The Art of Teaching Science in Secondary Schools: A Meta Analysis

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ABSTRACT
This study attempted to highlight the trend of research in science related subjects specifically in schools. Articles and journals were retrieved from Google scholar under peer reviewed with the aim to highlight the trend of research methods, findings and teaching strategies. The themes were based on pedagogical approaches of teaching science, students' motivation in learning sciences and challenges hindering effectiveness of teaching sciences. The paper contributes to policy makers and science teachers to employ appropriate strategies and integrate suitable technologies for teaching science in secondary schools. Based on the meta-analysis, tables are provided to summarise the research trend and findings. It has been found that the trend of low interest in learning science is still apparent for the past five years. The barriers of effective teaching and motivation have been the main discussion among researchers. Recommendations have been drawn to ensure teachers to involve in action research for effective intervention in teaching and learning science in schools. The limitations of study include the narrow search in the Google scholar rather than in indexed Scopus and ISI journals. Thus the quality of the research journals is not addressed.
Keywords: Pedagogy, science education, motivation

INTRODUCTION
The demand of skilful human capital imparting scientific knowledge, values and problem solving has changed the education perspectives in the 21st century. The world continues to witness unprecedented development and challenges in science and technology. It has been a great concern for every developing country to invest hugely on children's education from early age in facing the new wave of Information Communication Technology (ICT). Economic growth in Malaysia has grown very fast in achieving 2020 vision where the country has to accomplish scientifically driven economy and a developed nation as reported in Amardio (2015). However, Malaysia is experiencing a decline number of students who are interested to pursue their specialization in Science and Technology (S&T) (MOSTI, 2008; MOSTI, 2015). OECD (2016) has reported on the economic slowdown in Malaysia which requires the Government to venture into innovation system which is hoped to drive the growth of economy and social development. A few considerations that need to be addressed is to overcome the mismatch of skills and education, and lack of coordination of science and technology policies with other overlapping policies and initiatives.

Many research has been carried out to highlight the trend of research in S&T. The findings will inform on the current status of science teaching throughout the countries in the world. Thus, a systematic review is needed to analyze previous research trend and to draw a conclusion from the analyses.

FOCUS OF STUDY
This paper aims to identify the research trends of teaching science subjects in secondary schools from the years 2010 to 2016. The reviews of the articles were based on identifying the areas of the research, most frequent employed methodologies; research instruments; and data analysis techniques. Finally, the researcher reviewed the major findings of the articles where teachers' pedagogical approaches of teaching science, students' motivation in learning sciences and challenges hindering effectiveness of teaching sciences were identified and discussed as the main themes of the analysis. The paper contributes to policy makers and science teachers to employ appropriate strategies and integrate suitable technologies for teaching science in secondary schools.

Based on the focus this study, the following research questions are addressed.

1. What are the main areas of STEM have been researched?
2. Which methodology most frequently employed in research related to teaching and learning science in secondary schools?
3. What is the most common research instrument used for data collection in the research?
4. Which instructional strategies do science teachers prefer for teaching science subjects?
5. What is the trend of students' motivation in learning science?
6. What are challenges hindering the success of teaching sciences in secondary schools as reported from the findings of the reviewed articles?

RESEARCH DESIGN

This study attempts to identify the directions of research of S&T in secondary schools through the analysis articles related to the area published in different online scholarly open source journals from 2010 to 2016 and available in Google scholar. Thus, meta-analysis is deemed to be the most suitable design of this study. Meta-analysis and content analysis have been interchangeably used to identify the trend of research for the literature reviews. Content analysis is referred to as a research procedure uses to systematically interpret textual materials (Hsieh & Shannon, 2005) which utilizes both quantitative and qualitative methodologies. It is also referred to the study of the content with reference to the meanings, contexts and intentions contained in messages (Parasad, nd). The content can be written texts, pictures, artefacts and recordings (Cresswell, 2012). Bauer and Gaskell (2000) denoted that one of the essences of conducting content analysis is to provide the researcher an opportunity to link data which are related to each other and generate themes that can be read conveniently; also it is useful for reserachers to use it as a reference of their potentials studies. On the other hand, meta-analysis is analysis of analysis which refers to two categories: integrative and interpretive. In this study, integrative method is used to summarize the data from the quantitative findings and provide a qualitative understanding.

Parasad (nd) stated that meta-analysis has been widely used by researchers to understand different range of themes such as changing trends in the theoretical content of various fields of study, cultural symbols, social change, verification of authorship, changes in the mass media content, nature of news coverage of social issues like violence against women and children, divorce rate, truancy etc. Loy and Pamela (1979) indicated that one of the most common of meta-analysis employed by researchers is the one related to changing trends in the theoretical content and methodological approaches through analysing the contents of the journal articles related to the discipline.

For instance, in the field of science education, Uzunboylu and Aşıksoy (2014) explored the trends of research in physics education by reviewing 105 articles published between the years of 2008 and 2013. The researchers reviewed the articles based of their methods, subject areas, research titles, data analysis techniques, and sampling types. The findings of the study were analysed using frequency and percentage.

In addition to that, Geske (2011) analysed science text books for primary school in Latvia, Kazakhstan, Russian Federation, the Ukrain and the USA. He applied TIMSS research framework to assess the effect of textbooks on students' achievement. Similarly, Maleknejad Amoopour and Abdi (2015) conducted a content analysis of biology book of grade three students' viewpoint from public and private high schools in Rasht City during 2014-2015 academic year.

Thus, meta-analysis specifically the critical review of previous research is employed to analyse 20 articles from open source online publications between 2010 and 2016 available in Google scholar by considering the following steps: (i) Publication year, (ii) authors, (iii) Research titles (iv) Research objective, (v) Research methods, (vi) Data collection instruments, (vii) Data analysis techniques and (viii) summary of the major findings of the study.

The articles were selected from journals based on the key words of the research questions. The journals were properly selected to ensure they are peer reviewed and not listed in the predatory list. The journals are: *The Malaysian Online Journal of Educational Technology, Journal of Science and Mathematics Education in Southeast Asia, British Journal of Science, Asia-Pacific Forum on Science Learning and Teaching, International Journal of Instruction, Journal Science Education Technology, Baraton Interdisciplinary Research Journal, Journal of Social Sciences, Procedia Social and Behavioral Sciences, Eurasia Journal of Mathematics, Science & Technology Education, Educational Research International, Journal of Agricultural Education, International Journal of Machine Learning and Computing, European Journal of Science and Mathematics Education,*

Procedia-Social and Behavioral Sciences, International Journal of Environmental & Science Education, International Journal of Science and Mathematics Education, and *Journal f Educational Research*

RESULTS AND DISCUSSIONS
STEM as the key search
This study firstly referred to STEM which is denoted as Science, Technology, Engineering and Mathematics. The data reveal that science is the major area of the research articles (60%) with a total of 12 out of 20 articles, followed by Mathematics with a total of 7 articles (35%) while technology only covers 5% (1 article). These indicate that science has the highest focus on STEM research area for the past six years. Table 1 shows the distribution of research for each area of study with the specified years.

Table 1.0: Frequency and percentage of publications from Scholar Open source publications

Areas of study	2010	2011	2012	2013	2014	2015	2016	Percentage	Frequency
Science	-	-	1	5	2	-	3	60%	12
Technology	-	-	-	-	-	1	-	5%	1
Engineering	-	-	-	-	-	-	-	-	-
Mathematics	3	1	1	-	-	-	2	35%	7

Research Methodologies Employed in the Articles
Research methodology is defined by Rajasekar, Philominathan and Chinnathambi (2013) as a systematic way of solving identified problem of a research. They have also defined research methodology as procedures by which researcher goes about his work of describing, explaining and predicting phenomena. There are three types of research methodology; quantitative, qualitative and mixed method research. It is revealed that the most employed research method is quantitative which accounts for 75% (15 out of 20 articles) followed by mixed method research with 10% (4 articles), while qualitative research method has the least (5%) with only one article. Table 2 presents the frequency and percentage of research methods from the Open source publications.

Table 2: Frequency and Percentage of Research Methods from Scholar Open Source Publications

Research Category	2010	2011	2012	2013	2014	2015	2016	Percentage	Frequency
Quantitative	3	-	2	4	2	1	3	75%	15
Qualitative	-	-	-	-	-	-	1	5%	1
Mixed Method	1	1	-	1	-	-	1	15%	4

Research Instruments Used for Data Collection in the Articles
This section tends to find out the most frequent instrument used for data collections in the reviewed articles. Research instruments are referred as the tools for data collections such as questionnaire, interview, observation, document analysis, test score etc. In a few of the articles, there were more than one instruments used for data collection. In such case, each of the instruments is counted separately and independently. The results of this study reveal that the instrument mostly used for data collection is questionnaire 63. 6% (14) followed by interview 18.2% (4), test scores 13.6% (3) and observation 4.56% (1). This indicates that the questionnaire is the most employed instrument for data collection, specifically quantitative data, while observation is the least instrument employed. Table 3 presents the summary of the instruments used for data collection from the reviewed articles.

Table 3: Instruments Used for Data Collection from the Reviewed Articles

Research Instruments	2010	2011	2012	2013	2014	2015	2016	Percentage	Frequency
Questionnaire	3	1	1	4	2	1	2	63. 6%	14
Interview	1	1	-	-	-	-	2	18.2%	4
Test score	2		1	-	-	-	-	13.6%	3
Observation				1				4.5 %	1

Techniques Employed for Data Analysis in the Articles
There are two types of data in educational research; quantitative and qualitative data. Quantitative data are numeric, thus, the suitable techniques for analysing them are the statistical tools such as t-test, ANOVA, Correlation and so forth. Conversely, qualitative research data are usually text based, thus, its analysis procedures are not numerical. The findings of this study reveal that the statistical data analysis techniques used

in the articles are descriptive statistics, t-test, ANOVA, ANCOVA, Correlation, Multiple Regression Analysis (MRA), Principal Component Analysis (PCA), Pearson's Chi Square test, and Spearman Rank Correlation. With regards to qualitative data analysis procedure, Thematic Analysis procedure was used. Table 4 shows that the most used data analysis technique is descriptive statistics accounting 27%, followed by t-test and ANOVA with 23% and 13.3% respectively. However, the least used techniques for data analysis are Chi-Squared and Principal Component Analysis CPA with just 3.3% each. Table 4 presents the techniques of data analysis employed in the analysed articles.

Table 4: Summary of Presents Techniques of Data Analysis Employed in the Analysed Articles

Research Instruments	2010	2011	2012	2013	2014	2015	2016	Percent	Freq
Descriptive Statistics	1	-	1	2	2	1	1	27%	8
Independent Sample T-test	2	-	2	1	1	-	1	23%	7
ANOVA	-	-	-	-	2	-	2	13.3%	4
ANCOVA	1		1	-	-	-	-	6.7%	2
Correlation /MRA	1	1		-	-	1	2	16%	5
Chi-Square				-	-		1	3.3%	1
Principal Component Analysis				1	-	-	-	3.3%	1
Qualitative Analysis-themes			-	-	-	-	2	6.7	2

Summary of the Major Findings of the Reviewed Articles

This section provides the major findings of the twenty selected articles on teaching science in secondary schools. Finally, three main themes were defined in this section; (i) teachers' method of teaching sciences, (ii) students' motivation in learning sciences and (iii) issues inhibiting the process of teaching and learning science successfully in secondary schools.

Instructional Strategies opted by Science Teachers

Arends (2009), and Jaboksen,Eggen and Kauchak, (2008) defined method of teaching as the procedure and actions employed by a teacher to help his students achieve a particular objective of learning. There are other terms which are interchangeably used with teaching methods like instructional strategies and teaching techniques (Ibrahim, Musa & Idris, 2016). Mainly, teaching methods are divided into teacher-centred and student-centred (Arends, 2009, Jaboksen,Eggen & Kauchak, 2008). This is due to different theories of learning sequentially emerged (behaviourism, congnitivisms and constructivism) in the literature of learning. Each of the teaching method has its theoretical bases from one or two of the learning theories. For instance, teacher centred or inductive method has its theoretical bases from behaviourism and cognitive theory while students' centred or deductive method is supported by constructivism learning theory (Tomie, 2010). Selection of any of the methods depends on the objectives of the lesson, students' characteristics, nature of the subjects, students' population, teachers' competency etc (Abdullahi, 2008).

The findings also indicate that science teachers are no longer interested in teacher centred method through which the teacher dominates most of learning activities. Thus, they are making effort to shift their instruction from teacher centred to student centred method which offers more opportunities for students to discover scientific facts and mathematic solutions by themselves. They have the perceptions that teacher centred is not fully accommodating neither the teachers nor students' demands of teaching and learning respectively. Thus, efforts have been made to discover the effects of student centred method such as problem based learning, cooperative learning, discovery learning on students' learning performance and motivation. For instance, Abdullaha,, Tarmizia, and Abub (2010) conducted an experimental study on the effect of Problem Based Learning (PBL) on mathematics performance and they found that PBL is one the most effective approaches of teaching that help students to better understand complex mathematical concepts and help them to explain the concepts effectively. They also found that students in the experimental group (where PBL was applied as teaching method) obtained higher scores, higher team work, involved more in the classroom activities than those in the control group. Thus, the students in the former group expressed that PBL is more preferable method for them. Similarly, Vlassi and Karaliota (2012) in their comparative research between guided inquiry and traditional method, they discovered significant supremacy of guided inquiry against the traditional teaching method. Finally, Zakaria, Chin, and Daud (2010) examined the effect of cooperative learning on students' achievement in mathematics and they discovered that cooperative learning approach of teaching enhance students' achievement in mathematics.

In addition, the analysis of the findings reveals that there are other instructional techniques which are very helpful for teaching science in secondary schools. The techniques emphasize students' active involvement in learning science subjects. Some of the techniques are outdoor learning and instructional congruence. The former is defined as an experiential process of learning by performing acts and experiences that take place largely

outside classroom settings, and students learn through outside exposure with the environment (Dhanapal & Lim, 2013). They also expressed that the technique is found to be effective in improving students' academic performance. The latter is defined by Zain, Samsudin, Rohandi, Jusoh and Samsudin (2010) as the agreement or harmony between the students' experiences and cultures that relate to their goals and career undertaking. The technique has also revealed that it promotes students' attitudes toward learning, enhance their interest in learning science and it encourages their participations in the classroom (Zain, Samsudin, Rohandi, Jusoh and Samsudin, 2010). Table 5 presents the summary of the studies; major findings on the advantages of some instructional strategies and techniques in teaching science.

Table 5: Research Major Findings on the Advantages of Instructional Strategies and Techniques in Teaching Science

Author	Topic	Major findings
Dhanapal, (2013)	A comparative study of the impacts and students' perceptions of indoor and outdoor learning in the science classroom	i. Indoor and outdoor learning complement each other in improving students' academic performances ii. Positive responses among the students in choosing outdoors than indoors for learning science.
Zain, Samsudin, Rohandi, Jusoh and Samsudin (2010)	Improving Students' Attitudes Toward Science Using Instructional Congruence	The results show that instructional congruence in science education promotes positive students' attitudes toward science, especially in the constructs of the practical work of science, science outside of school, future participation in science, and a combined interest in science.
Abdullaha,Tarmizia,& Abub (2010)	The Effects of Problem Based Learning on Mathematics Performance and Affective Attributes in Learning Statistics at Form Four Secondary Level	i- overall performance scores of both groups, the PBL group appeared to obtain a higher mean score as compared to the CT group. ii- Overall both groups showed positive interest in the subject, students in the CT group showed a higher interest for mathematics. iii- PBL instructional strategy was a more effective approach in explaining difficult mathematical concepts and led them to understand the content better. This group also recommended the PBL approach for the next lessons and the teaching of other subjects. iv- The PBL group also displayed a higher total mean score for teamwork (13.24) as compared to the CT group (12.46). v- They were also awarded higher scores for working with others, attitude in group, and focus on the task and taking pride in their work.
Vlassi & Varaliota (2012)	Guided inquiry and traditional teaching method. A case study for the teaching of the structure of matter to 8th grade Greek students	The statistical analysis showed a significant supremacy of the guided inquiry against the traditional teaching method for the teaching of the structure of matter. Also, the findings indicated higher score performance in the tests for the boys compared to that for the girls
Zakaria, Chin and Daud (2010)	The Effects of Cooperative Learning on Students' Mathematics Achievement and Attitude towards Mathematics	Cooperative learning methods improve students' achievement in mathematics and attitude towards mathematics.

Students' Motivation in Learning Science
Motivation is considered among the most influential factors that enhance students' learning achievement, engagement and persistence in learning (Qin Xiaoqing, 2002), students' ability for autonomous learning, and improves their confidence to confront learning difficulties (Xiaoqing, 2003). Thus, teachers concert a lot of effort to enhance students' motivation for their teaching. Williams and Burden (2000) define motivation as a state of cognitive and emotional arousal, which leads to a conscious decision to act, and gives rise to a period of sustained intellectual and physical effort in order to attain a previously set goal. In the same vein, Deci and Ryan

(1985) identified two categories of motivation; intrinsic and extrinsic motivation. Intrinsic motivation is referred as internal drive that engages students into learning activities and feels enjoyed and satisfied.

Based on the selected research, the findings indicate that secondary students are not motivated in learning science subjects especially physics (Ondere, Edward and Baluku, 2016; Saleh, 2014). Saleh (2014) in his research on Malaysian students' motivation toward learning physics discovered that about 75% of the students felt that learning physics in school is boring and the method of teaching the subject does not attract their attention in the class. As a result, the number of students' enrolment into tertiary education in science subjects is decreasing almost every year (Yunus, and Ali, 2013). Yunus and Ali (2013) and Saleh (2014) in their research discovered that students have negative attitudes toward learning science. This is because of two reasons where firstly it relates to the syllabus which is considered too wide and rigid. Secondly is the adoption of traditional method which is still a norm in science teaching in secondary schools.

Notwithstanding, other recommendations reveal some strategies if implemented can enhance students' motivation in learning science. The strategies include; employing effective method of teaching, integrating instructional materials in teaching, questioning techniques (Rehman and Hider, 2013), providing and conducting science experiment effectively, teachers' personality, teachers' ability to provide clear examples and applications of knowledge, provision of adequate teaching and learning facilities for science, increasing students' awareness about the relevance of science in the everyday world and providing effective timetable for teaching science (Halim, Sharina Syed, & Meerah, 2014). Table 6 presents research and major findings related to secondary school students' motivation in learning sciences

Table 6: Researches and Major Findings Related To Secondary School Students' Motivation in Learning Sciences

Author	Topic	Major findings
Saleh, (2014)	Malaysian students' motivation towards Physics learning	i- most students (> 75.0%) felt that learning Physics in school is boring and they agree that Physics instructional methods were unable to attract their attention ii- In general, it was found that students' level of motivation to learn Physics is at a moderately high level, with an average score of 3:05 on the Likert Scale. iii- Among the factors found to exert strong influence in determining a student's motivation towards learning Physics are aspects such as relationships, stress and effort. According to the results, it was observed that, although students have encouraging motivation towards learning Physics, further analysis show that most of them think that learning the subject in schools is not that appealing
Halim Abdullah & Meerah (2014)	Students' Perceptions of Their Science Teachers' Pedagogical Content Knowledge	i- important factor that would be able to promote students' interest and contribute to the effective learning of science is providing and conducting science experiments effectively ii- Other characteristics or factors deemed to encourage science learning included teachers' personality, ability of teacher to provide clear examples and application of knowledge, well equipped with organizing teaching and learning facilities, including use of ICT, and providing effective time tabling of lesson iii- The most interesting finding in this study is related to teachers' personality and their ability to promote science as a career. Teachers' personality or personal quality was recorded as the second highest percentage given by the students. iv- Another interesting finding is that students would like to know about the relevance of science in the everyday world, the importance of science, the application of science, and the availability of careers in science fields.
Rehman & Haider, (2013)	The Impact Of Motivation On Learning Of Secondary School Students In Karachi:	i. Teacher agreed that usage of effective teaching methods cause to create motivation in students. ii. Teachers agreed that the concept of punishment and reward can create motivation in students to learn iii. Teachers agreed that teaching aids can help the students to learn

	An Analytical Study	easily
		iv. Students agreed that they learn better through question. Students were participating in class room activities. Due activities students learning improved.

Problems Inhibiting the Process of Teaching and Learning Science in Secondary Schools

The findings have highlighted some problems hindering the effective process of teaching and learning in secondary schools. Yunus and Ali (2013) identified some of the issues such as huge and wide syllabus which pushes the teachers to rush into completing the topics listed. Similarly, Ahmad (2013) in his research on the factors that inhibit science teachers from using ICT reveal that most of the teachers do not use ICT in their teaching. She attributed this issue to the teachers' self-handicapping thoughts, school support, attitude toward ICT and negative belief about ICT use. In addition to that Sim and Theng (2012) have identified other barriers that prevent science teachers from using ICT in teaching namely lack of technical support, lack of time and limited knowledge to make full use of ICT in teaching sciences. In similar views, Halim, Abdullahi and Meerah (2014) discovered that the time allocated for formal teaching and learning science during school hours was inadequate. Table 7 presents the research and findings related to issues inhibiting teaching sciences in secondary schools

Table 7: Summary of Research and Findings Related To Issues Inhibiting Teaching Sciences in Secondary Schools

Author	Topic	Major findings
Yunus &Ali, (2013)	Attitude towards Learning Chemistry among Secondary School Students in Malaysia	The syllabus too wide, thus, teacher are rushing to cover the syllabus A number of students enrolling in university to study chemistry is decreasing
Ahmad (2013)	Between School Factors and Teacher Factors: What Inhibits Malaysian Science Teachers From Using ICT?	i. Most of the teachers to do not use ICT in teaching sciences ii. The factors that inhibit them are (i) self-handicapping thoughts, (ii) school support, (iii) attitude toward ICT use, and (iv) negative beliefs about ICT use. iii. Three of these factors were teacher related. Self-handicapping thoughts emerged as the largest inhibitor, explaining about 38.2% of teachers' lack of ICT utilization in the science classroom.
Saleh (2014)	Malaysian students' motivation towards Physics learning	The instructional methods were unable to attract their attention. According to the results, it was observed that, although students have encouraging motivation towards learning Physics, further analysis show that most of them think that learning the subject in schools is not that appealing
Lilia Halim • Sharifah Intan Sharina Syed Abdullah • T. Subahan Mohd Meerah (2014)	Students' Perceptions of Their Science Teachers' Pedagogical Content Knowledge	The respondents, regardless of their ability, raised concern about the allocation of time for learning science in schools. A total of 9.82 % (n = 31) of the respondents felt that the time allocated for formal teaching and learning science during school hours was inadequate.
Janice CH Sim & Lau Bee Theng, (2012)	Teachers' perceptions of the use of ICT as an instructional tool in Mathematics and Science	i. Lack of technical support was perceived by most teachers as an ICT barrier in schools. ii. Lack of time was reported by the respondents as another strong ICT barrier in schools. iii. Limited knowledge to make full use of ICT, or to integrate ICT fully into teaching

CONCLUSIONS AND RECOMMENDATIONS

Efforts have been taken by teachers worldwide to ensure school students are motivated to learn science. However, there will be a future trend in the decline of students to enrol their career in science related fields due to lack of motivation. Thus, effective teaching strategies and the efforts to integrate ICT in science technology will ensure students to involve and engage in science subject. All the articles studied though were delimited to Google scholar search have shown a general idea of science research which were more focussed on teachers as factors of success. Nevertheless, the issues of pedagogical strategies, technology competency and wide syllabus

have been consistently raised and highlighted in the past five years. Thus, there is a need to involve teachers to become active researchers to find the solutions and interventions for effective teaching. Further collaborative inquiry is also needed between teachers in schools and academicians in Higher learning institutions to work hand in hand in dealing with student motivation and achievement in learning science. Even though assessment was not documented and raised in the journals involved, it is an essential argument to be researched. Assessments are the main concerns of schools and students that direct students to learn. The way students are accessed is crucial in understanding the focus of teaching and learning in the 21st century.

RFERENCES

Abdullahi, H. R. (2009). *An introduction to principles and methods of teaching.* Kano: HMD Publishers & Printers.

Abdullah, N. I., Tarmizi, R. A., & Abu, R. (2010). The effects of problem based learning on mathematics performance and affective attributes in learning statistics at form four secondary level. *Procedia-Social and Behavioral Sciences*, *8*, 370-376.

Ahmad, T. B. T. (2014). Between School Factors and Teacher Factors: What Inhibits Malaysian Science Teachers from Using ICT?. *Malaysian Online Journal of Educational Technology*, *2*(1), 1-10.

Ali, M. B., Halim, N. D. A., & Shukor, N. A. (2013). The Development of Active Learning Website for Learning Science. *International Journal of Machine Learning and Computing*, *3*(3), 284.

Amir, K., & Muhamad, H. C. (2016). Learners' Attitudes and Performance in Science Subjects in A-Level in Secondary Schools, in Mbarara, Uganda. *Journal of Educational Research 3*(2), 10-25.

Amadio,M. (2015). STEM education and the curriculum: Issues, tensions and challenges www.akademisains.gov.my/download/STEM%20education%20and%20curriculum.p   df

Arends, R. I. (2009). Learning to teach. Kuala Lumpor: Mc Graw- Hill Companies.

Bauer, M. W., & Gaskell, G. (Eds.). (2000). *Qualitative researching with text, image and sound: A practical handbook for social research*. Sage.

Chumbley, S. B., Haynes, J. C., & Stofer, K. A. (2015). A Measure of Students' Motivation to Learn Science through Agricultural STEM Emphasis. *Journal of Agricultural Education*, *56*(4), 107-122.

Creswell, J. W. (2012). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

Dhanapal, S., & Lim, C. C. Y. (2013, December). A comparative study of the impacts and students' perceptions of indoor and outdoor learning in the science classroom. In *Asia-Pacific Forum on Science Learning and Teaching* (Vol. 14, No. 2, pp. 1-23). Hong Kong Institute of Education. 10 Lo Ping Road, Tai Po, New Territories, Hong Kong.

Deci, E. & R, Ryan. (1985). Intrinsic Motivation and Self Determination in Human Behavior. NY: Plenum Press.

Halim, L., Abdullah, S. I. S. S., & Meerah, T. S. M. (2014). Students' perceptions of their science teachers' pedagogical content knowledge. *Journal of Science Education and Technology*, *23*(2), 227-237.

Hacieminoglu, E. (2016). Elementary School Students' Attitude toward Science and Related Variables. *International Journal of Environmental and Science Education*, *11*(2), 35-52.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), 1277-1288.

Hunter, J. E., & Schmidt, F. L. (2004). Methods of Meta-Analysis: Correcting Error and Bias in Research Findings (2nd ed.). Thousand Oaks, CA: Sage

Hüseyin Uzunboylua , Gülsüm Aşıksoyb (2014) Research in Physics Education: A Study of Content Analysis, Procedia - Social and Behavioral Sciences 136 (2014) 425 – 437

Ibe, E., Nworgu, L. N., & Anyaegbuna, N. J. (2016). Influence of teachers' characteristics on academic achievement of secondary school biology students. *British Journal of Science13*(2), 33-44.

Idris, N., Cheong, L. S., Nor, N. M., Razak, A. Z. A., & Saad, R. M. (2007). The professional preparation of Malaysian teachers in the implementation of teaching and learning of mathematics and science in English. *Eurasia Journal of Mathematics, Science & Technology Education*, *3*(2), 101-110.

Jacobsen, D. A., Eggen, P. D., & Kauchak, D. P. (2008). *Methods for teaching: Promoting student learning in K-12 classrooms*. Prentice Hall.

Loy, Pamela. (1979). Content analysis of Journal articles as a technique for historical research, Journal of the History of Sociology, 1,2, Spring: 93-101.

Masood, M. (2004). A Ten Year Analysis: Trends in Traditional Educational Technology Literature. *Malaysian Online Journal of Instructional Technology, 1*(2).

Mansor, N., Badarudin, M. I., & Mat, A. C. (2011). Teachers Perspective of Using English as a Medium of Instruction in Mathematics and Science Subjects. *Online Submission*, *4*(2), 129-138.

Mohammad Reza Maleknejad1 , Massoud Amoopour2 , Effat Abdi3 (2015), Content Analysis of Biology Book of Grade Three from Students of Public and Private High Schools Viewpoint in Rasht City during 2014-2015. J. Appl. Environ. Biol. Sci., 5(6)273-277, 2015

Onderi, P. O., Edward, B., & Baluku, M. (2010). Student factors related to mathematics achievement of public secondary school students of Masaba South sub county, Kenya: a qualitative study.

Prieto, E., & Dugar, N. (2016). An Enquiry into the Influence of Mathematics on Students' Choice of STEM Careers. *International Journal of Science and Mathematics Education*, 1-20.

Qin, X., & Wen, Q. (2002). Internal structure of EFL motivation at the tertiary level in China. *Foreign Language Teaching and Research*, *34*(1), 51-58.

Rehman, A., & Haider, K. (2013). The Impact of Motivation on Learning of SecondarySchool Students in Karachi: An Analytical Study. *Educational Research International*, *2*(2), 139-147.

Saleh, S. (2014). Malaysian Students' Motivation towards Physics Learning. *European Journal of Science and Mathematics Education*, *2*(4), 223-232.

Sim, J. C., & Theng, L. B. (2007). Teachers' perceptions of the use of ICT as an instructional tool in Mathematics and Science.

Stack S. (2002). Media coverage as a risk factor in suicide. *Injury prevention Journal*. 8(Suppl 4):IV30–IV32

Uzunboylu, H., & Aşıksoy, G. (2014). Research in physics education: A study of content analysis. *Procedia-Social and Behavioral Sciences*, *136*, 425-437.

Vlassi, M., & Karaliota, A. (2013). The Comparison between Guided Inquiry and Traditional Teaching Method. A Case Study for the Teaching of the Structure of Matter to 8th Grade Greek Students. *Procedia-Social and Behavioral Sciences*, *93*, 494-497.

Williams, M., Burden, R., & Lanvers, U. (2002). 'French is the language of love and stuff': Student perceptions of issues related to motivation in learning a foreign language. *British Educational Research Journal*, *28*(4), 503-528.

Xiaoqing, Q. (2003). L2 Learning Motivation Research and Its Problems [J]. *Foreign Language Education*, *3*, 003.

Yunus, F. W., & Ali, Z. M. (2013). Attitude towards learning chemistry among secondary school students in Malaysia. *Journal Of Asian Behavioural Studies*, *3*(11), 1-11.

Zain, A. N. M., Rohandi, R., Jusoh, A., & Samsudin, M. A. (2010). Improving students' attitudes toward science using instructional congruence. *Journal of Science and Mathematics Education in Southeast Asia*, *33*(1), 39-64.

Zakaria, E., Chin, L. C., & Daud, M. Y. (2010). The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. *Journal of social sciences*, *6*(2), 272-275.

OECD (2016). OECD Reviews of Innovation Policy: Malaysia 2016

http://www.oecd.org/sti/oecd-reviews-of-innovation-policy-malaysia-9789264255340-en.htm

MOSTI (2013). Malaysian, Science , Technology Indicators Report Report 2013. http://mastic.mosti.gov.my/documents/10156/38ae84ca-b8a0-4edb-a5b8-