The challenges faced by Higher Education Instructors (HEI) teaching Science-Technology-Society (STS)

Asia Pacific Journal of Multidisciplinary Research
Vol. 8 No.3, 87-95
August 2020 Part II
P-ISSN 2350-7756
E-ISSN 2350-8442
www.apjmr.com
ASEAN Citation Index

Faith Celeste B. Ole
Carlos Hilado Memorial State College, Talisay City, Negros Occidental, Philippines
faith.celeste29@gmail.com

Date Received: May 18, 2020; Date Revised: July 27, 2020

Abstract *–This phenomenological study intended to find out the challenges faced by Higher Education Instructors in teaching Science, Technology and Society course under the revised General Education Curriculum (GEC) guidelines of the Commission on Higher Education (CHED). It aimed to describe the challenges and difficulties encountered by seven Science instructors in terms of: (a) content, (b) teaching strategies, (c) learning resources, (d) planning and preparation, and (e) facilities. Interviews, focus group discussion and survey were conducted to conceptualize the patterns using thematic analysis. Findings revealed that their lack of trainings especially to deliver the STS contents impede them to confidently implement the STS science education. Likewise, the limited resources like textbooks or any learning material reflecting STS approach was also addressed as one its difficulties. However, factors related to teaching strategies, planning and preparation and facilities were not considered as difficulties by most participants during their conduct of STS instruction. Thus, to address these challenges, upholding of more training programs or seminar-workshops that are inclined to STS teaching is strongly suggested, in order to equip the science teachers in providing quality education in higher education. It is also suggested that more relevant resources parallel to the STS approach must be provided. Further, a similar study must be conducted to a larger sample size to validate these experiences from other HEIs.*

Keywords *–Higher Education Instructors, Challenges, **S**cience-**T**echnology-**S**ociety*

INTRODUCTION

In today's rapidly changing society, the essence of Science, Technology and Society (STS) education is of great importance because of the decreasing interest of younger generation in the areas of science and technology[1]. The goal for this science education is to equip the 21st century learners to become critical thinkers and reflective practitioners in facing the technological issues and scientific changes. In this way, they will be able to have a closer look at the current reality of science, technology and the society, and subsequently, prepare them well for their professional futures. Because of the need to develop lifelong learners in this modern era, a shift in the outlooks about science education from objective fact based knowledge to practical activity is inevitable [2].This means that Science contents and concepts traditionally taught in a rich context must be presented in a comprehensive and integrated way [1][3]that involves strategies like debates on controversial issues, encouraging problem solving based on realities or simulation games -- a characteristic of an STS approach[4]**.** Adopting into this science education however, entails challenges in the delivering process when compared to the traditional science teaching practiced by teachers. With the underlying relevance of STS in today's generation, teachers are considered a major component in determining the success of an STS curriculum [5]. More so, without the teachers' commitment, STS education will not be successful, accordingly [6]. Nevertheless, aside from teacher factor, other various aspects also contribute to the challenges brought by STS teaching.

Like in Pakistan, the challenges in adopting STS approach lie in the *four areas***.** Firstly, according to Jessani [7] the *examination* system that relies on a mark oriented culture and theoretical or factual knowledge needs restructuring of policies and practices in order to make its objectives aligned with that of STS science teaching[8]. Apparently, these barriers with the policy and practice related to curriculum and examination system are commonly

mentioned by other studies [6],[9],[10],[12]. Secondly, although STS is emphasized in the *science textbooks* and *syllabi*, it is still not reflected in all aspects of the chapters, exercises and activities. The emphasis is still predominated by scientific content and concepts which defeats the purpose of adopting fully the STS approach. Thirdly, as frequently cited in several studies [5]-7],[11],[12], a reform in the *Science Teacher Education Program* that promotes training programs parallel to STS approach is essentially needed for empowering teachers to be skilled and knowledgeable. And lastly, the *available resources and school facilities*[12] which influence the teachers' experience in the inquiry based approach of STS has to be carefully looked into before taking decisions about the STS approach for science.

Meanwhile, in the Egyptian science education, similar challenges are also observed but the focus tends to lead on understanding the constraints that affect the teaching and learning process of STS. According to Azjen's Theory of Planned Behavior [13], teachers' beliefs are mainly influenced by types of constraints called "perceived behavioral control", which composed of external and internal constraints. In order to resolve the inconsistencies between teachers' belief and practices, the Ministry of Education in Egypt must minimize some of the constraining factors. These factors include changing examination-orientation (which emphasizes the traditional science content) to a learning-orientation(that provides sufficient teacher education concerning STS approach), reducing curriculum content, supplying more relevant resources to teach STS issues, and giving teachers the sufficient pre-service preparation and in-service trainings[12].

Furthermore, similar findings are also observed from a study conducted at Portugal where Biology secondary teachers pointed out that the design, planning and implementation of STS strategies in their classrooms are considered as their obstacles. According to the study's result [1], the main difficulties found by the teachers are as follows: (i) the need to have an in-depth knowledge of the curriculum in order to articulate the scientific content within the real context that is being studied, (ii) the framework of the learning activities in the STS approach, (iii) the synthesis of the collected information, and (iv) the time needed to plan and prepare the learning activities.

In the Philippines, the transitions brought about by the implementation of the K-12 curriculum in the basic education have also significantly affected the tertiary education system. There visions that led to a reduction of General Education Curriculum (GEC) courses from 64 units to 36 units are necessary to align in the new basic education curriculum. Hence, the Commission on Higher Education (CHED) came out with guidelines on these new GEC courses that could be used in the teaching and delivery of the content for higher institutions. The integration of Science, Technology and Society (STS) is just one of the GEC courses suggested by the commission. This course as stipulated in CMO No. 20, series of 2013 aims to promote scientific and technological literacy to empower citizen participation. Students need to engage in this interdisciplinary course to instill reflective knowledge on how realities are brought about by science and technology in society. With these changes in the curriculum, Science instructors teaching general education courses in the old system had to adjust and are expected to teach STS. Adopting into this relatively new science education however, entails challenges in its delivery mode when compared to the traditional science teaching. As most science teachers in the higher education institutions (HEIs) are specialized in teaching the contents related to their field of specialization such as Physics, Chemistry, and Biology; this constructivist discipline targets a science education for all learners and not specifically for future scientists [14]. As defined by Orosa [15], content knowledge of teachers may be based on one's theoretical and factual knowledge of the subject matter, academic background, motivation for building expertise, and valued expertise. With this at hand, teachers' content mastery and expertise are challenged to teach a subject for which they have little background or no experience yet.

OBJECTIVES OF THE STUDY

Given the premises that teacher's knowledge on STS can influence students' understanding and likewise, on the success of its implementation; this study intended to find out the experiences of the college teachers after implementing STS in their classes under the revised GEC. Specifically this study sought to determine the challenges encountered by higher education science instructors in the implementation of Science, Technology and Society in terms of: (a) content, (b) teaching strategies, (c) learning resources, (d) planning and preparation, and (e) facilities.

METHOD

Research Design

This study employed a qualitative research design. In particular, the researcher used a phenomenological research methodology which examined the individual teaching experiences of the participants. This design of inquiry describes the experiences of several individuals who have all experienced the phenomenon [16].

Participants

A total of seven science instructors from one of the state universities and colleges (SUC) in the province of Negros Occidental participated in this research endeavor through a convenient sampling method. The inclusion criteria includes that they were all tertiary instructors specializing in any field in Science with no teaching experience yet on handling STS under the revised GEC. Likewise, these teachers have been teaching their specialization for more than 3 years. Table 1 shows the profile of the participants.

Table 1.*Profile of the participants*

Participants	Gender	Field of Specialization
1	Female	Chemistry
2	Female	Biology
3	Female	Chemistry
4	Male	Biology
5	Female	Chemistry
6	Female	Biology
7	Female	Physical Science

Data Gathering Instrument

The interview guide used a semi-structured question that was used in the collection of data. The teachers who participated were asked to share their experiences on the challenges they have encountered in the implementation of Science, Technology and Society in their classes in terms of: (a) content, (b) teaching strategies, (c) learning resources, (d) planning and preparation, and (e) facilities. But more importantly, before these interviews were conducted, it was first content validated by two experts in the field of qualitative research.

Data Gathering Procedure

Data was collected through an in-depth interview, which was the primary source of information from the key informants. The purpose of this type of interrogating was to describe the meaning of a concept or phenomenon that several individuals share. Another method employed in the study was the focus group discussion (FGD)for some teachers while the others were asked to answer the survey questionnaire (using the semi-structured question) expressing their answers in written form via email or messenger application. The latter form of collection was utilized in its satellite campus due to its distant location from the researcher. The purpose of collecting data from three different kinds of informants was a form of data triangulation to contrast and validate the data if it yields similar findings [17], [18], [19]. A cellular phone was used for audio recording all the verbatim accounts aside from field notes that the researcher prepared. Most of the participants expressed their answers in Hiligaynon language so as to articulately explain their lived experiences confidently.

Ethical Considerations

Before conducting the study, the importance of ethical considerations were strictly adhered by the researcher. The research objectives were articulated verbally and in writing to clearly inform the informants about how the data will be used [16]. Likewise, asking first for their full consent to be audio-taped was done and anonymity of their names was safely assured. The interviews usually lasted about an hour and it was only conducted upon their availability or free time. Moreover, sensitive issues that were brought out during the interview were excluded for confidentiality purposes.

Data Analysis

The obtained data was analyzed using thematic analysis method. The recorded conversations were transcribed from Hiligaynon dialect to an English language for further analysis. Themes or patterns from the interview generated by the participants were coded based on the saturation of information from the triangulation procedures. All gathered data was presented in a narrative form. The participant's quotes were indicated by "**P**", while those written outputs were highlighted in **bold text**.

RESULTS AND DISCUSSION

As indicated in the objectives of this study, five main categories that focused on the content, teaching strategies, learning resources, planning and preparation, and facilities were analyzed. The gathered information will be discussed in the following sections:

A. CONTENT

During the process of analyzing the themes of the data, the researcher was able to form subtopics related to this category. These are teacher's knowledge of the content in the new GEC, teachers' experiences in the old STS curriculum, and teachers' professional abilities.

A.1 Teachers' knowledge of the content in the new GEC

The teachers' knowledge of the content in the new GEC was a significant factor that affected the quality of their STS teaching. One particular aspect of the contents that they have found challenging in teaching STS was on the philosophical approach on certain topics. Given that philosophy was perceived as a difficult discipline, these studies on the deepest questions of humanity have been a challenging task for them. Philosophy articulates the ideas that all our technology, science and inquiry are based upon.

Based from the saturation of data, topics on Human Flourishing and The Good Life were the common areas they have found difficult to grasp. All of them found it difficult to explain the topics on the Human Flourishing and Good Life which pertained to the different philosophical natures and personal aspects of a person. The following statements were excerpts from the conversation:

"*(in the Human Flourishing, that's the part I have found difficulties to deliver and felt left out because it is kind of philosophical)***P-2**

This was also emphasized by participants 3, 4 and 5, respectively:

"*Actually as of the content, I find it hard to incorporate especially philosophy because I have to study especially the topic on Good Life*"

"…*usually it's more on the philosopher's ang topic*…" (usually, it's more on the philosopher's topic)

(It's not more on the science, the topics are on the philosophy so it's really different…you really need to read a lot…this is not my line of specialty….like the topic on the Good Life, it's really different because the definitions are not based on science, it seems leading to a different discipline)

In the written data, one teacher wrote this difficulty of:

"**Relating STS with Human Conditions**"**P-6**

According to studies[20] [21], one way to successfully attain the science education reform depends on the teachers' ability to integrate the philosophy and practices with his or her existing philosophy.As stated by Brickhouse [22], teacher's philosophies of science are important aspects of teaching and learning not only in the STS curriculum but also in the traditional instruction. Though this should occupy the central role in science education, thereality of incorporating the epistemological nature is just rarely a part of the formal curriculum and instead, usually relegated in the hidden curriculum. Thus, teachers in effect, tend to have a little formal content preparation and because of this unfamiliarity could hinder the STS education. In addition, Aikenhead [23] pointed out that in the absence of instruction in the epistemological and sociological nature of science, teachers will not have the prerequisite knowledge for implementing STS instruction. Therefore, addressing teacher's epistemological commitments in the pre-service and in-service teacher education programs are highly encouraged for advantageous classroom practices [22].

A.2Teachers' experiences about the STS in the old curriculum

Among the participants, three of the science instructors narrated their background on STS during their undergraduate course. Looking back to their experiences of this subject, they have interestingly cited the differences of the topics included in STS nowadays than the contents that were given to them before. According to these teachers, the new STS curriculum focused more on the values and philosophical aspects as compared to what they have encountered before which was more on the technicalities or content orientation. The following lines were taken from parts of the conversations:

(Unlike before, it's really about content and/or inventions of the Filipinos wherein they cited the differences about the technology in the past and the present; it's more on technicality rather than today's philosophical values) **P-2**

(it was mostly science and technology before, and really content wise...but now, it's more on the values side) **P-1**

(The STS is somehow similar to the Science and Technology before, but now there are topics that are part of other disciplines like history, philosophy, and sociology, it's just different from what it used to be) **P-5**

These experiences of teacher's are known as the previously held conceptions which were constructed during their pre-service education experiences and from teaching experiences [5]. Further, these experiences are supported by studies [21],[23],[24] wherein a process of socialization into a discipline is expected. Science teachers tend to develop deep-seated values about science teaching [5],[26] and believe that it is their responsibility to socialize their students into a specifically scientific discipline [27]. Hence, to implement an STS science course successfully is to look from a teacher's point of view. As cited by Aikenhead [5] in Mansour's study [21], the best way to initiate students into a discipline is the same way the teacher was initiated. Also, Tsai [28] supported this by stating that the beliefs of many teachers may have stem from their own school experiences, like holding to the traditional views of teaching and learning science.

Interestingly, Pinar [29] and Butt et al., [30] as cited in Mansour [31] called this prior experience to teaching STS issues as "the architecture of self" in which teachers are shaped by experiences of context and situation. Such as how the present study of teachers' life experiences and backgrounds affected what they believed, the way they interpret and taught.

A.3) Teachers' professional abilities

Teacher's specialization was another factor that limited the teachers' abilities to teach particular topics in STS. In view of that, they need to prepare and study the topics in order to deliver it properly. One teacher in Chemistry commented that,

(The difficulty that I encountered is the last part – about Genetics for I need major preparations) **P-1**

Another Chemistry teacher verified this,

"*… I had also found it hard to fathom and discuss the topic in Gene Therapy since I'm not a Biology major…"***P-3**

However, from a perspective of a Biology major,

(in that part of the Human Flourishing, that's the part I have found difficulties to deliver and sort of left out, but in the Genetics I'm quite okay with that)**P-2**

Reference [32] stated that teachers teaching a subject which they only have a flyspeck background causes confidence issues in the delivery of the lessons. Due to the lack of background knowledge, they will have additional research work like studying and reading the contents of the topics.

Other quotations from other instructors elucidated their experiences to the new subject,

"*…This is the first time that I taught STS and when I saw the coverage and the topics, I said, Wow! I find it hard to fathom because it's too deep. That's why I need to study, you have to learn twice to be able to deliver and to make it relatable because it's different to the courses I've taught before like Chemistry and Physics…"***P-3**

"Difficult encounter with some STS topics due to little background and as a first timer STS instructor" P-7

All of the statements implied a lack of professional knowledge of the teachers in teaching STS [12].According to Hofstein, et al. [33], teachers' traditional training rarely touches upon the teaching of an STS course or an STS issue. Similarly, this is supported by Fensham [34], wherein teachers' science disciplinary background has not prepared them for STS because their undergraduate education rarely allow them to be aware of the controversy in pure science itself. To counter this, Bybee and Mau [35] as cited in Mansour [36] suggested that this could be overcome if education offered courses will be designed parallel to the STS approach of teaching, and shall be strengthened by research-based training programs focusing on the content, context, structure and practices of teaching STS issues.

B. TEACHING STRATEGIES

According to Oulton, Dillan and Grace, [37] the teachers play an important role in the STS approach. They must be aware of the nature of issues to successfully implement the various tasks through their teaching strategies. Since one of the characteristic of STS teaching is a student-oriented approach, the teaching strategies used by the teachers must not be limited to just lecture and discussions - where a teacher is considered as the sole source of knowledge. As a matter of fact, STS science education follows a constructivist model of teaching and learning which active learning and participation from students are encouraged and teachers serve as facilitators rather than the sole source of knowledge.

Based from the participants' responses, the involvement of students in the transmission of knowledge was practiced as evidently shown in the various strategies used by the teachers.

"**I assigned topic for each student for reporting and doing team work with them. I also prepare questions about the current issues on technology for brainstorming activity."P-6**

(we do movie review like the film Artificial Intelligence and do sharing in the class…in the culmination of my class, they have really come up with a play) **P-1**

"…*You have to involve the students, the students must present their own perspectives the way they understand the topic. They have to share; and they are going to report*…" **P-3**

One instructor has written numerous strategies such as:

"**Lecture, discussion, role playing, brainstorming, group skit, philosophical debate or discussions"P-7**

Common strategies include reporting, group discussion, sharing, video clips, brainstorming and role playing. It was also noteworthy that, despite some difficulties found by the interviewees in implementing STS in the class, all teachers provided dynamic strategies. They have autonomy in their choices of teaching approach. The various teaching strategies mentioned could be considered student-centered that was closely related to the constructivist approach in which students are encouraged to participate [38].It was suggested, further [33] that involving students with a variety of learning techniques will help in breaking the monotony of the classroom and motivate the students to learn. One of the constructivist principles [39] was for the teachers to provide opportunities for students to reflect on their experience in learning.

C.LEARNING RESOURCES OR MATERIALS

Most teachers mentioned the insufficient or lack of materials in the library to be used as good references. Instead, they tend to rely on the internet and a few of themeven bought books from their own pocket.
One chemistry instructor said:

(another problem is the references because it is too limited. I bought my own book since the other books have little content; perhaps it's just published recently…most of the resources are in journals) **P-5**

While the others relied on the internet for references,

(good thing google is there, I was able to apply my ability of being resourceful) **P-4**

Another teacher using the written data listed the following:

"**No availability of references and textbooks needed from the time I am handling STS. I used to scout from the Internet the following topics that I am going to discuss with my students.** " **P-7**

Participant **6** also highlighted in the questionnaire the:

"**limited learning materials and hard to find updated textbooks**"

Learning materials are important because they can significantly increase student achievement by supporting student learning. It adds structure to the lesson planning and delivery of instruction. The quality of the learning materials directly impacts the quality of teaching.

These reports on the problems of availability of resource materials are found to be consistent with other studies on STS [6],[7**],[**38],[39]. This finding concurs with Jessani [7] indicating that textbooks are still predominantly focused on scientific content and concepts and Mansour's idea of external physical constraints [39] such as the lack of and difficulty in getting enough relevant resources to teach STS issues.

These views are also similar with Autieri [6] explaining the failure of science textbooks to reflect an STS viewpoint toward many science topics could impede the success of STS teaching. Additionally, the lack of appropriate instructional content related to local contexts may also lower teachers' motivation to practice STS [38]. Hence, highlighting as well the importance of an adaptive approach of STS fora local flavor in the context is suggested [7].

D. PLANNING AND PREPARATION

In some studies, the planning and preparation is seen as an obstacle in the implementation of STS such as: Bettencourt's [1] needed time to plan and prepare the learning activities, Mansour's [21] citation on the lack of adequate preparation to not adopt an STS framework to teaching science, and/or Meyer and James' [11] curricular planning and time constraints to carry out the STS implementation in the class.

However, in this particular study, the higher education instructors perceived this aspect as not a constraint for majority of them agreed that the Outcome-Based Education (OBE) syllabus reduced their time to prepare since the topics to be discussed are already outlined and structured for them. The One System One Standard (OSOS) approach as encouraged by the institution minimized their tasks in the preparation aspect. Several quotations from the participants mentioned:

*"…not much because we have the syllabus so we know the sequence of the topics…"***P-3**

(it was not that hard when it comes to planning because it's OSOS.., the course outline is the same for all, hence it is easier because of OBE…so the preparation is okay) **P-5**

(The planning and preparation was not a problem since it is somehow polished) **P-1**

E. FACILITIES

Meanwhile, majority of the interviewed teachers agreed that they did not have a hard time utilizing the ICT facilities. These facilities include the use of LCD projectors and TV monitors in each room for movie reviews or video clips.

"…*facility wise daw okay gid, it's not a problem"*
(facility wise, it's really okay/good, it's not a problem) **P-3**

(*we usually use projector because majority nowadays uses powerpoint, especially when one wants to show pictures)* **P-5**

(the facilities are not a problem, for as long as you do have an LCD projector and TV, it's okay) **P-2**

"ICT facility is available" P-6

This implies that teachers' school facilities aided them in implementing their instructions and did not add constraints to the challenges they have experienced teaching STS.

CONCLUSION AND RECOMMENDATION

Looking into the responses of the participants, this study was able to examine the teaching experiences faced by higher education instructors in one of the SUCs in Negros Occidental. The findings from the interviews, focus group discussion and survey revealed the lack of training for these participants. Their unfamiliarity with some STS contents that also requires teaching models and approaches could hinder the introduction of STS education in schools, accordingly [40][41]. Therefore, investing in teachers' training and seminar-workshops are fundamental because accordingly, the best way to initiate students into a discipline is the same way the teacher was initiated [21]. Another possible remedy based from Dass [42] is infusing as early in their preservice preparation so that they may more likely to employ the STS approach in their own teaching and more likely able to accomplish science teaching reform with their students.

The primary issue faced by tertiary faculty was content-related as what the findings have showed; most teachers had difficulty to relate the philosophical aspect in their classes because of their lack of professional knowledge to teach such content. Also, their previously held conceptions of STS contents and science disciplinary background that characterizes a traditional instruction indicated their flyspeck background in teaching some of the STS topics in this new GEC, and so their difficulties to implement successfully STS teaching. Another aspect which concurs with other studies [6],[7],[38],[39]was on the limited resources or learning materials that reflect STS contents or viewpoints in order to guide and equip them further in the instruction. On the other hand, factors related to teaching strategies, planning and preparation and facilities were not addressed as

difficulties by the most participants during their conduct of STS instruction. Hence, further in-depth study is encouraged to check consistency of the findings.

Furthermore, due to the specific context and to the small number of teachers interviewed, it is not possible to generalize the results. Thus, one of the goals for further research is to develop a similar study with a larger sample of science teachers. Moreover, investigating for more facets other than the five categories mentioned in this study related to students, administration, or peer related issues are highly suggested for further analysis. It would also be worthwhile to investigate more experiences about STS teaching of teachers from other SUC's to validate these experiences, particularly on the area of planning and preparation as this may seem contradicting to their addressed difficulties.

As a whole, since this revision in the GEC courses of HEIs is still relatively new, let these results and suggestions be widely disseminated so that these challenges faced by science teachers handling STS education will be addressed and developed.

REFERENCES

[1] Bettencourt, C., Velho, J. L., & Almeida, P. (2011). Biology teachers' perceptions about Science-Technology-Society(STS) education. *Procedia Social and Behavioral Sciences 15*, pp. 3148–3152.

[2] Donnelly, J. F., & Jenkins, E. W. (2001). *Science education: Policy, professionalism and change.* London: Paul Chapman Publishing Ltd.

[3] Galvão, C., & Freire, A. (2004). A perspectiva CTS no currículo das ciênciasfísicas e naturaisem Portugal [The STS perspective into the curricula of natural sciences in Portugal]. In I. Martins, F. Paixão and R. Vieira (Eds.), PerspectivasCiência-Tecnologia-Sociedadenainovação da educaçãoemciência (pp. 31–37). Aveiro: Universidade de Aveiro.

[4] Yager, R., &Tamir, P. (1993). STS approach, reasons, intentions, accomplishments and outcomes. *Science Education, 77*(6), 637-658.

[5] Aikenhead, G. (1984). Teacher decision making: the case of Prairie high. *Journal of Research in Science Teaching, 21*(2), 167-186.

[6] Autieri, S. M., Amirshokoohi, A. &Kazempour, M. (2016).The science-technology-society framework for achieving scientific literacy: an overview of the existing literature. *European Journal of Science and Mathematics Education, Vol. 4, No. 1,* 75-89.

[7] Jessani, S. I. (2015). Science Education: Issues, Approaches and Challenges. *Journal of Education and Educational Development Vol. 2 No. 1,* 79 – 87.

[8] Orpwood, G. (2001). The role of assessment in science curriculum reform. *Assessment in Education, 8*(2), 135-151.

[9] Bybee, R.W. (1991). Science-Technology-Society in Science Curriculum: The Policy-Practice Gap. *Theory Into Practice,* 30(4),294-302.

[10] Rubba, P.A. (1991). Integrating STS into School Science and Teacher Education: Beyond Awareness. *Theory Into Practice,* 30(4),303-308.

[11] Meyer, J.D., & R.K. James. (2002, April). STS For Pre-Service Teachers: Does It Translate In The Classroom? Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Philadelphia, PA.

[12] Mansour, N. (2007). Challenges to STS Education: Implications for Science Teacher Education. *Bulletin of Science, Technology and Society, Vol. 27*,No. 6 December, 482- 497.

[13] Ajzen, I (2002). Perceived behavioural control, self-efficacy, locus of control, and the theory of planned behaviour, *Journal of Applied social Psychology, 32*, pp. 1-20.

[14] Rennie, L., Goodrum, D., & Hackling, M. (2001). Science teaching and learning in Australian schools: Results of a national study. *Research in Science Education*, 31, 455-498.

[15] Orosa, M.A. B. (2008). Inquiring into Filipino Teachers' Conceptions of Good Teaching: A Qualitative Research Study, *TheAsia-Pacific Education Researcher 17:2*, pp. 157-171.

[16] Creswell J.W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* SAGE Publications, Inc.

[17] Arksey, H., & Knight, P.(1999). *Interviewing for social scientists.* London: Sage.

[18] Holloway, I.(1997). *Basic concepts for qualitative research*. Oxford: Blackwell Science.

[19] Groenewald,T. (2004). Phenomenological Research Design Illustrated. *International Journal of Qualitative Methods, 3* (1), pp. 42-55.

[20] Bybee, R. (1993). *Reforming science education: Social perspectives and personal reflections.* New York: Teachers College Press.

[21] Mansour, N. (2009). Science-Technology-Society (STS): A New Paradigm in Science Education. *Bulletin of Science, Technology & Society 29 (4),* 287-297. DOI: 10.1177/0270467609336307

[22] Brickhouse, N. (1989) The teaching of the philosophy of science in secondary classrooms: case studies of teachers' personal theories, *International Journal of Science Education, 11:4*, 437-449, DOI: 10.1080/0950069890110408

[23] Aikenhead, G. S. (1987 b). A module for teaching scientific decision making. *Bulletin of Science, Technology, and Society, Vol. 7*, 137-145

[24] Barnes, B. (1985). *About science*. Oxford: Basil Blackwell.

[25] Ziman, J. (1994). The rationale of STS education is in the approach. In J. Solomon & G. Aikenhead (Eds.).*STS education: international perspectives on reform*. (pp.21-31). London: Teachers College Press.

[26] Pedretti, E., &Hodson, D. (1995). From rhetoric to action: Implementing STS education through action research. *Journal of Research in Science Teaching, 32* (5), 463-485.

[27] Aikenhead, G. (2000). STS in Canada: From policy to student evaluation. In D.D. Kumar & D.E. Chubin (Eds.), *Science, technology, and society: A sourcebook on research and practice* (pp.49-89). New York: Kluwer Academic/Plenum Publishers

[28] Tsai, C. (2002). Nested epistemologies: science teachers' beliefs of teaching, learning and science. *International Journal of Science Education, 24*(8), 771-783.

[29] Pinar, W. (1978). Notes on the curriculum field. *Educational Researcher, 7*(8), 5–12.

[30] Butt, R., Raymond, D., McCue, G., & Yamagishi, L. (1992). Collaborative autobiography and the teacher's voice. In I.F. Godson (Ed.), *Studying Teachers' Lives* (pp. 51–98). London: Routledge.

[31] Mansour, N. (2008). The Experiences and Personal Religious Beliefs of Egyptian Science Teachers as a Framework for Understanding the Shaping and Reshaping of their Beliefs and Practices about Science-Technology-Society (STS),*International Journal of Science Education*,*30*:12,1605 — 1634.

[32] Pacana, Nina Mae., Ramos, Charmen, Catarata, Maryland. (2018). Problems Met by Non-Social Science Teachers in Teaching Social Studies. https://www.academia.edu/37916535/Problems_Met_by_NonSocial_Science_Teachers_in_Teaching_Social_Studies

[33] Hofstein A., Aikenhead G., & Riquarts, K. (1988) Discussions over STS at the Fourth IOSTE Symposium. *International Journal of Science Education*, 10:4, 357-366, DOI: 10.1080/0950069880100403.

[34] Fensham, P. J. (1988). Approaches to teaching of STS in science education. *International journal of science education, 10* (4), 346-356.

[35] Bybee, R., & Mau, T. (1986). Science and technology related global problems: An international survey of science educators. *Journal of Research in Science Education, 23*(7), 599–618.

[36] Mansour, N. (2004). *Does the Egyptian preparatory science curriculum provide for the development of the Scientific Literacy (SL)?* Paper at the Annual Staff Student Research Conference at the School of Education and Lifelong Learning, University of Exeter, 15 May, Exeter, UK.

[37] Oulton, C., Dillan, J., & Grace, M. M. (2004). Re-conceptualizing the teaching of controversial issues. *International Journal of Science Education*, *26*, 411-423.

[38] Tsai, C. (2001). A Science Teacher's Reflections and Knowledge Growth about STS Instruction after Actual Implementation. *Science Education86*.23 –41. DOI 10.1002/sce.10006

[39] Mansour, N. (2006). The mediating factors between Egyptian science teachers' beliefs and practices concerning teaching science through Science-Technology-Society(STS): Implication for science education. Paper presented at the annual conference of the British Educational Research Association (BERA) University of Warwick, UK, 9-6 September.

[40] Jegede, O. J. (1988). The development of the science, technology and society curricula in Nigeria. *International Journal of Science Education, 10*(4), 399-408.

[41] Mansour, Nasser. (2010). Science Teachers' Perspectives on Science-Technology-Society (STS) in Science Education. *Eurasian Journal of Physics and Chemistry Education. 2*(2): 123-157.

[42] Dass, P. M. (2005). Using a science/technology/society approach to prepare reform- oriented science teachers. *Issues in Teacher Education*, *14*, 95-108.