

Bibliometric analysis of SCAMPER strategy over the past 20 years

Yusinta Dwi Ariyani^{1,2}, Insih Wilujeng³, Siti Irene Astuti Dwiningrum⁴

¹Department of Basic Education Doctoral Program, Faculty of Education, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

²Department of Elementary School Education, Faculty of Teacher and Education, Universitas Alma Ata, Yogyakarta, Indonesia

³Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

⁴Department of Educational Philosophy and Sociology, Faculty of Education, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

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ABSTRACT

This study aimed to explore the publication trends of substitute, combine, adapt, modify, put to another use, eliminate, and rearrange (SCAMPER) research over the past 20 years. The method used to explore the research trends was literature review through bibliometric analysis. The results of the bibliometric analysis identify core research or authors, as well as their relationship, by covering all the publications related to a given topic or field. The publication related to SCAMPER from 2000 to 2020 was retrieved from Google Scholar, Pubmed, and Scopus. The research trends of SCAMPER were visualized using the VOSviewer program. The results showed that the research trend of SCAMPER has continually increased over the past 20 years, especially in the last five years. A network analysis based on the co-occurrence of keywords showed the main keyword study was creative thinking. Based on the analysis of the field of study, SCAMPER has been widely studied in science. Only a few have been studied in engineering, architecture, sports, social studies, management, mathematics, psychology, and health. The benefit of this research can illustrate the extent to which SCAMPER strategies have been applied to develop 21st-century skills.

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Corresponding Author:

Yusinta Dwi Ariyani

Department of Basic Education Doctoral Program, Faculty of Education, Universitas Negeri Yogyakarta
Karang Malang, Caturtunggal, Depok, Sleman, Indonesia

Email: yusintadwi.2020@student.uny.ac.id

1. INTRODUCTION

The biggest challenge in the industrial revolution (IR) is in the education sector [1]. This situation challenged the education system across the world and forced educators to improve quality teaching and learning [2]. The emphasis on learning is the balance between character and literacy that will distinguish graduates from artificial intelligence work systems. In addition, several other skills need attention in developing learning in the current revolutionary era: i) Communication; ii) Collaboration; iii) Critical thinking and problem solving; and iv) Creativity and innovation [3]. In this case, the teachers' role will be an essential factor in creating change (agent of change) [4]. Therefore, the capacity development of teachers is a priority in developing their competencies and commitments, which can act as agents of change and provide these changes in various education sectors, especially when facing the era of the IR 4.0 [5], [6].

Teacher competence in the IR 4.0 era is not yet optimal. Higher-order thinking skills (HOTS) can strengthen the acceleration of teacher competency. HOTS is a thinking ability needed in the 21st century [7]. However, it is very difficult to define HOTS because many experts do not clearly define it. Some experts

defined HOTS as the ability to think related to analyzing, evaluating, and creating. This argument comes from Blooms' taxonomy which divided HOTS into two parts, including lower-order thinking skills (C1-C3) and HOTS (C4-C6) [8]. Other experts define that HOTS consists of four important components: critical thinking, creative thinking, problem-solving, and decision-making [9]. HOTS needs to be considered integrated into each subject, and many countries have integrated it into their curriculum.

One of the strategies that are currently being promoted in HOTS development is the substitute, combine, adapt, modify, put to another use, eliminate, and rearrange (SCAMPER) strategy. This strategy is a new learning approach that can address challenges in the 21st century [10]. SCAMPER is innovative learning developed by a US psychologist named Robert Elberle, which consists of seven strategies (substituted, combine, adapt, modify, put to another use, eliminate, and reverse) [11]. Substituted was the process of replacing a part of a product, service, or process with another part. The combine is to combine ideas, processes, or products into one or more efficient outputs. Adapt is the use of ideas that have existed before but have never been used. Modify updates an aspect/situation/problem to add new values to an idea/product or process. Put to another use is putting the previous process or product into a new situation with a more specific goal of solving a problem. Eliminate is removing a process or idea to improve the quality of an aspect or product due to an error in the previous result. Reverse takes a new direction or orientation of a process or product that aims to produce something original [12].

The SCAMPER strategy has been applied to improve students' drawing skills [11]. Another study applied the SCAMPER strategy to improve creative thinking skills in vocational students [13]. The SCAMPER strategy was also implemented to develop the creative imagination of elementary school students, and the results of the application showed an excellent increase in creative thinking skills, especially in the fluency dimension [11]. Developing creativity for grade five elementary school students is also carried out using SCAMPER to improve fluency and language application [14]. Despite the popularity of SCAMPER in research areas, no studies have yet represented the publication trends on SCAMPER through visual analyses using bibliometric analysis.

Bibliometric analysis is a quantitative method for analyzing large articles or literature using mathematical and statistical tools through visualization [15]. Bibliometric analysis can measure the co-occurrence of keyword information, author, country, and the number of citations contained in the article and allows understanding of various network relationships. Previous research determined the current state of scientific production regarding "competitiveness" in the international context through a bibliometric analysis [16]. Bibliometric analysis has been used to see publication trends for six years in social science and arts and humanities [17] and research trends in environmental science [18]. In this study, we aimed to: i) Analyze a large number of studies on SCAMPER from a macroscopic perspective using a bibliometric method; ii) Understand the characteristics of network data among the studies; and iii) Discuss future research directions and specific tasks that may be undertaken in related research areas.

2. RESEARCH METHOD

The research method used in this study is a literature review. The literature review is carried out by describing and discussing the topics discussed from a theoretical and conceptual perspective. Some of the steps taken in writing this literature review are presented in sub sections.

2.1. Collection of articles to be reviewed

An initial search was carried out for appropriate sources using Google Scholar, Scopus, Pubmed by entering the keywords "SCAMPER strategy" or "SCAMPER technique". Searching these keywords resulted in 100 articles in the last 20 years. Then the data filtering was carried out where the author limited the readable data to only SCAMPER articles and 19 articles so that around 81 articles were found. Furthermore, the data obtained is stored with the help of the Publish or Perish application in the research information system (RIS) format. In the next step, the author does a mapping using the VOSviewer application so that the variables studied and how they are distributed are obtained. SCAMPER used the learning strategy to search for the next article from the variables that appeared.

2.2. Article selection

Articles about SCAMPER are then collected, and abstracts are read to list articles related to the main topic discussed, namely SCAMPER and its application. The article that is used as the object of this study is an article that discusses the SCAMPER. There are 51 articles reviewed in this study from various journals. The selection of articles sampled in this study was carried out using a purposive sampling technique, where samples were taken from several journals and then filtered articles that discussed models/methods and learning strategies to improve students' skills.

2.3. Designing a conceptual framework

In this step, we summarize the main arguments among the researchers who conducted the study. Then, all articles related to the framework that have been designed are reviewed, discussed, and analyzed for the relationship between one article and another. The relationship of each article is represented by using the Vos Viewer to map the relationship between previous studies

2.4. Discussion

The discussion was carried out through a comprehensive review of all the articles collected and found their relationship to the conceptual framework of the study. The discussion includes the process of determining the articles to be researched, discussing the relationship of articles or mapping of articles as a result of VOSviewer, and mapping of articles according to the field of study. In addition, the discussion section also provides recommendations or opportunities for further research.

3. RESULTS

Article collection is based on the main topics discussed and the implementation process. The articles that are used as the main source are articles published in reputable international journals. There are 51 articles sampled in this literature review. The articles are saved in RIS format using the Mendeley desktop application. The list of articles can be seen in Figure 1.

★	Authors	Title	Year	Published In	Added
★	Altıparmak, T; Eryılmaz-Mustu, Ö	The Effects of SCAMPER Technique Activities in the 8th Grade Simple Machines Unit on Students' Academic Achievement, Motivation and Attitude towards Science ...	2021	International Journal of Educational ...	5:11pm
★	Wu, T	Applying project-based learning and SCAMPER teaching strategies in engineering education to explore the influence of creativity on cognition, personal motivation, and...	2020	Thinking Skills and Creativity	4:44pm
★	Lopes, R	A Creative Information System Based on the SCAMPER Technique	2020	Lecture Notes in Business Information Processing	4:44pm
★	Aisyah, S	The differences in learning outcomes of programmatic control systems between class with brainstorming models and scamper models on vocational school students	2020	4th International Conference on Vocation...	4:44pm
★	Fiadotau, M	Comparing Ideation Techniques for Games Education: SCAMPER, Gamicards, Brainstorming	2020	ACM International Conference Proceeding ...	4:44pm
★	Lester, M M	Scamper: Generating test suites to maximise code coverage in interactive fiction games	2020	Lecture Notes in Computer Science	4:44pm
★	Hwang, H J; Huh, Y J	Idea Effect of Product Design Class Using Scamper	2020	Journal of the Korea Convergence Society	5:11pm
★	Kamis, A; Kob, C G C; Husted, G; Saad, N M; ...	The effectiveness of SCAMPER techniques on creative thinking skills among fashion design vocational college.	2020	EurAsian Journal of ...	5:11pm
★	Talebi, M; Moosavi, M; Poushaneh, K	Evaluating the Impact of Brainstorming and Scamper technique on promoting the creativity of architectural design skills	2020	Technology of Education Journal ...	5:11pm
★	Dehham, S H; Hasan, A A Nayif; ...	Analysis of the Psychological Effect of Scamper Education Program and Creative Thinking among Primary Pupils.	2020	Indian Journal of Public ...	5:11pm
★	Sayed, A S M	Using SCAMPER Strategy For Developing Third Year English Majors' Creative Writing Skills	2020	Journal of Modern Research	5:11pm
★	Jassin, L W K; Hadi, L F H	Effect Of SCAMPER Program For Generating Ideas On The Divergent Thinking Of The Fourth Grade Students In Physics	2020	Journal of Talent Development and Excele...	5:11pm
★	Al-Zuwayni, I S M	The impact of scamper's strategy in developing creative thinking and achievement for fifth graders in the field of eloquence and application	2019	Indian Journal of Public Health Research and De...	4:44pm
★	Gündoğan, Aysun	Scamper: Improving creative imagination of young children	2019	Creativity Studies	4:05pm
★	Suh, S	A study on the application of SCAMPER techniques for the development of fashion design-focusing on the development of the SCAMPER questions	2019	Journal of Fashion Business	5:11pm
★	Ozyaprak, M; LEANA, M Z	The Effectiveness of Self-Regulated Learning on Teaching SCAMPER Technique of Creativity.	2019	Türk Ustün Zeka ve Eğitim Dergisi	5:11pm

Figure 1. List of articles saved with the Mendeley application in RIS format

The article saved in the RIS format is then visualized with the VOSviewer to describe the researched variables related to the topic. VOSviewer visualized the relationship of each keyword, and the circle size indicates the number of studies that have been carried out the most study. In Figure 2, some keywords are the focus of the study, including SCAMPER and creative thinking. This can be seen from the thicker or larger the circle on each variable, the more often research on this field is carried out. For example, SCAMPER is often associated with creativity or other keywords similar to these variables, such as creative thinking, creative imagination, divergent thinking, creative ideas technique, creative problem-solving, and creative information system. Meanwhile, there are very few studies that examine SCAMPER in the scope of critical thinking. It can be said that SCAMPER was indeed formed with the focus of its development being directed to support the development of creativity.

Analysis of the SCAMPER research area shows that there are 21 clusters based on the SCAMPER research study. Cluster 1 (eight items) includes achievement, compound attack, creative thinking, critical, fencing, preschool teachers, psychological effect, rhetoric and application. Cluster 2 (five items) includes architectural design, brainstorming, creativity components, game education, gamecards. Cluster 3 (four items) includes academic achievement, attitude, motivation, and science education. Cluster 4 (four items) include creative information systems, creativity techniques, information, systems architectures. Cluster 5

(four items) includes creativity thinking, effectiveness, fashion design, surrealism. Cluster 6 (four items) includes early childhood education, idea generation technique, musical instrument, preschoolers. Cluster 7 (four items) includes education, engineering, personality trait, project-based learning. Cluster 8 (four items) includes creative imagination, imagination, kindergarten, and young children. Cluster 9 (four items) includes creative thinking skills, divergent thinking, elementary school, physics. Cluster 10 (four items) includes creative writing skills, SCAMPER, skills, the six thinking hats. Cluster 11 (four items) includes creative ideas technique, fashion design development, Korean image, Cluster 12 (three items), creative problem-solving model, and creative thinking ability math anxiety. Cluster 13 (three items) includes critical reading skills, English, secondary schools. Cluster 14 (three items) includes flexibility, idea generation, product design. Cluster 15 (two items) includes self-regulated learning, teaching creativity. Cluster 16 (two items) includes animal studies, elementary education. Cluster 17 (two items) includes girl students, sixth biological secondary, Cluster 18 (two items) includes fashion design elements, item structure. Cluster 19 (two items) includes brainwriting, learning outcomes. Cluster 20 (two items) creativity training, social studies. Cluster 21 (two items) includes gifted students, and thinking programs.

Other analysis results presented in Figure 2 are strengthened by Figure 3 regarding the visualization of research density. Figure 3 shows that the brightest variable or has a high density is a very variable lot studied. In contrast, the variable that is dark or has a low density is a study that is still very little studied from the article. Figure 2 is similar the Figure 3, which shows that the focus of the study is mostly on SCAMPER and creative thinking.

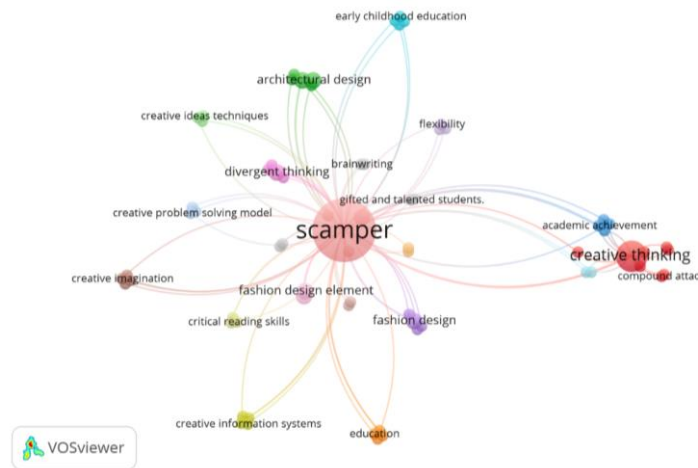


Figure 2. Mapping and keyword relationships

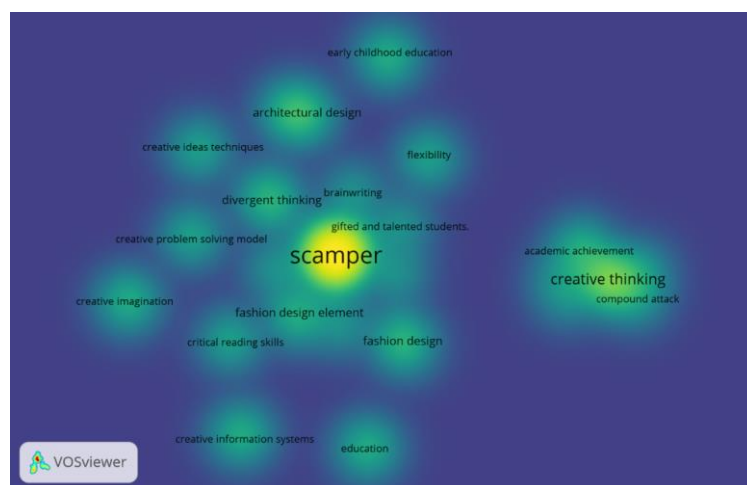


Figure 3. Density visualization with VOSviewer

The VOSviewer analysis in Figure 4 shows that research on SCAMPER based on the year of publication began in 2016. The keywords used in 2016-2017 include creative ideas techniques, creative problem-solving models, creative thinking abilities, math anxiety, gifted and talented students, creative thinking skills, creative training, social studies, critical, and compound attacks. The 2017-2018 range includes fashion design items, structures, and animal studies. The 2018-2019 range includes early childhood education, idea generation technique, preschoolers, musical instruments, creative thinking, girls' students, critical reading skills, English creative imagination, kindergarten, imagination, young children, and architectural design. The 2019-2020 range includes flexibility, idea generation, product design, brainwriting, gamecards, brainstorming, game education, physics, fashion design, effectiveness, creative technique, creative information system, system architecture, education, personal traits, engineering, science education, attitude, academic achievement, and motivation.

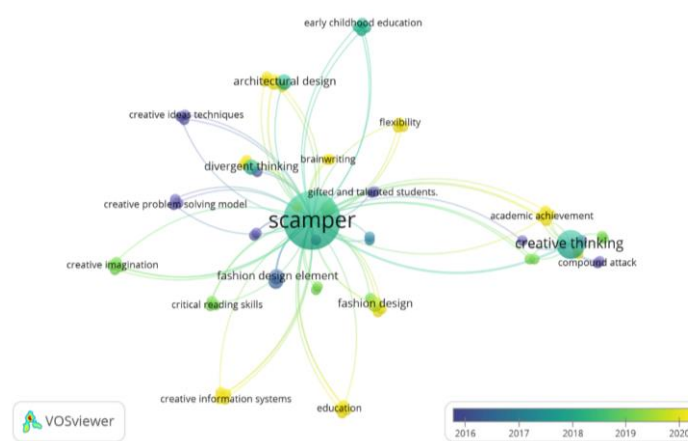


Figure 4. Distribution of keywords by year of publication

The mapping that has been done shows that SCAMPER is one of the variables that is still little researched in the implementation of learning. Several previous studies discussed SCAMPER related to the strategy used in the learning process and using students as research subjects. Several studies have also linked SCAMPER with other variables such as creative thinking, creativity, creative idea technique, and other variables, although not too much.

The analysis of SCAMPER research by field of study is shown in Figure 4. There are 41 articles that mention fields of study in their articles, and 10 articles do not mention it. There are 13 fields, including science, languages, arts, ICT, engineering, architecture, sports, social studies, management, mathematics, psychology, and health. Table 1 shows that the development of SCAMPER learning in the last 20 years has focused more on research in the fields of Science (11 articles) and art (seven articles), and language (seven articles). Meanwhile, research on fields of study (engineering, architecture, sports, social studies, management, mathematics, psychology, and health) is still minimal because only 1-2 articles are found.

Table 1. Literature mapping by field of study

Fields	Authors	Number of articles
Science	[19]–[29]	11
Without field	[11], [30]–[38]	10
Art	[13], [39]–[44]	7
Language	[14], [45]–[49]	7
ICT	[50]–[53]	4
Engineering	[12], [54]	2
Architecture	[55], [56]	2
Sport	[57], [58]	2
Social Studies	[27], [59]	2
Health	[60]	1
Psychology	[61]	1
Mathematics	[62]	1
Management	[63]	1
Total of article		51

4. DISCUSSION

SCAMPER is a learning strategy that follows educational needs today in developing 21st century skills, especially in developing student creativity. The purpose of this study is to determine the trend of SCAMPER research through a systematic literature review. The analyzed literature was obtained from various indexing institutions such as Google Scholar, Scopus, and Pubmed over the last 20 years. The research limitation is based on the period because very few researchers on SCAMPER publish it, so the researcher uses a larger time span. Based on searches from the three indexing institutions over 20 years, 51 selected articles were obtained, which were then analyzed with the help of VOSviewer software.

The working mechanism of using VOSviewer software is to conduct research analysis based on the title, keywords and abstract. In the VOSviewer setting, the selected analysis is the relationship between keywords. The words obtained were analyzed based on words that often appeared, namely one repetition. Furthermore, the existing keywords are mapped, reviewed, and checked for their suitability with the research scope. In Figure 2, research on SCAMPER on several keywords analyzed using the VOSviewer shows that creative thinking is the most dominant keyword used in SCAMPER research. This is because SCAMPER is a learning strategy designed to improve creative thinking skills. The acronym of SCAMPER has provided a way of developing creative thinking, starting from creative thinking through substitution, combination, adaptation, modification, put to another use, elimination, and reverse. In the SCAMPER, students analyze problems and solve them independently to produce a creative product [12]. In addition, SCAMPER makes students feel free and use the material in and around themselves without hesitation or fear to reveal their personality and instinctive creative behavior. SCAMPER enables children to dream, think differently, and produce original products [64]. Through SCAMPER, students can create original products through various questions that lead to different thinking. Students are built in a problem-solving culture that will impact solving these problems based on technology, information, and communication [22].

Research on SCAMPER by year has a pretty exciting trend. Since 2016, SCAMPER research has become a trend related to creativity. Although it is still related to creativity in the following year, many studies in the 2019-2020 period have begun to link SCAMPER with the use of technology development, such as gamification, creative information systems, and gamecards. This is due to advances in information and communication technology which is currently an essential component in education. SCAMPER can be associated with advances in information and communication technology because SCAMPER facilitates students to learn from various sources [53]. SCAMPER also allows it to be integrated with other learning, such as project-based learning [12].

Research on SCAMPER based on the field of study shows that SCAMPER is the most studied in science. Referring to its characteristics, Science consists of product and process aspects. Aspects of science products include concepts, laws, theories, principles, and principles of science. Meanwhile, the process aspect is related to process skills in science, including observing, asking questions, formulating hypotheses, discussing, and communicating. Therefore, science learning is highly emphasized to direct students to achieve science products through process skills so that Science learning positions students as scientists. Given the vital importance of process skills in science learning, there will be a nurturing effect in science learning, namely HOTS [65]. Creative thinking is one component of HOTS apart from critical thinking, problem-solving, and decision making. Creative thinking is a cognitive domain. In the perspective of Blooms' cognitive level revised by Krathwohl is the highest level (creating) [66].

Research on SCAMPER is still very little used in engineering, architecture, sports, social studies, management, mathematics, psychology, and health. In the field of social studies itself, research on SCAMPER is only found in two articles. The study investigated the impact of SCAMPER-based creativity training on social problems among selected prisoners in Nigeria [59]. Another study analyzed SCAMPER through creative development techniques to improve creative problem solving (CPS) [27]. SCAMPER research in the field of social studies in the two articles took the theme of social problems. Social problems are seen that the creative process through SCAMPER learning that facilitates students in discussing social problems will play an essential role in constructing and constructing ideas obtained by students [10].

Our results suggest several important directions for further research on SCAMPER. First, we suggest the construction of a more detailed and precise search string that includes relevant keywords not only on SCAMPER strategy but also on other SCAMPER design learning. The keywords used in this research were "SCAMPER strategy" and "SCAMPER technique" but these might not be enough to encompass all the implementation of SCAMPER in education. Second, we suggest to construction study on the application of SCAMPER in the areas of little or not yet study. It will provide research opportunities to develop and expand knowledge and become the novelty of research.

5. CONCLUSION

This study analyzed 51 papers on SCAMPER to analyze research trends over the last two decades using a bibliometric approach. Bibliometric is defined as applying mathematical and statistical methods to papers, books, and other means of communication used in the analysis of publications, recognizing the research trends, and evaluating scientific manuscripts. First, our analysis showed that the number of publications increased from 2000 to 2020. Specifically, the number of studies had risen steadily since 2016, demonstrating that research had been actively conducted. Second, in terms of research area and journals, a number of papers have been published in the fields of science. Third, in terms of network analysis based on the co-occurrence of keywords, the analysis revealed the main topic was creative thinking.

Further research needs to use more appropriate keywords to cover the entire literature related to SCAMPER learning design. The keywords used in this study are SCAMPER technique and SCAMPER strategy, and the keywords have not been able to cover articles related to the implementation of SCAMPER in education. The study results also suggest exploring the application of SCAMPER in areas that are still little or not yet study to be able to construct the SCAMPER body of knowledge.

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BIOGRAPHIES OF AUTHORS







Yusinta Dwi Ariyani     is a Ph.D. candidate at Department of Elementary Education, Post Graduate, Yogyakarta State University, Indonesia. She is also a Lecturer at Department of Elementary School Education, Universitas Alma Ata. Her research focuses on social studies learning, character education, and higher order thinking skills. She can be contacted at email: yusintadwi.2020@student.uny.ac.id; yusintada@almaata.ac.id.



Insih Wilujeng     is a Professor and Lecturer at Yogyakarta State University, Indonesia. Currently, she is head of the science education department at Yogyakarta State University. Prof. Insih's research interests are related to inquiry in science learning, higher order thinking skills, STEM, and 21st century teaching and learning. She can be contacted at email: insih@uny.ac.id.



Siti Irene Astuti Dwiningrum     is a Professor and Lecturer at Yogyakarta State University, Indonesia. Currently, she is the Secretary of the Institute for Research and Community Service at the University. Prof. Siti Irene's research interests are related to resilience, multicultural education, 21st century teaching and learning, and character education. She can be contacted at email: siti_ireneastuti@uny.ac.id.