



INTEGRATION OF CLIMATE CHANGE IN TEACHING SCIENCE, TECHNOLOGY, AND SOCIETY COURSE: TRENDS AND ISSUES

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Abstract:

This study aimed to know the trends and issues of climate change integration in science teaching, specifically in GE 5 (Science Technology and Society). The qualitative method was utilized in this study through the in-depth interview of fourteen (14) participants, as well as document analysis. Results revealed that teachers used experiential learning as the current trend in climate change integration; while the major issue was about the insufficient preparation to integrate climate change in the subject. Conclusively, teachers used innovative strategies and faced various concerns in integrating climate change to Science, Technology, and Society course. It is then recommended that a training proposal are needed to enhance teacher's integration level, and further study to the identified issues to effectively teach the topics and avoid problems in integrating climate change.

Keywords: climate change integration, trends in teaching, issues in teaching

1. Introduction

The Science of Climate Change is one of the most evident human effects on past, present, and future climate. Wherein some vital information on climate change can be taught and integrated in some subjects of higher education to further strengthen student's knowledge and awareness regarding the topic. However, in order to execute this, higher education may have a concrete and substantial way to properly integrate climate change to its curriculum and instruction (Alam & Al-Amin, 2014). Also, actions that are essential to successful climate change integration like teacher's training to climate change education and integration, methods and strategies to be used, and possible problems in integration are needed to address for effective climate change integration. The United Nations Educational, Scientific, and Cultural Organization (2010) included the climate change education (CCE) in the overall context of education for sustainable development (ESD) as one of their four core programs in their climate change initiative. In response to

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this, many countries implemented climate change and environmental education strategies in their curriculum, such as Dominican Republic (Domingo, 2013), China (Wang, 2014), and Ethiopia (Ababa, 2017). However, in the United States of America, climate change education is not fully implemented in different states (Jackson & Gould, 2017) due to several factors such as politics (Worland, 2015), teachers aligning (Goldenberg, 2016), and science literacy (Drummond & Fischhoff, 2017).

In the Philippines, Republic Act 9729, otherwise known as the Climate Change Act of 2009, allows mainstreaming of climate change into government policy formulations. Additionally, the said law mandates the Department of Education to integrate climate change education at the primary and secondary levels. However, Capili (2012) conducted a study on teachers' lived experiences in teaching climate change and found out that climate change is nonessential to the lesson, and they have the option to teach or not to teach it. Moreover, Ouano (2013) found out that some college students in the country have a low level of climate change awareness and imply that inclusion of climate change to the subjects and other school-related activities should be implemented. To bridge the gap, there must be a change in education practices for students to develop a full understanding and awareness of climate change. In response to R.A. 10121, otherwise known as Philippine Disaster Risk Reduction and Management Act of 2010, Mindanao State Universities and Colleges will integrate disaster risk reduction and management (DRRR) as well as climate change adaptation and mitigation (CCAM) in their curriculum (Mindanao Development Authority, 2014). Moreover, 20 Higher Education Institutions (HEI) attended the climate change seminar hosted by the University of the Philippines in Mindanao (UPMin) that tackled different topics ranging from mainstreaming climate change education to offering climate change studies in Mindanao (Sun Star, 2018).

Further, the findings of this study will give directions to science educators and administrators especially in crafting trainings on climate change integration in Science, Technology, and Society. It could be generalized that not all instructors in STS are fully capable of integrating climate change in their discussion, and training will give them enough knowledge on how to properly incorporate it. On the other hand, gaps will serve as inputs to program heads and science teachers to create new methods and strategies. Further, findings will strengthen the science teacher's ability to incorporate climate change in STS for possible linkages and school assessment in climate change education.

2. Research Questions

The study focuses on climate change integration in GE 5 (Science, Technology, and Society). Specifically, it aims to answer the following question:

- 1) What are the trends in integrating climate change across disciplines?
- 2) What are the issues in integrating climate change across disciplines?
- 3) How do these trends influence or affect:
 - a. Teaching and learning processes
 - b. Learning outcomes (Knowledge, Skills, Attitude, and Values)

- 4) How do these issues influence or affect:
 - a. Teaching and learning processes
 - b. Learning outcomes (Knowledge, Skills, Attitude, and Values)

3. Method

The main purpose of this study is to determine the trends and issues in teaching Science Technology and Society course as well as how these trends and issues affect the teaching-learning processes and learning outcomes of the students. The research design employed in the study involves the utilization of phenomenological-qualitative research in addressing the problems. This research design is used since Science Technology and Society course is a new general education course implemented by the new curriculum of the Commission of Higher Education (CHED) in the Philippines. A qualitative methodology was used in this study because it helps to understand the underlying reasons, opinions, and motivations of teachers in this new offered course (Watkins, 2012). In addition, document analysis was also used in obtaining valuable data.

This qualitative study was conducted in the University of Mindanao - Digos College, an institution located in the Southern part of the Philippines. In selecting the participants of the study, the following inclusion criteria was strictly followed: for teachers, (1) they must be a full-time faculty member of the institution; (2) has teach this course for at least one semester; (3) attended trainings related to this course; (4) willing to be interviewed. For students, (1) officially enrolled in the institution for at least two semesters; (2) they finished the course one semester prior to the conduct of study; (3) has a passed the course; (4) willing to be interviewed. After the rigorous process of selecting the participants, a total of four (4) teachers and ten (10) students were selected as participants of the study. Letters including letter to the Dean's office to allow the researcher to conduct the study, letter to the guidance office of the institution, and letters to the participants was secured first prior to the conduct of interview. In the conduct of IDI, the researcher observed the ethical standards including after the interview.

In analyzing the data, the researcher uses thematic analysis following the Colaizzi's (1978) method. This involved extracting meaningful texts from the statements of the participants. In this study, basic themes are generated from the initial statements of the participants. Then followed by identifying organizing themes for each basic themes created. Lastly, an emergent/ global theme was created out of those organizing themes. Moreover, in obtaining the basic themes, the researcher uses the steps used by Streubert-Speziale and Carpenter (2007) these includes; (1) the preparation of transcripts, memos, and summaries. These are transcribed and reviewed several times; (2) significant statements are extracted and outlined; (3) Formulating meanings from the significant statements; (4) Formulation of thematic clustering; (5) Combining the themes and validation; (6) Polishing the output.

After the completion of data analysis, the researcher sent a copy to each of the participants including their transcribed statements, result of analysis, and recorded discussion to verify the results of the study. After the verification of the participants, the researcher secured all documents including audio-recorded discussion, writings, transcripts, and documents used in a safe place. The final paper was given to the participants to review the whole manuscript to verify that the paper maintains anomaly of the participants as well as to verify the whole process of the study.

4. Results and Discussion

Presented below are the findings and discussion based on the data gathered. The presentation is organized in four sections: (1) trends in climate change integration in GE 5 (Science Technology and Society); (2) issues in climate change integration in GE 5 (Science Technology and Society); (3) effects of trends and issues in integrating climate change towards teaching-learning process and learning outcomes; and (4) the synthesis of the findings.

Analysis of the data led to six (6) emergent themes which provided visible and revealing insights into the research questions in Chapter 1. These themes were; (1) Experiential learning, (2) Teacher's insufficient preparations, (3) (a.) Become a Motivating Teacher, (b.) Student's Climate Change Awareness is Strengthen, and (4) (a.) Deliver Insufficient Information, (b.) Affect Student's Decision-making.

4.1 Trends in Climate Change Integration in Science Technology and Society Course

Theme 1: Experiential Learning

The first theme, Experiential Learning, emerges due to various strategies used by the teachers on how to integrate climate change to their respective topics in Science, Technology, and Society course.

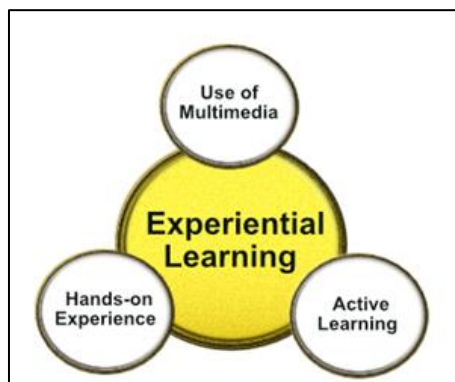


Figure 1: Trends in Climate Change Integration

The trends in integrating climate change, as presented in Figure 1 shows that the emergent theme is experiential learning. This theme is composed of three (3) basic themes which are the following: use of multimedia, hands-on experience, and active learning.

Experiential Learning. The responses led to the idea called experiential learning (Kolb, 1981) that defines as "learning through reflection on doing." This learning style is represented by four-stage learning cycles, and these stages are (1) concrete experience, (2) reflective observation, (3) abstract conceptualization, and (4) active experimentation. With the proper use of experiential learning, learners can grow personally and professionally because they are exposed to various activities that enable them to think critically if their current actions or judgments lead to a greater good. With these, learners can reflect and give modification to their old perspective and formulate new ideas that help them solve the current issues. This method is helpful in climate change integration in Science, Technology, and Society since most of the topics in the subject deal with the causes and effects of certain things, especially how humans alter the environment they lived in. Through the use of this method, learners can acquire a life-long learning knowledge and skills that can be used to change their ideals and actions towards environmental issues.

4.2 Issues in Climate Change Integration in Science Technology and Society Course

Theme 2: Teacher's Insufficient Preparation

The second theme, Teacher's Insufficient Preparation, emerges due to various issues that the teachers experienced in integrating climate change to their respective topics in Science, Technology, and Society course.

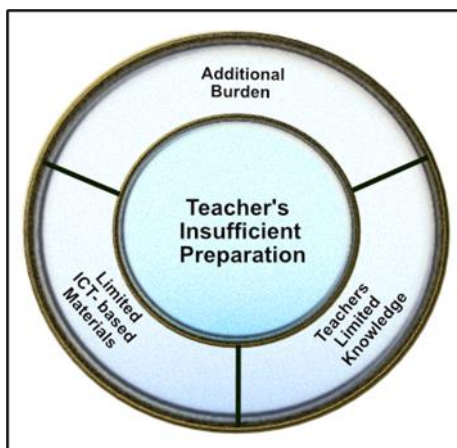


Figure 2: Issues Experienced by Teachers in Climate Change Integration

The issues in integrating climate change, as presented in Figure 2 shows that the emergent theme is teacher's insufficient preparation. This theme is composed of three (3) basic themes which are teachers limited knowledge, additional burden, and limited ICT-based materials.

Teachers Insufficient Preparation. The responses show how the three (3) issues are directly related to the teacher's insufficient preparation to integrate climate change in GE 5 (Science, Technology, and Society). Ingersoll, Merrill, and May (2014) identified that content and substance of teacher's preparation in pedagogy is one of the fundamental principles why teachers last in their chosen field. In addition, the more prepared the

teacher is, the more likely the teachers feel satisfaction in their field. Villegas and Lucas (2002) suggested that teachers should be socio-culturally conscious, have affirming views of diverse student backgrounds, see themselves as responsible for and capable of bringing about the change to make schools more equitable, understand how learners construct knowledge and are capable of promoting knowledge construction, and know about the lives of their students to design instruction that builds their students. With this, teachers are guided on how to cater to the diverse needs of the students. Furthermore, teacher's limited preparation can profoundly affect the students' learning outcomes and their ability to demonstrate the necessary competencies prepared for that curriculum (Mupa & Chinooneka, 2015).

4.3 Influence or Effects of Trends to Teaching-Learning Processes and Learning Outcomes

A. Teaching-Learning Processes

Theme 3: (A) Become a Motivating Teacher

The third theme, Become a Motivating Teacher, emerges due to various trends that influence or effects teaching-learning processes used by the teachers to integrate climate change to their respective topics in Science, Technology, and Society course

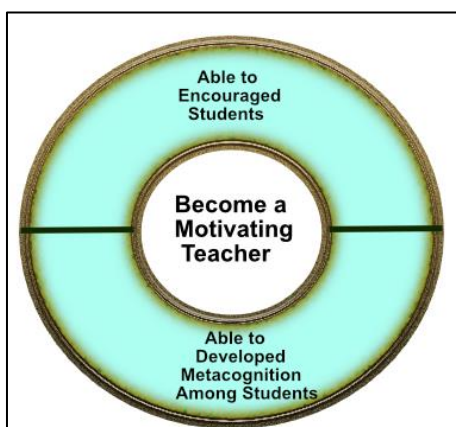


Figure 3: Influence or Effects of Trends to Teaching-Learning Processes

The influence or effects of various trends used by the teachers in teaching-learning processes, as presented in Figure 3 shows that the emergent theme is become a motivating teacher. This theme is composed of two (2) basic themes which are able to encouraged students and developed metacognition among students.

Become a Motivating Teacher. Riswanto (2017) argued that for students to have good record, they should be motivated as well. Williams and Williams (2011) identifies the role of teachers in higher education as one of the five key ingredients in improving student motivation. In addition, for teachers to be an effective motivator, they should have the following quantities: (1) expert in subject content, (2) skilled enough to deliver the lessons correctly, (3) has a qualifying factor in teaching the subject, (4) know the type of tests or performances they gave to students, and (5) has scientific management and human

relations (Williams & Williams, 2011). With these quantities, teachers can motivate more students to learn the subject as well as able to digest the learning outcomes to the students.

B. Learning Outcomes

Theme 4: (B) Developed Climate Change Awareness

The fourth theme, developed climate change awareness, emerges due to various trends used by the teachers to influence the learning outcomes of the students under Science, Technology, and Society course.

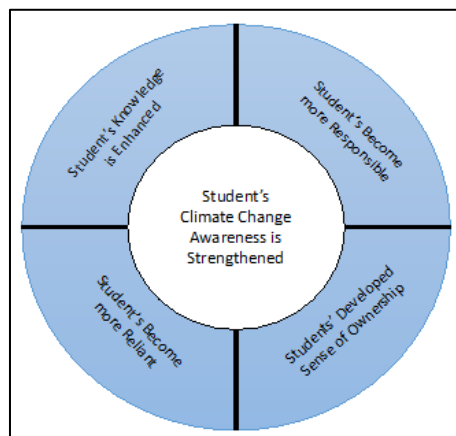


Figure 4: Effects of Trends to Learning Outcomes

The influence or effects of various trends used by the teachers to the learning outcomes of students, as presented in Figure 4 shows that the emergent theme is student's climate changes awareness is strengthened. This theme is composed of two (4) basic themes which are able to student's developed sense of ownership, become more reliant, their knowledge is enhanced, and students become more responsible.

Student's Climate Change Awareness is Strengthened. Due to various trends that the teachers used to integrate climate change in Science, Technology, and Society course, students understanding of climate change has been improved, resulting in the development of awareness among students. These findings are also similar to the findings of Ogunsola, Araromi, and Adeshina (2019) that the integration of climate change to the tertiary educational curriculum of students would create better awareness of the given topic. In addition, these ideas are directly related to the seven (7) environmental principles which are (1) everything is connected to everything else, (2) all forms of life are essential, (3) everything must go somewhere, (4) ours is finite Earth, (5) nature knows best, (6) nature is beautiful, and we are the stewards of God's creation, and (7) everything change (Galang, 2003, Commoner, 1971). These principles guide students' actions about environmental issues. These issues involved the proper waste disposal, the connections of all species, the protection of the planet, and the actions needed to be done to cope up with the changing world. With all those acquired knowledge, skills, attitudes, and values, students are now able to take care of the planet because they are now more

responsible for their actions. Thus, a successful environmental education includes the creation of environmentally accountable and concerned generation (Prihatiningsih, 2018).

4.4 Influence or Effects of Issues to Teaching-Learning Processes and Learning Outcomes

A. Teaching-Learning Processes

Theme 5: (A) Limited Climate Change Integration

The fifth theme, limited climate change integration, emerged due to various issues that influenced or affected the teaching-learning processes of the teachers to integrate climate change in Science, Technology, and Society course.

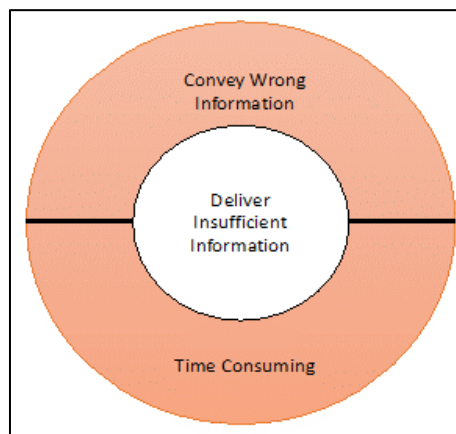


Figure 5: Effects of Issues to Teaching-Learning Processes

The influence or effects of various issues faced by the teachers in teaching-learning processes, as presented in Figure 5 shows that the emergent theme is deliver insufficient information. This theme is composed of two (2) basic themes which are able to time-consuming and convey wrong information.

Deliver Insufficient Information. Teachers faced various issues in integrating climate change in Science, Technology, and Society course, wherein these issues affected their teaching-learning processes. Insufficient climate change integration arises primarily because there are barriers that make integration successful. In the study of Adams (2013) about the barriers of teaching in environmental education, it revealed that teachers face various barriers, including support, lack of participation to the field of experiences, and sacrifices of great personal time and expense. In addition, the findings also indicated that issues faced by teachers in climate change integration could affect their teaching-learning processes.

B. Learning Outcomes

Theme 6: (B) Affect Student's Decision Making

The sixth theme, affect student's decision making, emerges due to various issues that influence or affect the learning outcomes of the students in GE 5 (Science, Technology, and Society).

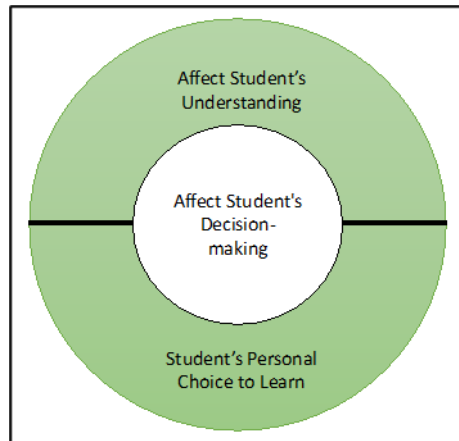


Figure 6: Effects of Issues to Learning Outcomes

The influence or effects of various issues faced by the teachers to the learning outcomes, as presented in Figure 6 shows that the emergent theme is affect student's decision-making. This theme is composed of two (2) basic themes which are students personal choice to learn and affects students understanding.

Affect Student's Decision-making. Learning outcomes of the students can be affected by several issues that the teacher faced during and after climate change integration. Wortner (2001) explained that students from a generalization to every causes and effects of the environmental problem and resulted in blended information. Moreover, due to issues that the teacher faced to integrate climate change in the learning outcomes of the student, the student's decision-making is affected. These results in confusion on how to address the problem and create a better solution.

5. Synthesis of the Findings

This section deals with the summary of the major findings from various trends and issues in integrating climate change.

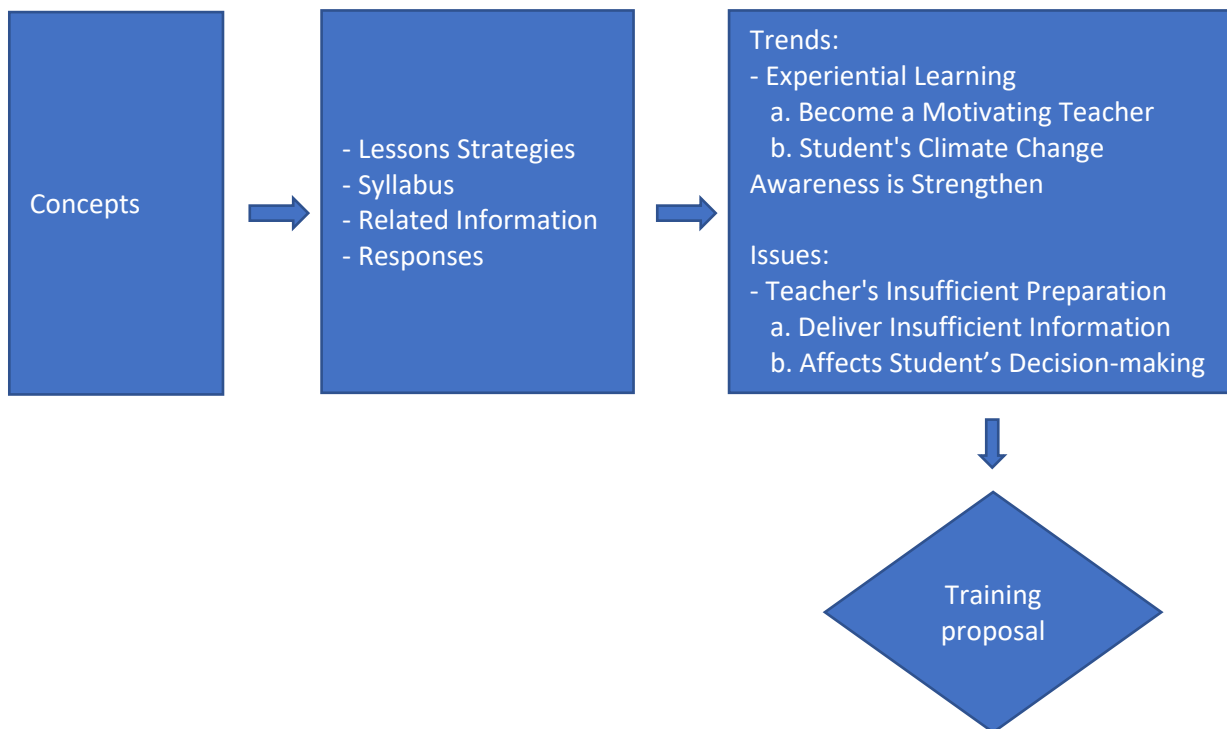


Figure 7: The Synthesis of Trends and Issues in Integrating Climate Change in Science, Technology, and Society Course

Presented in Figure 7 is the framework showing the synthesis of various "trends and issues in integrating climate change in Science Technology and Society course. The concepts of climate change have been integrated into the lessons or topics in GE 5 (Science, Technology, & Society or STS) through different lesson strategies by the teacher. It was revealed that there were six (6) themes that were divided into two (2); (1) Experiential Learning, and (2) Teacher's Insufficient Preparation. Under Experiential Learning are (a) Become a motivating Teacher, and (b) Student's climate change awareness is strengthened. For Teachers' Insufficient Preparation are (a) Deliver Insufficient Information, and (b) Affect Student's Decision-making. The findings resulted in a training proposal that will be used for teachers to enhance their ability to integrate climate change in GE 5 (Science, Technology, and Society).

Science education can make an essential contribution to students' awareness, understanding, and ability to adapt to climate change. To do this, the teacher should be competent, content-wise, has effective classroom management, and has various learning strategies to deliver the concepts of climate change to the students. Aside from that, teachers should be able to instill to the students the importance of knowing the causes and effects of climate change to come up with solutions that could mitigate the impact of climate change. In addition, the United Nations Educational, Scientific, and Cultural Organization (2010) developed initiatives to combat this issue, and one of its objectives is an innovative teaching and mainstreaming climate change. UNESCO highlighted the action area which is "*integration of climate change into science education curricula, programs*

and material promoting participatory and interdisciplinary teaching of the science of climate change", this concerned area has an outcome of "strengthened knowledge and understanding of climate change and sustainability (based on scientific methods, disciplines, and evidence). With the help of training proposal, teachers will be immersed in a workshop that enables them to enhance their understanding of climate change and develop plans and strategies to integrate climate change in Science, Technology, and Society course.

6. Conclusion

The following are the conclusions drawn based on the findings derived from this study: Teachers use different strategies in integrating climate change in science technology and society. These strategies also affected the teaching-learning processes and learning outcomes in a way that teachers become an excellent motivator for students to understand the concepts of climate change better. However, due to various issues that the teacher's experiences in climate change integration, it affected their processes and as a result, they provided insufficient information to the students. Moreover, this insufficient information could lead to student's confusion that could affect their understanding towards climate change.

7. Recommendations

In light of the findings and conclusions, the following recommendations are offered:

- 1) Higher Education Institutions should create a training proposal and conduct seminars for teachers to address the prevailing issues of climate change integration in Science, Technology, and Society;
- 2) Increase HEI teachers participation in any advance training and workshops related to climate change and environmental education
- 3) Further study may be conducted on integration and barriers experienced by teachers in integrating climate change in Science, Technology, and Society.

Note

The present research has been presented on International Research Conference hosted by Asia-Pacific Movement for the Advancement of Pedagogy and Research on October 17, 2021 via Google Meet. This study is also an improved version of study titled "Integration of Climate Change in Teaching Science, Technology, and Society (STS): Trends and Issues".

Conflict of Interest Statement

The authors declare no conflicts of interests.

About the Author

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