication and collaboration skills in attitudes and skill dimensions also have a high percentage of negative statements, indicating that pre-service Chemistry teachers have problems to teach in front of the class and to collaborate with the students in classroom learning. Interview results prove that pre-service Chemistry teachers lack confidence when teaching. In addition, they prefer to provide one-way explanations rather than cooperating with their students. In the twenty-first century, more often than not, interdisciplinary teams must work together to advance knowledge. The research indicates that communication and collaboration skills are extremely important in the field of science including Chemistry [22]. In the meantime, the skills of collaboration and communication both orally and in writing are the skills needed in the workplace [23][24]. Therefore, those skills should be incorporated into a list of skills that should be professionally enhanced by pre-service Chemistry teachers [25].

3.2. Pre-service Chemistry teachers’ attributes

Recognizing the attributes or thoughts of pre-service teachers is important to do [26]. Attributes in pre-service teachers can be known by interview. In this study, the focus of the attributes of pre-service Chemistry teachers was based on their perceptions of skills in the twenty-first century. The results of the interviews about the attributes of pre-service Chemistry teachers are presented in table 2.

| No | Skills                                      | Pre-Service Chemistry Teachers’ Perception                                                                 |
|----|--------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|    | Ways of Thinking                           |                                                                                                           |
| 1  | Creativity and innovation                  | The teachers’ skills to use and apply various ideas and methods in the learning process so that classroom learning is not monotonous |
| 2  | Critical thinking, problem solving, and decision making | The teachers’ skills to find and connect information to use as a basis for solving problems in the classroom and everyday life |
| 3  | Learning to learn, metacognition           | The teachers’ skills to manage themselves and manage the situation around so that learning in the classroom can run successfully and effectively |
|    | Ways of working                            |                                                                                                           |
| 4  | Communication                              | The teachers’ skills to obtain, process and convey information in the classroom to be easily understood by students |
| 5  | Collaboration                              | The teachers’ skills to collaborate and engage students and society in learning |
|    | Tools for Working                          |                                                                                                           |
| 6  | Information literacy                       | The teachers’ skills to seek and link information to improve students’ knowledge |
| 7  | ICT literacy                               | The teachers’ skills to use various kinds of technology as a learning media in the classroom               |
|    | Living in the world                        |                                                                                                           |
| 8  | Citizenship                                | The teachers’ skills to adapt and take a role in the community |
| 9  | Life and career                            | The teachers’ skills to balance personal and professional life |
| 10 | Personal and social responsibility         | The teachers’ skills to act, contribute and have a sense of social responsibility in the society           |

Based on table 2, pre-service Chemistry teachers have understood and have the correct knowledge of the twenty-first century skills. However, they do not have much experience to apply the knowledge and
understanding of the twenty-first century skills they have. One of the problems faced by pre-service teachers is the limited opportunity to practice teaching at schools [27]. They should be trained as those who are able to develop student potentials [28]. Increasing diversity and difference in education worldwide has meant that pre-service Chemistry teachers need to have experiential learning outside of the comfort zone. Service-learning, as an alternate community-oriented learning pathway, when offered to the students is a meaningful context for learning [29].

Pre-service Chemistry teachers who have positive attitudes and attribute tend to appear more likely to actively include students with additional learning needs into classroom [30]. In addition, those who have positive attitudes and attribute tend to improve their behaviour in learning [31]. Researches on the attitudes and attribute of pre-service teachers toward 21st century learning [32] and also on improving teacher quality and education in general have touched on various fields such as Biology [33], Mathematics and Engineering [34] [35], and Social [36]. There are various ways to improve teachers’ quality in the twenty-first century learning such as tutoring programs [37], lesson study [38], designing authentic learning environment [39] and various applicable approaches [40].

4. Conclusion
The conclusion of this study is that pre-service Chemistry teachers expressed moderately positive attitudes and attribute toward the twenty-first century skills, but lacked of the ability to learn and metacognition in the ways of thinking and communication and collaboration skills in the ways of working. This is caused by the lack of skills of pre-service Chemistry teachers to control themselves, and their students. The other cause is the lack of experience to communicate and collaborate with the students. For the future research, it is suggested to promote the twenty-first century skills using appropriate methods and approaches to pre-service Chemistry teachers’ in order to get more qualified education.

Acknowledgments
The authors wish to thank the head of Chemistry education master program, Universitas Sebelas Maret, who has guided and funded this research and publication. Special gratitude is also addressed to the Lembaga Pengelola Dana Pendidikan (LPDP) which has supported my doctoral program.

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