

Curriculum Delivery Constraints of Arabic Language as a Foreign Language in the UAE

Mohamad Ezzat Alkutich
British University, Dubai

Abstract: This paper illustrates the constraints of the curriculum delivery of Arabic as a Foreign Language (AFL) in the United Arab Emirates Senior School. As the UAE is one of the Arab countries, so the Arabic language is a key subject of the national curriculum which compulsory for students in all year groups for both types of students, local citizens and residents. The aim of this study is to investigate the constraints that face the teaching and learning of AFL, such as, teaching AFL speaking, understanding pupils' differentiation, learning resources, classroom activities, teaching methods, and speaking assessment. A qualitative research methodology is employed; a semi-structure interview was the main tool with a sample of 2 heads of departments, four AFL teachers and 6 students. The main research question is "what are the constraints of curriculum delivery of AFL in the UAE?" This study provides solutions to the discussed constants in order to improve the quality of curriculum delivery of AFL as well as its quality of teaching and learning.

Keywords: component; formatting; style; styling; insert (Minimum 5 to 8 key words)

1. INTRODUCTION

The UAE is one of the Arab countries, and the Arabic language is one of the key subjects of the national curriculum besides Islamic Education and Social Studies, That are compulsory for students in all year groups for both types of students, local citizens and residents. Teaching Arabic language for non-Arabic speakers has become increasingly significant in UAE. Arabic language is a compulsory subject in all levels of UAE's schools. The focus of this study is the curriculum of Arabic language in Emirati private and international secondary schools. The general standard objectives of Arabic language for non-Arabic speakers at secondary schools in UAE are the same as English as a second language: (1) improving oral and written communication skills in order to obtain informational literacy level; (2) increase the awareness of the importance of Arabic language worldwide; (3) developing the awareness of learners about the relationship between the Arabic language and Arabic and Islamic culture (Depdiknas RI, 2006).

2. PROBLEM STATEMENT

Even though Arabic as AFL is a compulsory subject and is taught for all year groups, but still very few numbers of AFL pupils who can communicate in simple Arabic. The reasons beyond this issue vary. Some of these reasons are behind of school context so educators have no control over them. Such as, the domination of English language worldwide as it is the language of new sciences and a default language of technology, another reason is that the Arabic language has many different dialects not as other foreign languages. On other side, other reasons are under the control of educators as they are the focus of this study.

3. THE RATIONALE OF THE STUDY

Based on my experience as I was an Arabic teacher for English speakers and as a subject coordinator in one of the UAE international schools, I was facing this dilemma of the quality of teaching and learning of Arabic language. No one of school players is happy with the performance of the Arabic language, each one of these players throw the ball at others, eventually and unfortunately, the weakest among these players is the teacher. School inspectors, head teachers, heads of departments, pupils and parents blame teachers for this

failure. As a teacher I see that this is unfair judgment and all school players are responsible for this failure, but as a researcher I am trying here to search for all the constraints that face Arabic language and then try to offer solutions in this regard. There is not that much of research conducted to discover the reasons behind these shortcomings in learning Arabic as AFL. The only available publications about this issue are the school inspection reports provided by KHDA in Dubai and ADEC in Abu Dhabi. However, these reports and their finding are criticized by school players as these two school inspection instruments are in their 7 years age and the result of AFL performance still the same not as expected (Alkutich, 2016). This research tries to add to the literature a reliable academic reference, as well as to provide educators and education stack holders some answers about the constraints that face the process of curriculum delivery of AFL

4. THE PURPOSE OF THE STUDY

The aim of this piece of research is to investigate the constraints that face curriculum delivery of AFL in the UAE international schools, as well as to suggest some answers that might help them to solve these constraints.

5 THE SIGNIFICANCE OF THE STUDY

The significant of this research comes from that there is not that much of academic research conducted about the reasons behind the shortcomings in teaching and learning Arabic as AFL. The only available publications about this issue are the school inspection reports provided by KHDA in Dubai and ADEC in Abu Dhabi. This research tries to add to the literature a reliable academic reference, as well as to provide educators and education stack holders some answers about the constraints that face the process of curriculum delivery of AFL

6. RESEARCH QUESTIONS

This study was built on one main research question in addition to other five sub-research questions. The research question is

“what are the constraints of curriculum delivery of AFL in the UAE?”, and the five sub-research questions are;

- 1- What are the school based-curriculum constraints that face AFL?
- 2- What are learners' differentiation constraints that face AFL?
- 3- What are the constraints of learning material resources that face AFL?
- 4- What are the classroom activities constraints that face AFL?
- 5- What are the constraints of teaching and learning methods that face AFL?

7. LITERATURE REVIEW

Arabic language as a foreign language AFL is called as Arabic B in majority of UAE schools, as well as Arabic for non-Arabs. In this study I will use the first terminology which is Arabic language as a foreign language or AFL. As it is mentioned earlier, there are few studies in the literature that focus on AFL.

Arabic language the mother language of 22 Arab countries, and it is the language of the Qur'an the holy book for Muslims all around the globe that have to memorize some chapters from the Qur'an to be able to perform their prayer (Wahba, K., 2014; Alhawary, M. T., 2013). Arabic language is one of the worldwide spread languages, it is spoken by about 250 million people, and it is one of the six official languages in the United Nations (UN.org, 2017).

8. LEARNING ARABIC AS A SECOND LANGUAGE

Arabic language as a foreign language AFL is called as Arabic B in majority of UAE schools, as well as Arabic for non-Arabs. In this study I will use the first terminology which is Arabic language as a foreign language or AFL. As it is mentioned earlier, there are few studies in the literature that focus on AFL.

Arabic language the mother language of 22 Arab countries, and it is the language of the Qur'an the holy book for Muslims all around the globe that have to memorize some chapters from the Qur'an to be able to perform their prayer (Wahba, K., 2014; Alhawary, M. T., 2013). Arabic language is one of the worldwide spread languages, it is spoken by about 250 million people, and it is one of the six official languages in the United Nations (UN.org, 2017).

9. CONSTRAINTS OF AFL BASED ON SCHOOL CURRICULUM

Private schools in the UAE are school based-curriculum, these curriculum are different. Such as, Arabic, Islamic, American, British, Indian, Pakistani, and others. All these schools are required to teach Arabic. In this study the focus is only on the English curriculum schools, such as American and British. The features of school-based curriculum are two competences,

competence standards (Speaking, writing, reading and listening) and the basic standards which mean the distribution of these four language skills on different year groups, such as three years in secondary school. In order to students to achieve these competences, the educators designed for each grade some goals and learning objectives.

10. CONSTRAINTS OF AFL ON CLASSROOM ACTIVITIES

Alasraj (2014) as a result of his study is increasing the awareness of AFL teachers about the role of internet and technology in classroom activities.

11. CONSTRAINTS OF AFL ON TEACHING AND LEARNING METHODS

Different studies conducted about Arabic as a foreign language, some of these studies focused on teaching and learning strategies that improve the quality of the subject (El Essawi, R., 2013). A study conducted in Saudi Arabia, Alasraj (2014) compared between the effectiveness of the traditional and blended learning strategies in learning AFL at the Islamic University in Medina. The results of his study showed that the blended learning strategies have greater impact in imparting knowledge, besides, blended learning strategy developed students independency and enhanced them to experience different way of content learning. Another study conducted by Aburezeq and Ishtaiwa (2013) in the UAE, the researchers in their qualitative study investigated the perceptions of pre-service Arabic teachers about the influence of Whatsapp mobile messaging as a tool of improving students' instructional engagement. The study found that using WhatsApp in teaching and learning AFL enhance the power of the three types of interaction, pupil-pupil interaction, pupil-content interaction, and pupil-teacher interaction.

12. RESEARCH METHODOLOGY

This study investigates the constraints that face the quality of teaching and learning of AFL in UAE secondary schools. A qualitative methodology is employed in order to collect the viewpoints of the participants. This qualitative research strategy permits the researcher to get a close look to the viewpoints of participants about the obstacles that affect curriculum delivery of AFL (Yin, 2011:P.8). Creswell highlighted that qualitative methodology allows the researcher to get better understanding of the phenomenon (2012).

13. RESEARCH SAMPLE

This study is a case study with two private secondary schools in UAE, these two schools located in Abu Dhabi, and both of them international schools that teach Arabic as AFL. The curricula of these two schools are British and American and the spoken language is English.

In order to build strong questions that are relevant to the research question, A pilot study was conducted with one teacher and 3 students. This pilot study helps the research to estimate the time needed to the interview.

14. RESEARCH PARTICIPANTS

This study, employed 12 participants from the both sampled schools. The participant were distributed equally in both schools, from each school there was one head of department, two Arabic language teachers and 3 students. An email was sent to 8 schools as invitation to participate in this study; however a positive response received from only 3 schools. The teachers were one teacher AFL of GCSE curriculum, and one AFL teacher for IB curriculum. Whereas, students participants were 3 follow GCSE and 3 for IB.

15. DATA COLLECTION

In order to launch this study an email was sent to the principals of these participants schools to get the permission to conduct this study. When permission was received, another email was sent to the participant head of departments and teachers, with this email also the researcher sent consent for ethical clearance to be signed by the participants. However, three students of each school were chosen randomly with the help of heads of departments who ask the students that we need three students of Arabic class to volunteer to participate in this study.

16. SEMI-STRUCTURED INTERVIEW

In this qualitative research a semi-Structured interview was employed as the main tool to collect the data and findings of this study. The importance of semi-Structured interview as it is supportive to extract data from participants' opinions, and the shortcomings of semi-Structured interview are the unwillingness to reveal their experiences and the potential bias.

17. DATA ANALYSIS

Right after data collection, the second stage of the research is data analysis. Data analysis refers to the process of interpretation of the collected data. The purpose of data analysis is to make sense from the viewpoints of the study partakers (Jansen & Vithal, 2001). Part of data analysis, the researcher employed content analysis method which is important to offer a briefing of the collected data. Moreover, content analysis enables the researcher to code, categorise and compare data, as well as it shapes the research theoretical conclusion (Cohen et. al., 2011).

18. RESEARCH CREDIBILITY

The credibility of this study is ensured by applying different tools; such as, the triangulation tool by using different categories of the participants (Creswell, 2012), namely, head of department, teachers and students. Besides, the researcher retrieved relevant documents to the research questions. Moreover, a pilot study was applied with one teacher and three students.

19. RESEARCH DEPENDABILITY

The researcher ensured a high level of dependability in this qualitative study by different ways. So, the notes, records and transcripts were preserved. Moreover, the researcher made sure that participants were treated as partners. Finally, the research ensured that interview questions relevant to research questions, so there will be no or less effect on the findings because of the experiences and potential bias of the participants, I made certain that the are relevant to the research questions, and I also did not use any leading questions with the interviewees.

20. ETHICAL CONSIDERATIONS

The issue of ethical consideration is one of the important features of qualitative research. Trust and privacy protection are ensured in order to guarantee that interviewees reveal their perceptions based on their own experiences (Creswell, 2012). For this reason, the researcher sent via email, a consent form about ethical clearance to be signed by the contributors. Moreover, the research ensured that all the participations are volunteers, and they were informed that at any time they can withdraw, also, permission for audio recording was requested.

21. THE FINDINGS DISCUSSION OF THE STUDY

The distribution of the research participants were equally divided on both schools for each participant's category. These two schools were international schools, located in Abu Dhabi, the spoken language in both of them is English language, one is American and the other is British. Majority of teachers and heads of departments have teaching experience more than 10 years, with 50% have minimum education of bachelor degree in Arabic and 50% of them with post-graduation diploma in Arabic language. Moreover, teachers and heads of departments participants were 4 females and 2 males, all of them were below 45 years old. On other side, students were 4 females and 2 males, they were equally distributed as one third for three years groups year 10, year 11, and year 12. Moreover, students' participants were not attending AFL in all their previous academic years, this shows the importance of teaching differentiation as not all students in AFL class have the same Arabic knowledge. So, here in this study, about 65% have more than 5 years learning Arabic, and about 35 % have 3 years or less of learning Arabic.

Participant	School	Teaching experience per year	Student's Grade	Gender	Age	Qualification
Head of department 1	A	19	7	M	44	Bachelor degree in Arabic
Head of department 2	B	10	1	F	33	Post-Graduation Diploma & Bachelor degree in Arabic
Arabic teacher 1	A	12	2	F	35	Bachelor degree in Arabic and Islamic
Arabic teacher 2	A	15	0	F	37	Post-Graduation Diploma & Bachelor degree in Arabic
Arabic teacher 3	B	16	4	M	40	Master degree in Arabic
Arabic teacher 4	B	4	0	F	28	Bachelor degree in Arabic
Student 1	A	-	11	F	16	5 years learning AFL
Student 2	A	-	11	F	16	9 years learning AFL
Student 3	A	-	12	M	17	9 years learning AFL
Student 4	B	-	10	M	15	7 years learning AFL
Student 5	B	-	10	F	15	2 years learning AFL
Student 6	B	-	12	F	17	3 years learning AFL

Table 1: Research Participants Demography distribution

(School A or B it does not mean that A for American school nor B for British school, it is just coding).

22. THE PILOT STUDY

The importance of a Pilot study in qualitative research, comes from the intention of the researcher to guarantee that the interview questions with teachers and students are relevant to the research questions, and to ensure the clarity of questions and the time required for each interview, Kim, (2011) addressed that pilot study is a preparation process whereby the researcher amend the study plan. In this pilot study, one teacher with 3 students were employed from a school that is not involved in the sampled schools. After getting the

permission from the principal of this school responding to the researcher email invitation, the research contacted the teacher with three students of his AFL class who were in grade 10; this school follows the American curriculum and students doing AFL for GCSE examinations.

Research Question 1: School-Based Curriculum

The first sub-research question was “What are the school based-curriculum constraints that face AFL?”, and the responses of the participants came as the following;

Heads of departments showed that the context of international schools is not that healthy for teaching Arabic language whether for native or non-native speakers, as everyone speaks English, and Arabic language is not in the top interesting second language for most of them. One head of department said: “Besides all other core subjects that our students study, you find that most of them lack motivation to learn Arabic, as they feel that they are forced to do it, since it is a part of the national curriculum and it is not part of their choices”. Another head of department added: “Teaching speaking Arabic is a complex task, as Arabic language has many dialects, and teachers sometime are not committed to teach the official Arabic regardless teachers dialect background “.

On other side, teacher feels that international schools bias to the curriculum of the school and are not serious when it comes to subjects like Arabic language. One teacher had this to say: “In Arabic speaking class, not all pupils have the confidence to speak”, another teacher pointed: “I face multiple challenges in my class, some students are forced to attend and their behaviour is not as expected, some students have no background in learning Arabic, as they just have one year in the country and never studied Arabic before”.

Similarly, students of AFL believe that it is difficult to learn Arabic and they do not give the required time to learn and practise Arabic language, besides, teachers do not give equal balance for teaching each language skill. One student said: “I feel anxious in Arabic class and prefer to keep silent”, another student added: “I have too many subjects to study and to do homework and I prefer to learn Spanish as my second language”, on other side, one student addressed: “Our teacher teaches us for the exam not to learn or to speak the language, he uses English language to explain the topics”.

Research Question 2: Learners Differentiation

Responses of participants on the second sub-research question “What are learners’ differentiation constraints that face AFL?” fallen into two themes, students attitudes and students motivation.

Students’ Attitude

Attitude is to have a mental position toward the subject such as behaving and thinking. Positive or negative view of students toward Arabic language has great impact to establish their attitude. Students who have a positive belief about Arabic language have a high possibility to obtain their attraction toward learning Arabic. One head teacher said: “we are challenged in Arabic that majority of our students do not show positive attitude in Arabic class, also some of the teachers believe that we can’t change students’ attitude or inspire them”.

Similarly, one teacher said: “Some of my students believe that learning Arabic is not important for them”, another teacher added: “I use to explain how important is the Arabic language

and I use different strategies and techniques with lots of educational games to get their attention and attitude, it works while they are in the class but many of them dedicate not time to the subject at home”

However, a student participant said: “I am trying my best to pass the Arabic exam as I have to, but with the minimum efforts” another one added: “I can’t concentrate because the behaviour of my classmates is really bad, they do not behave the same way in other subjects like maths and science”.

Students’ Motivation

Motivation of AFL (Arabic as a Foreign Language) learners is one of the challenging issues in UAE’s international schools. Motivation can be maximized by activities that students use to achieve their goals, when students attitude toward Arabic is positive, they will have higher expectation (Blanchard & Thacker, 2007). However, in the context of Arabic as AFL in this study, the responses of the participants were in different direction. A head of department said: “Pupils come to the Arabic class just to fulfil the attendance list”, another head of department added: “Most of students in AFL are passive learners”. The same head of department said: “Some Arabic teachers are not motivated in their teaching, they do their job without enthusiasm”.

Regarding teachers participants responses, one teacher articulated: “one of the reasons that my students are not motivated is that they feel hesitate of doing mistakes if they try to speak Arabic”, one other teacher added: “I am quite sure that no one of them practise Arabic outside the class”. Similarly, students presented their lack of motivation but for different reasons. One student said: “I learn Arabic just to get good marks”, Another student added: “Why do I have to learn Arabic?!, I will never use it, and it is very difficult” .

In order to solve these challenges, one head of department said: “I think that we need to use students centred teaching strategies so students will be active and engaged in the class activities”, one teacher added: “Our school has to build a new policy for motivation, by certificates, commendations, points, or anything good to attract them “, one students suggested: “I think if the teacher teaches us by digital games and work then we can learn better”.

Research Question 3: Subject Materials and Resources

Resources and materials are significant for learning Arabic language, so special materials and resources for communicative activities. Besides, the use of technology plays a significant role as part of the teaching and learning process (Al Musawi, A.,et. al, 2016). However, most of the research participants agreed that textbooks still the main focus in Arabic language classroom. The responses of the third sub-research question “What are the constraints of learning material resources that face AFL?” can be summarized as the following: One head of department said: “The textbook is very important, and we should follow it as it is required from the ministry”, one teacher had this to say: “I can’t neglect the textbook, as some parents use to ask about the work on the textbook, also school inspectors will check students work based on the textbook that the is required by the educational authorities” . One students added to this point: “we feel bored because just we follow the textbook, and there are too much details so we can’t finish them all, I think the curriculum is too much”

Lack of variety of teaching and learning strategies and techniques. So students feel bored and not motivated.

Research Question 4: Classroom Activities

Classroom activities means here the domination ratio of teach versus students. The responses of the third sub-research question “What are the classroom activities constraints that face AFL?” can be summarized as the following: One head of department said: “Some of the teachers lack questioning techniques, I observed one teacher once, she asked a student one question, and while the students trying to think and then give the answer, the reset of the class was doing nothing and some were chatting because they have no task to do”, one teacher, on other side, said: “When I give a task to the class to do with their peers, some of them do not follow the instruction and do nothing”. One student shared: “We just sit and write or listen to the teacher while he explain and talk the whole time”.

Research Question 5: Teaching and Learning Strategies

Teaching and learning strategies are the activities that used by teachers and learners to facilitate the comprehension of the taught subject. Students can use different strategies and methods while learning the language. The responses of the third sub-research question “What are the constraints of teaching and learning methods that face AFL?” can be summarized as the following: All participants agreed that teachers should use new strategies based on student centred education. One head of department commented: “I always encourage teachers to do group work and peer learning classwork, but some of them prefer traditional methods and use teacher-centred teaching”.

One teacher said: “I divide the class in groups, and give them work to do, it works with some students, but for those who lack motivation, they just rely on other group members to do their work” another teacher added: “If we use technology the class will be better, but it is so complicated in the school to book tablets to use computer games”. Whereas, one student said: “I do not think that our teacher has plan of what or how to teach the topic”, another student commented: “We just sit and write or listen to the teacher while he explain and talk the whole time”.

23. CONCLUSION

Based on the above findings and discussion, it is found that AFL curriculum delivery in international schools with spoken foreign language face many challenges and constraints. These challenges affect the performance and the quality of AFL teaching and learning. This study distributes the constraints in different categories:

- Educational authorities are not evaluating the implementation of the curriculum.
- Lack of subject materials to enrich the curriculum, there is a misconception between the textbook and curriculum, which limits teacher’s freedom and creativity.
- Different assessment for AFL (Ministerial, GCSE, A level and IB) makes teaching Arabic harder, so the teachers will teach for the exam not for learning.

24. RECOMMENDATION

This study suggests some recommendations for reducing the constraints in Arabic as a foreign language, to improve AFL curriculum delivery and the quality of teaching and learning:

- Schools to design smart awarding policies and tools to enhance students’ motivation to learning.
- Teachers to attend CPD about teaching and learning strategies and other skills. Such as, learners differentiation, time management, class management, behavioural management, and questioning techniques.
- Teachers to implement student-centred educational approach.
- Head of departments and teachers to design subject curriculum with respect to the textbooks and the national agenda of Arabic language and the interested international exam, by giving teachers more freedom in this regard.

Schools and teachers to support the use of technology, computer games and mobile applications in teaching Arabic.

25. LIMITATIONS AND FURTHER STUDIES

This research uses a qualitative methodology by employing two international schools in UAE, so the findings can’t be generated to other types of schools or other emirates and countries. I recommend that for future studies to increase the size of sample and use mixed research methodology to investigate the impact of digital-based curriculum, computer games and mobile applications in teaching Arabic.

26. REFERENCES

- Aburezeq, I.M. and Ishtaiwa, F.F., 2013. The impact of WhatsApp on interaction in an Arabic language teaching course. *International Journal of Arts & Sciences*, 6(3), p.165.
- Alasraj, A. and Alharbi, H., 2014. The effectiveness of blended learning in teaching Arabic as a second language. *International journal of research in humanities and social studies*, 1(1), pp.13-17.
- Alhawary, M.T., 2013. Arabic second language acquisition research and second language teaching: what the teacher, textbook writer, and tester need to know. *al-'Arabiyya*, pp.23-35.
- Alkutich, M., 2016. Examining The Impact of School Inspection On Teaching and Learning. Dubai Private Schools as a Case Study.
- Al Musawi, A., Al Hashmi, A., Kazem, A.M., Al Busaidi, F. and Al Khaifi, S., 2016. Perceptions of Arabic language teachers toward their use of technology at the Omani basic

education schools. *Education and Information Technologies*, 21(1), p.5.

Blanchard, P.N. & J.W. Thacker. (2007). *Effective Training: Systems, Strategies, and Practices*. New Jersey: Pearson Education International.

Cohen, L., Manion, L. and Morrison, K., 2011. Surveys, longitudinal, cross-sectional and trend studies. *Research Methods in Education*, 7th edition. Abingdon: Routledge, pp.261-4.

Creswell, J.W., 2012. Collecting qualitative data. *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Fourth ed. Boston: Pearson, pp.204-35.

Dajani, B.A.S., 2015. Teaching Arabic Language: Towards a New Beginning that Stimulates Creativity. *Procedia-Social and Behavioral Sciences*, 192, pp.758-763.

Depdiknas RI [Departemen Pendidikan Nasional Republik Indonesia]. (2006). *Pedoman Kurikulum Tingkat Satuan Pendidikan untuk Sekolah Menengah Atas Tahun 2006*. Jakarta: Depdiknas RI.

El Essawi, R., 2013. Language Learning Strategies in Arabic as a Foreign Language Textbook. *al-'Arabiyya*, pp.37-59.

Jansen, J. and Vithal, R., 2001. *Designing your first research proposal: A manual for researchers in education and the social sciences*. Lansdowne: Juta & Co, Ltd.

Kim, Y., 2011. The pilot study in qualitative inquiry: Identifying issues and learning lessons for culturally competent research. *Qualitative Social Work*, 10(2), pp.190-206.

Un.org. (2017). *Official Languages*. [online] Available at: <http://www.un.org/en/sections/about-un/official-languages/> [Accessed 3 Jul. 2017].

Wahba, K., 2014. *Handbook for Arabic language teaching professionals in the 21st century*. Routledge.

Yin, R.K., 2011. *Applications of case study research*. Sage.

Principals Perceptions on the Effective School Leaderships

Mohamad Ezzat Alkutich
British University, Dubai

Abstract: Leadership is one of the key subjects in education. It has long been researched in both theory and practice. The link between school performance and quality of its leadership has been covered in research. The purpose of this research is to define the leadership experiences of Abu Dhabi international secondary school principals, their description of effective school leadership, and the needs for their leadership continuous learning. A phenomenological qualitative methodology to the research is applied in order to show fruitful account of the participants' principal's practises. Data will be collected through one to one semi structured interview of 16 Abu Dhabi international secondary school principals. These interviews will take place in the participant's offices at their schools.

Keywords:

1. INTRODUCTION

The purpose of this research is to define the leadership experiences of Abu Dhabi international secondary school principals, their description of effective school leadership, and the needs for their leadership continuous learning. A phenomenological qualitative methodology to the research is applied in order to show fruitful account of the participants' principal's practises. Data will be collected through one to one semi structured interview of 16 Abu Dhabi international secondary school principals. These interviews will take place in the participant's offices at their schools.

The responsibilities of today's schools principals are vary. Such as, defining the culture of the school, improving teaching, school management and procedures, managing the availability of resources, communication with community, promoting school vision. School principalship is one of the main aspects of education in the 21st century beside teaching and learning. Gordon (2013) in his research, depicted that school leadership importance comes directly after teaching and learning (p. 3). Moreover, in their research Grissom and Loeb found that principals as instructional leaders make a formula of success in improving school performance (Grissom & Loeb, 2011).

In the field of leadership there are lots of questions that are still open to debate. Such as, what impact does leadership has? Is leadership inherent skill or learned? What effect does leadership have? Moreover, Greer (2011) explained that leaders impact their followers, set a vision and attract them to commit to this vision. Thus, a leader is expected to have ethics and faith and create opportunities to the followers.

2. RESEARCH PROBLEM

2.1 Statement

The literature contains lots of studies in the field of leadership focusing on leaders skills and traits. However, only few studies walk around the conception of school principals from the standpoints of the principals themselves. Thus, there is a need for more research that explores the beliefs of leaders from their own experiences. This study aims to discover the effective elements of leadership in private secondary schools based on the perspectives of these principals.

2.2 Purpose Statement and Research Question

The purpose of this study as a phenomenological qualitative research is to present the experience of the principals of Abu Dhabi private secondary schools. There are three research questions:

- What the leadership practices of Abu Dhabi private secondary schools principals?
- How do school principals describe effective leadership?
- What are school principal's needs for continuous learning?

2.3 Hypothesis

The primary hypothesis of this research is that the scholars as theorists and principals as practitioners have knowledge about the basic requirements to be a leader of an educational organization. Moreover, school principals would be willing to share their experiences in this research.

2.4 Limitations and Delimitations of the study

There are few studies that focus on school leadership in private secondary schools, and fewer studies concentrate on the perspectives of the leaders. However, no academic research has been conducted in this area of leadership in the Arabic world as I know. Moreover, being a teacher for several years in several private secondary schools in Abu Dhabi may add a bias as a researcher who might judge the participants principals from a teacher – follower- point of view.

2.5 Research Methodology

A phenomenology qualitative research approach is chosen to be conducted for this study, as it would be carried out by interviews with the sample school principals who would be willing to share their experience in school leadership.

2.6 The Significance of This Research

Several academic researchers have revealed that effective leaders take part in continuous learning for the improvement of their performance (Greer, 2011). However, spend the most of their time managing and dealing with details that are so far of the context of leadership continuous development. Thus, school principals need to get the chance to reflect on the characteristics of better leadership, they need to share and reflect with other principals and scholars about their strength and areas of improvements, they need as well to sharpen and develop their skill and fill the gap between their strength and weaknesses by continuous learning and development in all aspects of leadership. From this ground, this study has its importance by listening to the experiences of principals and providing them with the result of this research that help them to learn from each other and discover where they are on the track of school leadership.

3. REVIEW OF LITERATURE

3.1 Introduction

By reviewing the literature of school leadership one can find that there are various of topics and categories that covered. Such as, theory of leadership and school principal (evolution; principalship; complexity; its importance for school improvement; standards; and continuous learning)

Leadership of school principals and its improvement is one of the complex matters in education, the literature has numerous studies about leadership in general, these studies covered the aspects of school leadership from the theoretical approach. However, very few of them were interested with the perspectives of the experience of these leaders.

3.2 Development of the leadership

Scholars noted that the starting coverage of school leadership in the academic research was in the 1950's. These studies concentrated primarily on the characteristics of these leaders. Later on, in the 1970's, more attention was paid to behavioural issues of leaders and the impact of leadership in particular cases and situations. In the 1980's, the literature expanded to cover more areas in school leadership. Namely, the influence of leader on his/her organization (Abu-Hussain, 2014).

Eventually, in the 1990's, as Murphy (1994) presented in his research that lots of studies brought reform to the concept of school principal, these studies covered various aspects of school principal leadership. Such as, school-based management, teaching for meaningful understanding, site-based decision making, a dramatic change in the role of the principal, claiming a distinct break with the status quo" (p. 2).

In the 21st Century, the theory of leadership was reviewed by Dinh et al. (2014) who

discovered that the leadership has developed, and more studies are increasing and integrating the viewpoints about the influence of leadership theories in shaping the emergence of leadership phenomenology (Dinh et al., 2014).

3.3 Leadership Theory

The literature contains a lot of theoretical studies on leadership. The theory of leadership has been researched by a vast proportion of research. There are 66 domains has recognised of the leadership theory by Dinh et al (2014). Leadership can be deliberated as a cooperative team work, it is a bottom-up process, as well as it is a top-down power. Dinh et al (2014) stressed that no unified theory of leadership does exist so far.

There is a correlation between the leadership theory and school principal, this is presented by the connections and behaviour exhibited by school principals while leading their staff to accomplish the tasks that is linear with school goals, which eventually shape the style of their leadership (Cooper, 2012, pp. 5-6). Since the purpose of schools becomes expanded and more challenges are added, so leadership styles and behaviours should expand as well. However, not all theoretical approaches of leadership fit with education and school leadership. Thus, in some theoretical framework that works with the school context would be presented.

3.4 Transformational leadership theory

it is one of the theoretical frameworks of educational leadership. Transformational leaders have special characteristics that differentiate them from other leadership styles. Such as, having a vision, effective communication with followers, their abilities to stimulate followers of their vision (Cooper, 2012). Some of areas of concentrations of transformational leadership are school principals and behaviour of followers. The later has its importance as it helps leaders to be aware of the influence of their performance and mission on the followers, so it has a significant role in improving the followers' motivation and aspiration in order to get higher level of achievement and success (Abu-Hussain, 2014, p. 1270).

The transformational theory of leadership impacts the shared interest of leaders and followers by four components. Namely; charisma; motivation; stimulation, and personalized consideration (McCleskey, 2014). The charisma of the leader influences the followers in two ways. Firstly, followers appreciate leaders with particular qualities, secondly, leaders behaviour and attitude have a significant influence on the followers (McCleskey, 2014, p. 120). Moreover, leaders can inspire and stimulate their followers by solving problems in different advanced ways (Cooper, 2012). Likewise, leaders inspire followers when they show interest in their followers' individual goals (Cooper, 2012).

In educational context, research discovered that teachers highly appreciate principals with traits and behaviours of transformational leadership (Hauserman & Stick, 2013, p. 185). Research as well found that transformational principals encourage their staff to maximize their leadership, assist with problem solving, and accentuate teamwork and critical thinking skills (Hauserman & Stick, 2013)..

3.5 Servant leadership theory

This theory is emphasizes the importance of ethics where followers' welfare has a significant priority (van Dierendonck, 2011). Servant leaders actions and attitudes are based on their beliefs. The attributes of servant leaders are many; problem-solving, encouraging diverse views, powerful interpersonal communication, emotional intelligence, and empathy (van Dierendonck, 2011).

3.6 Invitational leadership theory

It is a fresh theory that formed with an encouraging design that help leaders through complexity. The founders of this theory are William Purkey and Betty Siegel in 2002 (Burns & Martin, 2010). William Purkey and Betty Siegel based this theory on five elements of leadership: Intentionality, positivity, respect, trust, and hope (Purkey & Novak, 2015; Burns & Martin, 2010). Invitational leadership theory is characterized with its five powerful factors that called the "5 P's". These factors are: people, place, policy, program, and process" (Burns & Martin, 2010, p. 35).

3.7 Followership theory

This theory is not well researched as the Leadership theory. It focuses on the significant power of followers. In their research, Uhl-Bien, Riggio, Lowe, and Carsten stressed that without followers there is no leadership, and leadership approach would not be understood without understanding of the behaviour of followers (2014). This theory has its importance in education, as it pronounces the importance of understanding and researching the relationship between teacher and principals.

3.8 Leadership: Innate behavior versus Learned Skill

The question whether leadership is a learned skill or inherited behaviour is long debated and researched. Some scholars found that leadership is personal individualities (McCleskey, 2014, p. 117). On other side, other scholars believe that leadership is a combination of both a learned skill and innate behaviour. Thus, leadership can't be learnt (Doh, 2003, p.54). However, for those who present leadership as learned skills, they go to an extreme that leadership can't be taught in a formal sense (Greer, 2011).

3.9 Elusiveness and Complexity

Fullan in his study found that school principals work is a combination of technical problems that are easy to solve and adaptive complex work (Fullan, 2005, p. 53). Ethics and trust are central issues in school leadership characteristics that might be elusive (Larsen & Derrington, 2012, p. 2). School principals are expected to communicate the value of trust to teachers and students (Papaku Malasa, 2007, p. 23). Norman et al conducted different studies about school leadership, these studies questioning the leader communication with followers during difficult times and how to build with their followers. Eventually, they found that there is a strong relationship between trust and principals' transparency (Norman, Avolio, & Luthans, 2010, p. 350-362).

3.10 The Importance of School Leadership

Numerous studies in the field of leadership has been done focusing on school leadership in general, and on the impact of school principals in particular. Seashore et al in their research investigated the importance of principal on students achievements, and they found that school leadership is second to teaching and learning in their impacts on students learning (Seashore Louis, Wahlstrom, Leithwood, & Anderson, 2004, p. 65). These findings are in line with the findings of Suber (2011). Another study depicts that school principal's leadership have indirect influence on teaching and learning (Gordon, 2006). However, other studies found that school principals might have a negative impact on teacher's commitments and job satisfaction (Hudson, Graham, & Willis, 2014).

3.11 Effective School Principals

School leadership effectiveness has covered by numerous studies that explore effective traits and skills of school principals. Grissom and Loeb (2011) found that Principals need to bestow their energy on understanding the instructional needs, smart use of resources, hiring best teachers, and managing the school efficiently" (Grissom & Loeb, 2011, p.1119; Clabo, 2010, p. 227).

In his research, Costellow's (2011) elaborated that there are five significant traits that principals should have "communication, visibility, culture, focus, and discipline" (p. 110). In another research, Sammons et al. (2010) discovered that school leadership for school improvement characterized in five categories "good teaching, academic emphasis, reshaping school organization, setting directions, staff's continuous development" (p. 93).

3.12 Continuous Learning

School principalship is a complex job, it is described by some researchers as a solo endeavour, and principals have no time for their own continuous learning and leadership improvement, cause they spend most of the time doing managerial job and leading and participating school instructional issues (Spillane & Hunt, 2010, p. 296). Fullan (2003) in his study articulated that school leadership plays a significant role for school improvement and developing this leadership is a moral imperative (p. 80).

In another study, Day et al expressed that leaders development does not happen only in enrolling in programs or attending seminars, or even participating in workshops but also it happens through participating in actual development events (Day, Fleenor, Atwater, Strum, & McKee, 2014, p. 80). Moreover, school leadership can show more improvement when educational leaders build their learning communities and increasing their professional network (Huber, 2013). Besides, daily leadership performance is one of the major areas where the leader can develop his/her leadership skills (Day et al., 2014, p. 80).

4. RESEARCH METHODOLOGY

4.1 Research Design

A qualitative phenomenological method has been chosen for this research to explore the experiences of school principals, their continuous development. A phenomenological approach in qualitative research consists of a group of people who have practiced this phenomenon (Creswell, 2013, p. 78). Using a phenomenological methodology permits for concentrating on understanding the experience as a whole in order to grasp the whole experience of these leaders (Castro, 2003, p. 47). Moreover, applying a phenomenological tactic necessitates the researcher to be unbiased when revealing individual experiences with the phenomenon (Creswell, 2013). Giorgi in her research found that the existential Phenomenological approach contains 4 substantial stages: (1) design the research questions, (2) data generating (3) data analysis and finally (4) findings' presentation (Castro, 2003).

Semi structured interview will be used to collect the data from 16 principals of secondary schools from Abu Dhabi Educational Council (ADEC). (see Appendix A). The sample of the research will be chosen by an email invitation to all private secondary schools in Abu Dhabi that follow (ADEC).

4.2 Sample Selection

The sample selection of this phenomenological qualitative research will be based upon the sampling criterion of Creswell by inviting peoples with experience of this in hand phenomenology (Creswell, 2013). The sample of this study is selected from Abu Dhabi private schools, the invited principals of these international secondary school follow (ADEC) school inspection framework (Irtiqah), these 16 principals are divided as two principals from each inspection report grade (Outstanding, good, acceptable and unsatisfactory). It would be a great opportunity for the validity of the study if the researcher gets 50% of these participants' principals are female.

The way of selecting the sample is by sending an email to ADEC to get its approval to conduct this study, and Upon permission being granted, the researcher will send an email to all international secondary schools in Abu Dhabi, then the principals that are willing to participate in the research will be contacted by email to explicate the details of the study. Such as, confidentiality, participation consent, and interview instructions.

4.3 Data Collection

Data will be collected by 1 to 1 Semi-structured interviews with the sample of the study (16 principals), in a preferred location to be quiet and comfortable without interruptions. Most preferably in a setting that is quiet and comfortable to them. The researcher will arrange for a meeting with the participants, as one to one and face to face in order to conduct the interviews. The process of the semi-structured interviews with the principals is referenced by Creswell (2013), who stressed in his research that interviews to be recorded and backed up by note taking.

In order to provide a framework for the conducted interviews, an interview protocol will be employed. Moreover, a pilot testing will be carried out in order to design the interview questions Creswell (2013). In this pilot testing, the Interview questions will be suggested and drafted, then, the sample interviews will be carried out with four familiar international schools principals who will not be participating as part of the research.

When conducting the interviews, the pilot testing participants will be invited to offer views on the questions and the interview process. Before conducting the interviews, consents between the researcher and the participants will be obtained. Besides, the researcher will provide the participants with the purpose of the study; explain the required amount of time for the interview.

4.4 Data Analysis

Primarily, an initial analysis of collected data, this step will focus on interpreting the description of interviewees. The transcripts of the conducted interviews will be saved and organized in computer files and a hard copy notebook. In order to whole data absorption, the researcher will read the www.ijsea.com

transcriptions multiple times. In the meantime, the researcher will be looking for indicators that might be as a sign of invariant features of this phenomenon (Castro, 2003).

On another side, Giorgi's approach in distributing the findings into smaller approachable units, then a "imaginative variation" will be used (Castro, 2003, p. 53). Following this step, synthesizing the perceptions of the participants about each divided meaning units, this enables the researcher to formulate the experiences of these principals in a prompt final description (Castro, 2003). Utilizing Giorgi's approach is helpful in order to find an answer to each of these two questions: What is the essential frame of the phenomenon? And how does this phenomenon take place? (Castro, 2003, p.54). Finally, all protocols will be studied and integrated for the sake of discovering what the descriptions have collectively (Castro, 2003, p. 55).

4.5 Data Analysis

Primarily, an initial analysis of collected data, this step will focus on interpreting the description of interviewees. The transcripts of the conducted interviews will be saved and organized in computer files and a hard copy notebook. In order to whole data absorption, the researcher will read the transcriptions multiple times. In the meantime, the researcher will be looking for indicators that might be as a sign of invariant features of this phenomenon (Castro, 2003). On another side, Giorgi's approach in distributing the findings into smaller approachable units, then a "imaginative variation" will be used (Castro, 2003, p. 53). Following this step, synthesizing the perceptions of the participants about each divided meaning units, this enables the researcher to formulate the experiences of these principals in a prompt final description (Castro, 2003). Utilizing Giorgi's approach is helpful in order to find an answer to each of these two questions: What is the essential frame of the phenomenon? And how does this phenomenon take place? (Castro, 2003, p.54). Finally, all protocols will be studied and integrated for the sake of discovering what the descriptions have collectively (Castro, 2003, p. 55).

4.6 Research Validation and Reliability

In order to have strong validation of the study, triangulation and peer review will be employed (Creswell, 2013). Moreover, a variety of sources of documents and research will be used for the triangulation of this study. Besides, expert review will be used to evaluate research procedures. The researcher then will provide the participants with a draft of the conducted interviews to allow them to provide feedback.

4.7 Ethical Considerations

The interviews with the participants contains personal nature questions, and the answer on these questions based on self-reflection of the Interviewees, thus, the researcher will assure that the participants feel comfortable in revealing their views honestly (Merriam, 2009).

5. EXPECTED RESULTS OF THE STUDY

This study is aiming to contribute to the literature of school principal leadership based on the perception of school principals. The findings of this research would discover the authentic perception of the principals and contribute to the literature. The importance of this study comes from it provides knowledge from the experience of school principals of what create an effective leader. Besides, it would suggest of the needs of school principal of continuously development and learning.

6. REFERENCES

- [1] Abu-Hussain, J. (2014). Leadership styles and value systems of school principals. *American Journal of Educational Research*, 2(12), pp. 1267-1276.
- [2] Burns, G., & Martin, B. N. (2010). Examination of the effectiveness of male and female educational leaders who made use of the invitational leadership style of leadership. *Journal of Invitational Theory and Practice*, 16, pp. 30-56.
- [3] Castro, A. D. (2003). Introduction to Giorgi's existential phenomenological research method. *Caribbean Journal of Psychology*, 11, pp. 45-56.
- [4] Clabo, B. (2010). The high school principal as instructional leader: An explanatory, mixed methods case study examining principal leadership within the context of rural secondary schools. Knoxville, TN: University of Tennessee, Knoxville Trace: Tennessee Research and Creative Exchange.
- [5] Cooper, G. (2012). Examining the transformational and distributive leadership styles of secondary principals: A mixed methods study. Dissertation, Texas Tech University, Educational Leadership.
- [6] Costellow, T. D. (2011, August 1). The preferred principal: Leadership traits, behaviors, and gender characteristics school teachers desire in a building leader. Western Kentucky University Top SCHOLAR.
- [7] Creswell, J. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3rd ed.). Thousand Oaks, CA: Sage.
- [8] Day, D. V., Fleenor, J. W., Atwater, L. E., Sturm, R. E., & McKee, R. A. (2014, February). Advances in leader and leadership development: A review of 25 years of research and theory. *The Leadership Quarterly*, 25(1), pp. 63-82.
- [9] Dinh, J. E., Lord, R. G., Gardner, W. L., Meuser, J. D., Liden, R. C., & Hu, J. (2014, February). Leadership theory and research in the new millennium: Current theoretical trends and changing perspectives. *The Leadership Quarterly*, 25(1), pp. 36-62.
- [10] Dinham, S. (2011). Pilot study to test the exposure draft of the national professional standard for principals. Melbourne: Australian Institute for Teaching and School Leadership.
- [11] Doh, J. P. (2003). Can leadership be taught? Perspectives from management educators. *Academy of Management Learning and Education*, 2(1), pp. 54-67.
- [12] Fullan, M. (2003). *The moral imperative of school leadership*. Thousand Oaks, CA: Corwin. Fullan, M. (2005). *Leadership & sustainability*. Thousand Oaks, CA: Corwin.
- [13] George, B., Sims, P., McLean, A., & Mayer, D. (2007, February). Discovering your authentic leadership. *Harvard Business Review*, 85(2), pp. 129-138.
- [14] Gordon, G. (2006). *Building engaged schools*. New York, NY: Gallup Press. Gordon, G. (2013). *School leadership linked to engagement and student achievement*. New York: Gallup, Inc.
- [15] Greer, M. (2011, June). Dare to lead: Continuous learning creates the best leaders. *American Society of Safety Engineers*, 56(6), pp. 30-31.
- [16] Grissom, J. A., & Loeb, S. (2011). Triangulating principal effectiveness: How perspectives of parents, teachers, and assistant principals identify the central importance of managerial skills. *American Educational Research Journal*, 48, pp. 1091-1123.
- [17] Hauserman, C. P., & Stick, S. L. (2013). The leadership teachers want from principals: Transformational. *Canadian Journal of Education*, 36(3), pp. 184-202.
- [18] Huber, S. G. (2013, July). Multiple learning approaches in the professional development of school leaders—Theoretical perspectives and empirical findings on self-assessment and feedback. *Educational Management Administration & Leadership*, 41(4), pp. 527-540.
- [19] Hudson, P. B., Graham, K., & Willis, J. (2014). How can principals enhance teacher job satisfaction and work commitment? (pp. 1-13). Australian Association of Research in Education (AARE) Conference, Brisbane.
- [20] Larsen, D. E., & Derrington, M. L. (2012). *Calibrating one's moral compass: How principal preparation shapes school leaders*. Ypsilanti, MI: National Council of Professors of Educational Administration.
- [21] Leithwood, K., Day, C., Sammons, P., Harris, A., & Hopkins, D. (2006). *Seven strong claims about successful school leadership*. Nottingham: National College for School Leadership.
- [22] McCleskey, J. A. (2014, June). Situational, transformational, and transactional leadership and leadership development. *Journal of Business Studies Quarterly*, 5(4), pp. 117-130.
- [23] Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.
- [24] Merriam-Webster. (2015, October 30). Merriam-Webster. Retrieved October 30, 2015, from Merriam-Webster.com: <http://www.merriam-webster.com>
- [25] Murphy, J. (1994, April 4-8). Transformational change and the evolving role of the principal: Early empirical evidence (pp. 1-50). New Orleans, LA, USA: Educational Resources Information Center (ERIC).
- [26] Norman, S., Avolio, B., & Luthans, F. (2010). The impact of positivity and transparency on trust in leaders and their perceived effectiveness. *The Leadership Quarterly*, 21(3), pp. 350-364.
- [27] Papaku Malasa, D. (2007). *Effective school leadership: An exploration of issues inhibiting the effectiveness of school leadership in Solomon Islands secondary schools*. Hamilton, New Zealand: University of Waikato.

- [28] Purkey, William Watson & Novak, John Michael. (2015). An introduction to invitational theory. Retrieved on March 31, 2016
- [29] http://www.invitationaleducation.net/intro_to_invitationaleducationtheory.pdf Sammons, P., Gu, Q., Day, C., & Ko, J. (2010). Exploring the impact of school leadership on pupil outcomes: Results from a study of academically improved and effective schools in England. *International Journal of Educational Management*, 25(1), pp. 83-101.
- [30] Seashore Louis, K., Wahlstrom, K., Leithwood, K., & Anderson, S. (2004). How leadership influences student learning. Ontario Institute for Studies in Education: Center for Applied Research and Educational Improvement.
- [31] Day, D. V., Fleenor, J. W., Atwater, L. E., Sturm, R. E., & McKee, R. A. (2014, February). Advances in leader and leadership development: A review of 25 years of research and theory. *The Leadership Quarterly*, 25(1), pp. 63-82.
- [32] Spillane, J. P., & Hunt, B. R. (2010, June). Days of their lives: A mixed-methods, descriptive analysis of the men and women at work in the principal's office. *Journal of Curriculum Studies*, 42(3), pp. 293-331.
- [33] Suber, C. (2011). Characteristics of effective principals in high-poverty South Carolina elementary schools. Ypsilanti, MI: National Council of Professors of Educational Administration.
- [34] Uhl-Bien, M., Riggio, R. E., Lowe, K. B., & Carsten, M. K. (2014). Followership theory: A review and research agenda. *The Leadership Quarterly*, 25, pp. 83-104.
- [35] van Dierendonck, D. (2011). Servant leadership: A review and synthesis. *Journal of Management*, 37(4), pp. 1228-1261.

Examining Students perspectives on the Impact of Formative Assessment on Teaching and Learning; Abu Dhabi Private Schools as a Case Study

Mohamad Ezzat Alkutich
British University, Dubai

ABSTRACT

Assessment is the process of gathering evidence of students' knowledge, skills and attitudes. Assessment for learning plays a significant role in improving students learning, and the literature is full with academic studies about the importance of this sort of formative assessment. However, less research is done about students' perspective on the impact of formative assessment on their learning. This paper aims to explore students' perceptions about the impact of formative assessment on teaching and learning. The population of this study is 207 participants; 7 teachers and 200 students from one of the private schools in Abu Dhabi of the United Arab Emirates. The methodology that used in this study is mixed of qualitative and quantitative approaches. A focus discussion group was used as a tool of a qualitative methodology in this study, beside the questionnaires is used as well for this sake. The research question is; what do students believe about the impact of the formative assessment on their learning?

The findings of this study shows that teachers and students give less importance to formative assessment techniques as it is expected. Thus, teachers and students need to be trained to know about the importance of formative assessment strategies and techniques. Moreover, students need to be assessed by more interactive tools of assessment based on students interests and differentiations, because when knowing the cognitive approach and learning style of the students, teachers can provide effective feedback that help students comprehend their learning contents, goals, expectations and self-assessment. Besides, this study provides some helpful formative assessment techniques and strategies to assist teachers, students and parents to have a good understanding of the effective implementation of these tools of assessment for learning.

1. INTRODUCTION

Assessment is defined as the process of collecting evidence of learner's knowledge, skills and attitude toward the subject (p.3). How to conduct this assessment and the reasons for doing this assessment are vary (Dudley & Swaffield, 2008). Research found that assessment should be done for improving students learning which means it should be assessment for learning not assessment of learning (Harlen, 2000, p.112). Therefore, there is an urgent need for reforming and changing the traditional use of assessment (Qassim, 2008). This piece of research aims at reforming the use of assessment, namely, the use of formative assessment. Hence, practice-based research is carried out aiming for the betterment use of assessment in educational. The limitation of this study is that it is based on the findings of exposing the views of students only, thus, other researchers are recommended to examine the believes of teachers in this regard, as teachers influence students' views (Franke, Fennema, & Carpenter, 1997).

Examining student's perspectives on the influence of assessment for learning on the quality of their learning is significant (Ramsden, 1997). To give a clear picture of the strategies and tools of assessment for learning that has

practised in schools, a focus discussion group is used as a tool of a qualitative methodology in this study, beside the questionnaires. The goal of this research is to give an answer for this research question: (1) what do students believe about the impact of the formative assessment on their learning?

2. STATEMENT OF RESEARCH PROBLEM

The reviewed literature covers lots of studies about the importance of assessment on learning. However, only few of these studies walk around the notion of formative assessment from the viewpoints of students themselves. This study aims to determine the impact of formative assessment from the views of students.

Purpose of the Study and Research Questions

The purpose of this research is to present the views of students of Abu Dhabi private secondary schools on the importance of assessment for learning. There is one research question:

□What do students believe about the impact of the formative assessment on their learning?

Hypothesis

The main hypothesis of this study is that students have knowledge about the basic understanding of the importance of assessment on their learning. Moreover, students would be willing to share their experiences in this regard.

Limitations and Delimitations of the study

There are few studies that focus on the effectiveness of formative assessment on students learning and achievements, but fewer studies focus on the viewpoints of students. However, so far, there is no academic research is done based on students perspectives in the Arabic world as I know. Moreover, the population of this study comes from one secondary school in Abu Dhabi, so this would affect generating the results of this study.

Methodology

The methodology that used in this study is mixed of qualitative and quantitative approaches. A focus discussion group was used as a tool of a qualitative methodology in this study, beside the questionnaires is used as well for this sake. The population of this study is 207 participants; 7 teachers and 200 students from one of the private schools in Abu Dhabi of the United Arab Emirates.

The Significance of This Research

Several academic studies have revealed that assessment plays a significant role on students learning, most of these researches come from theoretical background, and some of them focused on exam results analysis, but fewer studies focused on the perspectives of teachers and students viewpoints. So, the significance of this study that it tries to cover one of these two missing main players of education. This study aims to discover students' views and experiences about the importance of formative assessment on their learning. Moreover, it recommends other researchers to do more research and studies on teachers' viewpoints about the formative assessment use and effectiveness.

3. THEORETICAL FRAMEWORK

Definitions of Formative Assessment

Researchers depict that assessment needs to be used for improving students learning not for testing their learning as it is proved by many researchers that formative assessment increase the quality of learning (Wiliam, Lee, Harrison & Black, 2004). Assessment for learning is defined as it is the (Van De Walle, Karp, 2013) define formative assessment as a tool of discovering how much students learn in order to aid teachers to plan the next lesson accordingly.

Techniques and Strategies of formative assessment

The concept of assessment and its impact on students' learning has attracted the researchers for 30 years (i.e Crooks, 1988; Black & Wiliam, 1998).

Some of these studies focused on providing strategies and techniques that help teachers when assessing students' learning. Such as, giving oral questions to students while learning a topic, this technique helps for continuous assessment for learning (Cauley & McMillan, 2010). Other researchers, found that teachers and students appreciate highly the performance test besides the official observation more that the oral question and unstructured observation (Kyriakides & Campbell, 1999). Likewise, other studies stressed the importance of assessment for learning techniques. Such as, providing students with clear learning objectives before teaching take place. (Cauley & McMillan, 2010). In his study, Clark suggested a list of strategies and techniques of formative assessment that help in engaging students in the teaching and learning process with reflective and critical thinking and problem solving based learning (2010). The list of these suggested techniques includes; higher order question, feedback as comments on students work, verbal feedback sharing learning objectives, sharing assessment criteria, self-assessment, peer assessment.

The use of feedback in formative assessment

Feedback provided by teacher to students is one of the most significant tools of assessment for learning; it might be given by questions or even by peer assessment. Moreover, when researchers give a definition to formative assessment they link it with the provided feedback by teacher that improves the quality of learning (Sadler, 1998). Likewise, formative assessment is defined by Cauley and McMillan (2010) as a process of collecting evidence of students'

learning in classroom when teachers modify their teaching according to the provided feedback (Nicol & Macfarlane-Dick, 2004). However, Sadler (1998) Stressed that the use of feedback is not an easy process, because we will not get the fruits of this feedback if we do not train students in how to understand and explain the provided feedback, and how to respond to it.

The formative use of students 'errors

Students' errors are not something makes students feel ashamed about, these errors should be dealt with as an opportunity to improve students learning, when teachers check students work and listen to their answers, this gives both teacher and student an opportunity to know the weaknesses of students, so the teacher modifies his or her teaching strategies and techniques accordingly. Thus, when students know their weaknesses and errors, they will know eventually what they need to do in order to work to their full potential (Cauley & McMillan, 2010). Therefore, Gagatsis and Kyriakides in their research found that students 'errors can be used as a means for improving learning (2000). Moreover, it is important that teachers' future decisions about their teaching and students learning start from the pupils 'errors (Desforges, 1989).

4. METHODOLOGY

For the sake of study, a mixed methodology approach is used. A focus discussion group is nominated from 7 teachers of different subject to provide the researcher with the formative assessment techniques and strategies that they used in classroom, and to give their opinions on the questionnaires. Moreover, questionnaire for exploring students 'perceptions about the impact of formative assessment tools was developed. The questionnaire includes two sections. In the first section questions about the participants' demographics (gender, and class). However, in section two, 44 statements for students agreement or disagreement on Likert scale of 4-point (1=strongly disagree, 4=strongly agree). In the first group of these statements, the purpose of the formative assessment was asked in 10 statements. The second group focused on the use of the strategies and techniques of formative assessment, this group included 8 statements. In the third group there were 6 statements about the use of students results and errors in the formative assessment. The forth group had 20 statements asking about the role of (students, teachers, and parents) in the formative assessment.

The questionnaire was directed by the 200 pupils for 30 minutes during school time with the help of their teachers who were members of the focus discussion group. The

participants were secondary school students, aged 12-15.

Sample Selection

The population of this study are 207 participants. 200 secondary school students and 7 teachers, all students and teachers come from one international school in Abu Dhabi, these teachers and students cover different subjects (English, Arabic, Maths, Science, History, Spanish and Islamic Studies)

Data Collection

Data of this piece of research is collected by questionnaires designed and sent by Survey Monkey Website to all students and teachers. Each teacher will guide his/her students to answer the questionnaires in the school lab.

Data Analysis

The findings of this research is analysed by Survey Monkey Website, in which the questions are divided on units as shown in the five presented chains.

Research Validation and Reliability

In order to have strong validation, triangulation and peer review is hired (Creswell, 2013). Moreover, a variety of academic research is used for the triangulation. Besides, expert review will be used to evaluate research procedures.

Ethical Considerations

The questionnaires contain personal questions, and the answer on these questions based on self-reflection of the participants, thus, the researcher will keep the data of participants secret so they feel comfortable in revealing their views honestly (Merriam, 2009).

5. RESULTS

The findings of this study as it is shown in (Figure 1) present the correlation between particular statements of students' belief and the practice. These relationships offer signs about how specific factors influence the students' views about formative assessment. As a result of these relationships of these variables in (Figure 1) open the space of discussion for five distinguished chains.

Chain 1

This implicative chain stresses the involvement of parents in the process of the formative assessment. The teachers 'practice of sharing with parents or discussing with them the procedures of teaching and learning of their kids, either before (S10a: do your teacher call your parents for a discussion before the assessment?) or even after the assessment (S10b: do your teacher call your parents for a discussion after the assessment?)

Involving parents in these discussions minimize the gap between the teacher and students and their parents, so this assures that there will be no missing information regarding students learning. It is as well; motivate students for more participation in the assessment process, by providing them with the criteria of this assessment and the expectation of the teacher. (S19: do you make a personal check list in order to assess yourself before the assessment?) And also, by adding comments on the corrected work, in order to know what went well (S3: On your corrected work, do you make comments that inform you what you have done well?). Moreover, the sharing with parents the assessment process before the assessment influences the use of differentiation (T18: Do your teacher after an assessment give different activities based on your level?)

Table 1

Percentages of students' answers to the statements of the 1st implicative chain

	No answer	Never	Rarely	Sometimes	Often
Does your teacher call your parents to discuss before the assessment?	5,5	50,3	21,1	14,6	8,4
Does your teacher call your parents to discuss after the assessment?	4,2	31,5	25	25,3	14
Do you make a personal check list in order to assess yourself before the assessment?	4,2	40,3	24	17,5	14
On your corrected work, do you make comments that inform	1,3	39,9	22,4	21,8	14,6

you what you have done well?					
Does your teacher after an assessment give different activities based on your level?	3,2	46,4	22,1	20,8	7,5
Does your teacher after an assessment give different activities based on your interests?	3,6	45,8	25,6	17,2	7,8
Do you discuss with your teacher his/ her expectations before the assessment?	2,9	26,3	31,8	23,7	15,3

The data revealed from (Table 1) shows some indications about pupils' awareness and practice of formative assessment. Firstly, about one third of students used to practise self-assessment strategies sometimes. Also, the findings show that teachers do not focus on the differentiation while teaching and doing assessments, thus, they should give more attention on differentiation. Moreover, about 50% of the students said that teaches almost never discuss their expectations with students or even with parents.

Chain 2

The 2nd implicative chain is dedicated to investigate whether teachers share and discuss assessment criteria and their expectations with their pupils and parents before the assessment (S14: do you discuss with your teacher his or her own expectations before the assessment?). Moreover, this chain focusses on students' errors and its formative use (R5: does your teacher offers to be with you while you are correcting your mistakes?), in this chain as well there is a room to explore whether or not teachers based their planning of next lesson on students' errors and assessment results (R4: does your teacher uses your errors and interests in planning the next lesson?). Besides, the difficulties of students in learning and assessment for learning have a place of interest in this second chain to see if the teachers clarify from students whether or no they understood their own mistakes. (R3: does your teacher after the test verify whether or not you understood your mistakes?).

As a result of the formative assessment it is important that the teacher provides those students who failed the

assessment with beneficial knowledge that help them to improve their learning. Such as, planning the next lessons according to the students' needs. (T15: does your teacher change the planning of his/her next lessons based on the areas of weaknesses of the performance of the students in the assessment?).

In addition to these results, in (Table 2) the percentages shown below present students' answers about whether or not their teachers base their teaching on students mistakes, interest and areas of weaknesses, and whether or not teachers used to teach the topics again for more simplification.

Table 2

Second implicative chain of student's answers and their percentages

	No answer	Never	Rarely	Some times	Often
Does your teacher offer to be with you while you are correcting your mistakes?	3,2	15,6	24,4	32,8	24
Does your teacher use your errors and interests in planning the next lesson?	2,9	32,8	28,6	24	11,7
Does your teacher after the test verify whether or not you understood your mistakes?	3,6	35,7	30,5	21,1	9,1
Does your teacher change the planning of his/her next lessons based on the areas of weaknesses of the performance of the students in the assessment?	1,3	11	19,8	33,4	33,4

Chain 3

In the third implicative chain at the left side these are most famous formative assessment techniques and strategies that

teachers and students used to practise frequently while teaching and learning take place in classroom. The aim of this list is to explore how these techniques are significant for the students in their own point of views. In fact, the list is divided into two groups of statements and questions; one of these two groups is dedicated for the techniques that are related to assessment by tests. In which the questions are divided as, multiple choice test, true and false test, and matching two groups of statement test. On other side, the second group is focused on the techniques and strategies that can be used in the formative assessment process. Such as, assessing by interviews, assessing by projects, assessing by presentation of students work, assessing by group works, assessing by portfolio, peer assessment self-assessment and pre-assessment.

When students prioritize and discriminate between the above mentioned techniques and strategies of assessments regarding their use by the teachers and by their importance for the students. The findings of these studies as presented in (Table 3) show that students appreciate mostly the participation in classwork. Moreover, data shows that students see that tests are more important, this explains the relevant percentage given to this group of techniques, which means that this result comes from the factual experience of the students of what happens in the classroom.

Table 3

Students' belief on the importance of assessment techniques and strategies

1=strongly disagree, 4=strongly agree

Assessment techniques and strategies	No answer	1	2	3	4
Completion questions test	5,5	14,3	29,5	29,9	20,8
Multiple choice test	4,2	13,6	24,7	30,5	26,9
True – False test	3,9	8,4	25,6	27,6	34,8
Matching tasks test	7,1	14	28,6	27,3	23,1
Participation in class work	1,3	8,8	12,3	33,8	43,8
Portfolio as a tool of assessment	10,1	28,9	29,5	17,2	14,3
Homework as a tool of	3,9	8,4	20,8	38	28,9

assessment					
Project as a tool of assessment	5,8	36,4	23,4	19,8	14,6
Presentation as a tool of assessment	6,2	27,3	28,6	23,7	14,3
Peer assessment as a tool of assessment	7,5	18,5	26,9	30,5	16,6
Self-assessment	8,4	18,8	29,2	28,2	15,3
Interview as a tool of assessment	8,4	40,9	24	14,9	11,7
Group work and activities as a tool of assessment	10,7	18,2	24,4	26,9	19,8

According to (Table 3), the findings show that students mostly like participation in class work as a tool of assessment for learning. Likewise, about 66 per cent of students appreciate homework to be considered as a tool of assessment for learning. Moreover, about 50 % of students give high importance to the completion questions test, and about 55 % appreciate multiple choices test. Likewise, almost the same percentage is given to true-False tests, also matching tasks tests are appreciated from 50% of students. Thus, it is obvious that assessment by test in all its techniques has a significant impact on student's perspectives and practice. However, the data depicts that less appreciation from students is given to the formative assessment techniques and strategies, as the following; about 32 % of the participants liked portfolios as a tool of assessment, and 34 % chosen Project as a tool of assessment. Moreover, about 38 per cent highlighted the importance of Presentation of students work, projects, and reports as a tool of assessment. Besides, about 45 % of students expressed their appreciation to self-assessment, peer assessment and group work and activities as a tool of assessment for learning.

Chain 4

The importance of self-assessment statement in the questionnaire is shown in the fourth chain. Moreover, the benefits of continuous feedback are presented as well. (P5: Do you feel confident and aware about what you are learning in a particular subject when you are provided with continuous feedback?). Moreover, data shown that there is a relation between the continuous feedback and students' knowledge about the teachers; expectation (S16: do you

feel more motivated and engaged when you are provided with instructions about what and how to learn in a particular subject?). Nevertheless, there is a linkage between the continuous feedback with the positive belief of the purpose of assessment (P1: Do you think that Assessment helps you identifying your good skills).

All these given questions and statements in chain 4 are proven that continuous feedback impact positively students 'self-confidence (P7: Do you feel that you are more confident when frequent feedback provided about your progress in a particular subject). Likewise, continuous feedback influence students' motivation while learning (P9: When feeling not satisfied about the grades that received for your effort in a particular subject, do you feel that you have to try harder?).

Chain 5

The fifth and last chain contains a list of questions and statements about students' perspective of the importance of understanding the subjects versus grading. (S18: What is more important for you to understand the subject or to get a high grade?). Moreover, the list provided of this chain explores students' views if they consider assessment as a tool for discovering their skills (P1: Do you think that assessment helps you identifying your skills in the taught subject?). Besides, providing students' with information about the assessment helps the students set new learning goals (P8: Do you think when providing with assessment information motivates you to establish new and further goals in learning the taught subject?).

Students seem as well positive regarding the use of errors in the assessment in a formative way. (R1: Do you think that correcting your mistakes in the assessment helps you to understand the subject better?). Also, data appreciate the participation of parents in the formative assessment process by providing the students with comments about this assessment (S11: Do your parents make comments about your corrected works, even if when you get low or high grades?) and regarding the criteria of the assessment, students prefer to have them prior to the assessment as it helps them increase their efforts (S15: Do you prefer to know the criteria of the assessment?)

6. DISCUSSION

The data provided from the questionnaire shows that there are implicative relations between the different questions of the questionnaire, quite a few indications come about aspects that might have significant role in applying assessment for learning "formative assessment" in teaching and learning. Firstly, students believe that involving parents

in the process of assessment of their children has a positive influence on both the teacher and the students. Moreover, when offering parents the opportunity to participate in the assessment can help the students in improving self-assessment performance. Besides, it is appreciated when teachers provide students with assessment criteria and comments on their errors, however, it is highly appreciated when their parents' make comments on assessment criteria and teachers' expectations.

On other side, continuous feedback impact student's learning positively. Continuous feedback when provided, establishes a positive confidence about the purpose of the formative assessment. Continuous feedback as well offers the learners information about what to learn and how to learn. This provided knowledge increase students' intrinsic motivation. In their research, Nicol and Macfarlane-Dick found that the significant feedback influence students' self-assessment inspires peer conversation and comments from the teacher and students about their learning establish the foundations of the perfect practice of formative assessment by clarifying its goals, criteria and standards. It also provides teachers with information about their future planning (Nicol & Macfarlane-Dick, 2004).

In addition to the aforementioned findings, self-assessment is the source of students' feedback. Thus, it is important to develop their abilities of self-assessment in order to be provided with continuous feedback that benefit their learning. On other confront, feedback should not be provided from teachers only, but also it is important to train students to provide each other with formative feedback about their learning and errors in the assessments and other learning productions. Hattie in his study depicts that formative assessment has a significant impact on students learning only when powerful feedback from students' classmates about their knowledge and misconceptions (2009).

The findings of this study show that students prompt optimistic views about formative assessment. They appreciate the role of formative assessment in discovering the skills that they have and they highlight the positive influence of the formative use of assessment's errors and mistakes, as well as parents' comments. Thus, students by this effective use of formative assessment techniques are able to set their new learning goals, particularly when they are provided with the assessment criteria and their teachers' expectations. These findings are in agreement with the findings of Cauley and McMillan, as they expressed that showing the students their errors and misconceptions and giving them the directions of how to correct their answers to the task prompt and increase their motivation and encourage them to work harder to their potential (2010).

7. CONCLUSION

To sum up, this study aims to present students views on the impact of formative assessment on teaching and learning. Moreover, the purpose of this study is to answer the research question (what do students believe about the impact of the formative assessment on their learning?). Thus, the findings show that students' views of the importance of formative assessment vary based on the different techniques or strategies. The high percentage given to the assessment by tests techniques and strategies shows that our schools still provide old fashion teaching and learning that based on grading and tests. Thus, teachers and students need to be trained to know about the importance of formative assessment strategies and techniques. Moreover, students need to be assessed by more interactive tools of assessment based on students interests and differentiations, because when knowing the cognitive approach and learning style of the students, teachers can provide effective feedback that help students comprehend their learning contents, goals, expectations and self-assessment (Cauley & McMillan, 2010).

This study provides a table (Table 6) as a suggestion for helpful use of formative assessment techniques and strategies to assist teachers, students and parents to have a good understanding of the effective implementation of these tools of assessment for learning.

Table 6

Effective use of formative assessment factors

	Students	Teachers
Parents comments and feedback	Feedback source	Planning next actions differentiation
Assessment criteria	To know teacher's expectation. Identify self-criteria	Clarify their expectations To be discussed with students
Self-assessment	Feedback source	Sharpen self-assessment skills of students
Use of errors and mistakes	Maximizing concepts understanding	Planning next lessons according to learners' needs
Strategies and Techniques of assessment	Classwork participation	Effective interaction of learners

7. FURTHER STUDIES

This piece of research as presented earlier focuses on the beliefs of students about the importance of formative assessment on teaching and learning. However, more researches are needed to investigate the beliefs of teachers, because beside students, teachers are key players in the process of teaching and learning.

REFERENCES

Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan*, 80(2), pp. 139-148. [Accessed 3 December 2016]. Available at: <http://ai2-s2-pdfs.s3.amazonaws.com/15bc/cadd19dbeb64ee5f0edac90e5857e6d5ad66.pdf>

Cauley, K. M., & McMillan, J. H. (2010). Formative assessment techniques to support student motivation and

achievement. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 83(1), 1-6. [Accessed 3 December 2016]. Available at: <https://pdfs.semanticscholar.org/442e/04cacceeb9afeb5b6dc52884d69b5adfe5e.pdf>

Clark, I. (2010). The development of 'Project 1': Formative assessment strategies in UK schools, *Current Issues in Education*, 13(3). [Accessed 3 December 2016]. Available at: <https://cie.asu.edu/ojs/index.php/cieatasu/article/viewFile/382/102>

Creswell, J. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Crooks, T. J. (1988). The impact of classroom evaluation practices on students. *Review of educational research*, 58(4), pp. 438-481. [Accessed 1 December 2016]. Available at: http://www.mendhamboro.org/cms/lib02/NJ01000391/Centricity/ModuleInstance/638/Crooks_-_Impact_of_Classroom_Evaluation_Practices_on_Students.pdf

Desforjes, C., 1989. *Testing and Assessment*. Education Matters Series. Continuum Publishing, Co., 370 Lexington Ave., New York, NY 10017-6503.

Dudley, P., & Swaffield, S. (2008). Understanding and using assessment data, In S. Swaffield (Ed.), *Unlocking assessment: Understanding for reflection and application* (pp. 105-120), Routledge.

Franke, M.L., Fennema, E., & Carpenter, T.P. (1997). Teachers creating change. Examining evolving beliefs and classroom practice. In E. Fennema & B.S. Nelson (Eds.), *Mathematics teacher in transition. The studies in mathematical thinking and learning series*, pp. 225-282.

Gagatsis, A. and Kyriakides, L. (2000). Teachers' attitudes towards their pupils' mathematical errors. *Educational Research and Evaluation*, 6(1), pp.24-58. [Accessed 1 December 2016]. Available at: https://www.researchgate.net/profile/Leonidas_Kyriakides/publication/228408441_Teachers_Attitudes_Towards_Their_Pupils_Mathematical_Errors/links/0912f50f12c6c447f8000000.pdf

Harlen, W. (2000). *Teaching, learning and assessing science 5-12* (3rd ed.). London: Paul Chapman Publishing.

Hattie, K. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. New York: Routledge

Kyriakides, L. & Campbell, R.J. (1999). Primary teachers' perceptions of baseline assessment in mathematics. *Studies in Educational Evaluation*, 25(2), pp.109-130.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.

Nicol, D., & Macfarlane-Dick, D. (2004). Rethinking formative assessment in HE: a theoretical model and seven principles of good feedback practice. In C. Juwah, D. Macfarlane-Dick, B.

Qassim, J.A.S. (2008). Teachers' perceptions of current assessment practices in public secondary schools in the State of Qatar. Doctoral dissertation. The University of Hull.

Ramsden, P. (1997). The context of learning in academic departments. In *The experience of learning: Implications for teaching and studying in higher education*, 2, pp. 198–217. [Accessed 2 December 2016]. Available at: <http://www.etl.tla.ed.ac.uk/docs/ExperienceOfLearning/EoL13.pdf>

Sadler, D. R. (1998). Formative assessment: Revisiting the territory. *Assessment in education*, 5(1), pp.77-84. [Accessed 2 December 2016]. Available at: <http://dropoutrates.teachade.com/resources/support/5035b24fecda6.pdf>

Van De Walle, A. J., Karp, S. K., & Bay-Williams, M. J. (2013). *Elementary and Middle School Mathematics: Teaching Developmentally* (8 ed.). United States of America: Pearson.

William, D., Lee, C., Harrison, C. & Black, P. (2004). Teachers developing assessment for learning: impact on student achievement. *Assessment in Education*, 11 (1), pp.49-65.

Investigating the Leadership Role of Head of Departments of the Arabic Language on Teaching and Learning: Abu Dhabi Private Schools as a Case Study

Mohamad Ezzat Alkutich
British University, Dubai

ABSTRACT : This paper aims to examine the leadership role of the Head of Department (HoD) in teaching and learning of Arabic language in two of Abu Dhabi's private schools. The main research question is what is the impact of the HoD on teaching and learning Arabic language in Abu Dhabi private schools? This piece of research employs a qualitative methodological approach, whereby data were gathered from two private schools in Abu Dhabi. A Pilot study with 3 teachers and one HoD was conducted; 8 semi-structured interviews were employed with two head teachers, 2 HoDs and 4 teachers in two private international schools in Abu Dhabi.

The findings of this paper were that no formal preparation was provided to HoDs for leading the teaching and learning of Arabic language, HoDs practise their leadership role by running class observation, monitoring (teaching and learning, lesson plans, students' work and assessment) and providing teachers with feedback. HoDs lack of pedagogical knowledge, lack of curriculum design and implementation. The study found that HoDs face variety of challenges, such as, lack of teaching and learning resources, demotivated teachers, heavy workload and paperwork, HoDs perceived by teachers as fault hunters and lack of leading by example, and lack of quality CPD.

This study provides the following recommendations; HoDs should be provided with courses about the subject and curriculum knowledge and the leadership role. HoDs need to be trained about quality monitoring teachers' work and students learning and how to be critical friends. HoDs should engage Arabic teachers in planning, monitoring and evaluation processes.

INTRODUCTION

Educational leadership is one of the key aspects of improvement in education worldwide. The literature presents leadership as a significant factor in school success and betterment (Earley & Weindling, 2004). In the UAE, school management team (SMT) includes school principals, deputy heads and head of departments. This paper focuses on the head of departments (HoDs). The literature is full of research and studies about the impact and role of HoDs, but with a different given name, such as, subject leaders, coordinators, middle leaders and department chair. In this study, I will use the acronym 'HoDs' as it is very common in Abu Dhabi schools. Besides, both schools that I chose for this research use it as well.

PROBLEM STATEMENT OF THE STUDY

HoDs have lots of tasks to do while leading the teaching and learning. However, majority of HoDs lack significant skills

and competences as leaders. In the literature, it is found that HoDs are not ready to lead (Turner, 2000), they learn during doing their job, and lack of time for planning and leading (Ali & Botha, 2006; Zepeda & Kruskamp, 2007; Rosenfeld et. al, 2009; Bak, 2010). Almost all the continuous professional development (CPD) that HoDs attended is not relevant to their leadership role (Stephenson, 2010).

THE RATIONALE OF THE STUDY

The rationale of this research is based on my experience as a teacher and as a HoD who was holding this position as the best of the team (in the viewpoint of the principal), with years of experience and fluency of English language, not based on the leadership experience. I've learnt about the role of HoD from other HoDs who had the same experience of not being prepared for the leadership. To the best of my knowledge, there is a lack of research about the leadership impact of the HoDs in teaching and learning the Arabic language neither in primary or secondary school. The poor performance of the Arabic language among the learners in Abu Dhabi private schools as it is shown in the inspection

reports (ADEC, 2017) and the lack of research about the role of HoDs in teaching and learning the Arabic language are significant calls for this piece of research.

THE PURPOSE OF THE STUDY

The aim of this study is to investigate the perceptions of school educators about the leadership role of HoDs in teaching and learning the Arabic language in the private schools of Abu Dhabi, as well as to provide educators with some answers might help in improving the role of Arabic language HoDs.

THE SIGNIFICANCE OF THE STUDY

Many studies have been carried out exploring the different roles of the HoDs in schools; however, there is a lack of research about the impact of leadership role of HoDs on teaching and learning.

THE RESEARCH QUESTIONS

This study is based on one key research question and four sub-questions. The main research question is “What are the perceptions of school educators regarding the leadership role of the head of departments HoDs in teaching and learning of the Arabic language?”. The sub-questions are;

- 1- What are the responsibilities of HoDs as subject leaders in teaching and learning of the Arabic language?
- 2- What are the formal or informal preparatory courses that HoDs provided with while leading teaching and learning of the Arabic language?
- 3- What are the leadership activities that HoDs practise in leading teaching and learning of the Arabic language?
- 4- What are the challenges that HoDs face while performing the leadership of teaching and

LITERATURE REVIEW

Leadership in literature is defined differently. Kruger, in his research depicted that leadership is a mechanism of communicating team members with missions, goals and objective (2003). In another study, Leithwood and Riehl (2003) claimed that leadership is about directions and influence. However, Hoerr (2005:7) pointed that “leadership is about leadership”. Yukl (2006) asserted that leadership is the art of attracting staff to achieve a common goal, it is a two way event when leaders and followers affect and affected by each other. In education, there are various

approaches of leadership, the main two that are relevant to the purpose of this study are instructional leadership and distributed leadership.

INSTRUCTIONAL LEADERSHIP

The concept “Instructional leadership” is about the relationship between teachers and learners regarding teaching and learning activities (Bush & Glover, 2002). Besides, it is about leading teaching and learning (Robinson, 2006; Bush, 2007). As school principals are overall leaders, it is found that principals have no direct influence on teaching and learning, and it is delegated to HoDs (Bush, 2003).

DISTRIBUTED LEADERSHIP

The concept “distributed leadership” is recent notion in educational literature, and it is described as the practice of school leaders in guiding and influencing the development of teaching and learning (Spillane & e.t, 2003: P.535). In UK, Hammersley and others (2005) found that where distributed leadership is applied, there will be collaboration between staff for school improvement, also there will be an appreciation of delegation of responsibilities, and knowledge development, innovation and creativity are expected.

STUDIES ON HoDs

Regarding their roles and responsibilities, a study in UK (Fletcher & Bell,1999) found that the roles and responsibilities of subject leaders are many. Such as, providing and administrating the resources and making them available; influencing the performance of quality teaching and learning; monitoring and evaluating teachers work according to the set targets and goals; subject knowledge; providing CPD to the teachers in the department based on their needs; supporting teachers by listening to them and communicating with them effectively. However, Fletcher and Bell claimed that HoDs were facing different challenges. Such as, lack of time for development; lack of time for monitoring; and lack of cooperation among the staff.

On other hand, Bennet and others (2003) found in their research that subject leaders were not happy to run classroom observation; lack of subject knowledge compared to some teachers in the department. Ali and Botha (2006) in their study in South Africa found that the role of subject leaders has a significant impact on school improvement. In another study conducted in UK, Poultney (2007) claimed that subject leaders should be approachable and supportive to teachers. Besides, the study found that subject leaders were challenged in delegating duties and responsibilities.

In Australia, Rosenfeld and others (2009), discovered that HoDs were not aware of the leadership skills, and they lack trainings about middle leadership roles, the participants HoDs in this study claimed that they only learn on the job. Regarding the skills and competences that HoDs should have, a study conducted in Singapore by Heng and Marsh (2009) found that HoDs are required to sharpen their interpersonal skills, have subject knowledge, and pedagogical understanding of their subject. HoDs should be fair and just in their judgement.

HoDs instructional supervision

HoDs are the instructional leaders of their subjects, and the role of instructional supervision is delegated to them, so they are in charge of the quality of teaching and learning (Bush, 2007). Zepeda and Kruskamp (2007) conducted a study in the USA investigating the perceptions of HoDs about the provision of instructional supervision in their departments. It was found that HoDs were not prepared for the supervision role, they also lack support and guidance from the principals, and they faced role ambiguity in their assigned position, and role tension.

HoDs PREPARATION FOR LEADERSHIP

The literature shows that the position of head of department is given to teachers based on their years of experience and how perfect they appear in the interview as a way of marketing themselves (Turner, 2000). In his study, Turner (2000) found that HoDs learn from other HoDs with more experience, and they treat them as their role models, they also learn from leadership and management workshops.

Skills and competences of HoDs

In order to perform better leadership role, HoDs needs to have particular competences and skills to fulfil their responsibilities of the quality of teaching and learning. Bak (2010) in her study depicted that HoDs need to improve their interpersonal skills, administration work, subject knowledge, curriculum design and development, supervision and evaluation and continuous professional development. Stephenson (2010) illustrated the skills and competences that HoDs should have as leaders. Such as; subject knowledge; assessment knowledge; pedagogical knowledge; shared vision; strategic planning; team development; providing relevant CPD; people management; communication skills; time management; and delegation skills.

Challenges of HoDs

Head of departments face various issues in leading teaching and learning. Stephenson (2010) found that there are many

challenging facing HoDs, such as, time workload, leadership knowledge, lack of CPD directed at HoDs to assist them.

Research Methodology

Methodological approach

This study investigates the perceptions of school educators about the leadership role and impact of HoDs on teaching and learning the Arabic language in international schools in Abu Dhabi. A qualitative approach was employed in order to gather the perspectives of the participants. This qualitative approach allows the researcher to hear the voice of participants and gives him a deep understanding of their point of views (Yin, 2011:P.8). Qualitative methodology provides the researcher with better understanding of the phenomenon (Creswell, 2012).

Research Sample

This research is a case study of two international schools in Abu Dhabi, based on the curriculum provided by each school and based on the inspection report in Arabic language conducted by Abu Dhabi Educational council ADEC in the academic year 2016-2017, both schools have very good inspection grade with a good performance in Arabic language. These nominated schools are one follow the British curriculum and one follows the American curriculum, and both of them are secondary schools.

A Pilot study was conducted with one head of department and 3 teachers to assure the time needed to the interview and clarity of the questions.

Participants

The participants were 8 school educators from both schools, from each school there was one head teacher, one Arabic language head of department and two teachers of Arabic language. An email was sent to 7 schools that fit my criteria to ask permission to conduct this study, however only 3 schools replied positively. The teachers were one teacher for native speakers and one for non-native speakers from each school. Demographically, it was meant to have a balance percentage 50% among the participants' males and females, however, participants were 2 males head teachers, one male and one female HoDs, and three female teachers and one male teacher.

Data Collection

Prior to the study, I sent an email to the head teachers of the participant schools to get their permission to conduct this study, another email was sent as well to the participants as an invitation to partake in this research, attached with the

email a form of ethical clearance was sent as well to be signed by the partakers.

Semi-Structured interview

Semi-Structured interview was employed as the main qualitative tool to collect the data of this study. The significance of this tool that it is helpful to extract data from personnel opinions and beliefs and the shortcomings of such a tool are the unwillingness of the participants to reveal their experiences and the potential bias or unreliability.

Data Analysis

In this stage of the research, data analysis refers to the interpretation of the collected data, to make sense from the perceptions of the participants (Jansen & Vithal, 2001). To the sake of the best data analysis result, the researcher used content analysis method to get a useful briefing of the collected data, and content analysis method enables the researcher to code, categorise and compare data and it shapes the theoretical conclusion (Cohen et. al., 2011).

The Credibility of the Study

In order to ensure the validity of the findings of this study, I have applied different tools. Such as, triangulation by using different categories of the participants (Creswell, 2012), in this regard, the researcher included three categories of participants, namely, head teachers, head of departments and teachers. Besides, relevant documents to the research questions were retrieved. Finally, a pilot study with one head of department and three Arabic teachers was applied.

Dependability of the Study

Achieving a high level of dependability in qualitative study can be ensured by different ways. In this regard, the researcher preserved all the notes, records and transcripts of the interviewees. Moreover, participants were treated by the researcher as partner in this research. Finally, with respect to the experiences of the participants and their potential bias, I made certain that the interview questions are relevant to the research questions, and I also did not use any leading questions with the interviewees.

Ethical Considerations of the Study

Ethical consideration is one of the significant pillars of the qualitative research, thus, both trust and privacy protection need to be guaranteed to make sure that interviewees reveal their own perspective based on their experiences (Creswell, 2012). In this regard, I have sent via email, a consent form to be signed by the participants, I also ensured that all the participations were mere voluntary. Besides, participants were informed that they can withdraw at any time and they

have the right not to answer any of the interview questions. Moreover, permission for audio recording was requested.

FINDINGS AND DISCUSION

The participants in this study come from two international schools in Abu Dhabi of the UAE. One of these schools follow the British curriculum and the second school follows the American curriculum, both of them entitled a very good overall inspection report with acceptable grade for the Arabic language. in these two schools, 8 participants were involved and interviewed in this study, two head teachers, two Arabic language head of departments and four Arabic teachers. As it is shown in (Table 1), both head teachers have more than 17 year teaching experience, and more than 7 years leadership experience, and both of them carry a master degree in education. On other side, bot head of department have more than 10 years teaching experience in Arabic language, one of them has good leadership experience for 7 years. However, the other one is in her first year as a head of department. Both HoDs have a bachelor degree in Arabic but no one hold a master degree. Regarding the Arabic teachers, the majority of participants have more than 10 year teaching experience, 50% of them has no leadership experience. Besides, 100 % of the teachers participants hold a bachelor degree in Arabic language, and one of them hold master degree. It is clearly shown in Table 1 that in one of these schools these is a teacher who has more leadership experience and educational degree than his head of department, one teacher commented; that there is no clear criteria for successful candidates for the position of head of department,

Participant	School	Teaching experience per year	Leadership experience per year	Gender	Age	Qualification
Head teacher	A	20	10	F	47	MED in Education
Head teacher	B	18	8	M	50	MED in

						Educ ation
Head of depar tment 1	A	19	7	M	4 4	Bach elor degre e in Arabi c
Head of depar tment 2	B	10	1	F	3 3	Post- Gradu ation Diplo ma & Bache lor degree in Arabi c
Arabi c teach er 1	A	12	2	F	3 5	Bache lor degree in Arabi c and Islami c
Arabi c teach er 2	A	15	0	F	3 7	Post- Gradu ation Diplo ma & Bache lor degree in Arabi c

Arabi c teach er 3	B	16	4	M	4 0	Maste r degree in Arabi c
Arabi c teach er 4	B	4	0	F	2 8	Bache lor degree in Arabi c

Table 1: Demography description of the participants

(Coding School A/B it does not mean that A for American school nor B for British school).

The Pilot Study

Interview questions were tested by a pilot study to ensure the clarity of questions and the needed time for the interview process. Kim (2011) highlighted this small-scale methodology was carried out as a preparation to the study, so the researcher adjust his research plan accordingly.

As it was mentioned earlier, that three schools accepted to participate in this study, so out of these schools one was selected to run the pilot study. It was planned to interview the head teacher but she had a busy schedule at that time, so the members of this pilot study were one head of department and three Arabic teachers.

Research Question 1: The Responses of Head Teachers

Regarding the first research question "What are the responsibilities of HoDs as subject leaders in teaching and learning of the Arabic language?" head teachers responses came into four categories of roles that HoDs play as leaders. Namely;

Administration role

Head teachers participants in this study believe that the main responsibility of HoDs is administration, as they are in charge of monitoring the register and attendance of both teachers and students in the department. One head teacher said: " Part of being outstanding school, subject leader should record the attendance of teachers to assure that

teaching is taking place, and to record pupils attendance as well, to give avoidance why particular students (Absentees) are not learning”. Besides, they are responsible of providing the needed resources and material for teaching and learning. A head teacher added: “Head of department should be the best who know what resources and books we need to make sure that quality teaching and learning is taking place”.

Curriculum Management Role

As part of HoDs responsibilities, head teachers think that HoDs are the ones guarantee that the curriculum is linear with the national agenda and meets the long term goals of the subject. One head teacher indicated: “Head of department is in charge of curriculum delivery, by choosing in association with teachers what topics to be taught and what learning objectives to be achieved”.

Supervision Role

HoD as supervisor is another responsibility perceived by head teachers. Supervision role includes monitoring lesson plan, annual plan, assessment and classroom observation. One head teacher said: “head of department needs to check lesson plans, assessment coverage and teaching strategies”. Another head teacher highlighted: “As a principal, I have delegated classroom observation to the head of department, this tool is very important for school leaders, to assure that curriculum is delivered as it was planned by skilful teachers so our students enjoy while learning”

Support Role

Head teachers believe that part of head of department’s responsibilities is to provide support to teachers and students. A head teacher pointed: “Subject leader should support teachers by being a critical friend, facilitating their work, giving advices and needed CPDs”. Another head teacher said: “When it comes to support, experienced teachers and new teachers need support in different ways from their head of department, also students need support by providing special tasks to those with special needs and the gifted and talented”.

Responses of Head of Departments

Similar to the head teachers, head of department’s responses came into the same four categories for the first research question “What are the responsibilities of HoDs as subject leaders in teaching and learning of the Arabic language?” However, HoDs added one more category which is evaluation and appraisal. With respect to these categories, the responses of HoDs were as the following:

Administration Role

All HoDs participants agreed that the administration role is one of their key responsibilities. This role consist of

ordering and providing resources and subject materials, taking notes out of school meetings, approving teachers’ print outs, providing cover for absent teachers and dealing with the process of hiring new teachers. One head of department said: “We lack enough teachers in our school, so I have to search for new candidates, call them, meet them, observe their demo lessons, and also to cover or find a cover teacher for the class with no teacher to teach”

Curriculum Management Role

Managing the curriculum is the second agreed role between head teachers and HoDs. From the point of view of HoDs, curriculum management includes monitoring the process of teaching and learning, teaching strategies and assessment. One head of department commented: “I am responsible to check whether or not teaching and learning of the Arabic language is taking place in all year groups and all teachers, it is my duty to assure that teachers are teaching as we have planned in the beginning of the year”. Another head of department said: “Teaching nowadays is really complicated and not all teachers good in it, so my part is to make lesson observation to enhance teachers to engage all students by learner-centered teaching strategies. Sometimes I visit classroom and see there is teaching, but eventually no learning is achieved!”

Supervision Role

As part of supervision task, HoDs are responsible to check whether or not teachers adhere to the department plan, scheme of work and curriculum coverage. One head of department pointed: “In my department there are some teachers that are not totally committed to the subject policy, one of them do not check students’ work, another one do not give homework frequently, and most of them do not cover teaching all the planned topics of the curriculum” Another head of department added: “ All the teachers in the department are not strictly committed to make a written lesson plan and they claim that they have it in their mind and they are experience teachers so they know what to do in the classroom, but I believe that this is wrong and really I do not know how to encourage them to do it. When I force them to do lesson planning, it takes from them more than 1 hour for each lesson, it is too much as they have about 7 daily lessons”.

Support Role

HoDs articulated that it is part of their responsibilities as subject leaders to support teachers with the needed professional development. One head of department said: “Part of the improvement plan of my department is to support those teachers who lack experience and teaching strategies”

Teacher Appraisal Role

This point is the only different one comparing to the head teachers above mentioned points. Head of departments believe that they are in charge of evaluating overall teachers' performance.

One head of department stressed: "It is a significant role I have, which is evaluating teachers overall practice, because in my school, the senior leader team the only things that they care about, that the kids have a teacher, and this teacher is good in speaking English. However, they are not aware about the quality of teaching of this teacher".

Teachers Participants Responses

All teachers agreed that it is the responsibility of head of departments to assist teachers and support them. Unfortunately, all teachers participants as well agreed that their HoDs do not do so. One teacher said: "Our head of department is responsible to provide us with support, but he does not do this, instead he is a fault hunter!". Another teacher has this to say: "I respect my subject leader, she is so kind to us, but she does not that experience to help or support us". Moreover, one teacher claimed: "my head of department is a very hard worker to improve his own skills, but he never ever sent us to any workshop nor he delivered any CPD" On other side, one teacher pointed: "Part of our school culture is to exchange classroom observations and visits across the whole school, but he never invited or allowed us to visit his class to learn from his practice about the things that he does not like in our classes".

Participants' Responses on Research Question 2

Regarding the second sub-research question "What are the formal or informal preparatory courses that HoDs provided with while leading teaching and learning of the Arabic language?", the perceptions of both categories of participants, head teachers and head of departments were investigated. Head teachers agreed that HoDs in their schools did not have any preparatory course in order to hold their positions. One head teacher said: "I think that the years of experience in teaching and subject knowledge are what they have". Another head teacher added: "yes she does not have any experience in leadership, but we are offering her an opportunity to learn and get the needed experience". Similarly, one head of department said: "I was just a teacher, and I showed my interest in leading the department, I had no leadership experience, I attended lots of workshop, but none was about middle leadership".

Participants' Responses on Research Question 3

Responding to the third sub-research question "What are the leadership activities that HoDs practise in leading teaching and learning of the Arabic language?", three themes emerged. Such as, monitoring, hiring teachers and resources availability. All the three participant groups of head teachers, HoDs and teachers agreed about monitoring role and disagreed about the other two roles. However, HoDs added that part of their responsibilities is to manage the process of hiring new qualified teachers and providing them with trainings to facilitate their work as new bees in the school. Teachers' participants added that HoDs are in charge about the provision of resources and materials.

One head teacher said: "He has to check lesson plans, students work and curriculum coverage". A HoD added: "There is too much work to do; besides teaching my classes, I have to make sure that teachers planning their lessons and checking learners books; and finding, interviewing and hiring new expert teachers" On other side, one teacher pointed: "The head of department is responsible as a budget holder to make sure that the needed materials, books and resources are available.

Participants' Responses on Research Question 4

The forth sub-research question was "What are the challenges that HoDs face while performing the leadership of teaching and learning of the Arabic language?" and the responses brought four themes. Such as, workload, leadership, training, support and communication. Both head teachers and HoDs agreed that the workload of HoDs is so tough. One head teacher said: "They are teachers as well and they have to plan and teach their classes, and to deal with the issues of their departments, we try to give them less teaching classes, but when a teacher is absent or left the job, HoD is taking her place."

Also both groups were in agreement about the training issue. A head teacher had this to say: "she is not qualified as a leader, but he is an excellent teacher, we gave her the opportunity to learn and get experience, we send her to workshops as well". One HoD added: "I learn how to lead while doing my job, I go to workshops but none is about middle leadership" One teacher said: "Yes he pretend that he is a perfect leader, but he is not good in leadership skills at all, we meet weekly but useless there is no goal, no strategic plan".

Regarding the support and communication, A HoD said: "Some teachers do not do their work as it should be, they are here just for the salary, you ask them to do thing lots of time then they do it", one teacher claimed: "Some times and

because she does not know how to do things, she deal with teachers in a very bad way, I mean here that asking as to do things without discussing then we do the same thing again differently”. Another teacher stressed: “He is not that supportive, most of the time he acts as a fault hunter, not showing respect when talking, I think without him we can do things better, just leave us do our work!!”

Discussion

In reviewing the responses of the participants of the three groups, one can see that there are some similarities and differences on the viewpoints of the research questions. All the partakers in this research agreed that HoDs are not prepared as leaders, and they lack leadership skills training and courses. All participants as well are in agreement that HoDs are there to support, assist and facilitate teachers work. Head teachers and HoDs articulated that there is no such a professional program or course about middle leadership.

However, head teachers think that being an experienced teacher is adequate to be appointed as a head of department. In other point, teachers believe that HoDs should be skilful in team work and communication as in practice there signs of disrespect, autocracy and fault hunting.

Results and Conclusions

As a result of the research to answer the key research question “What are the perceptions of school educators regarding the leadership role of the head of departments HoDs in teaching and learning of the Arabic language?” the research found that;

- Head teachers in reality are not aware about the importance of preparing HoDs in middle leadership skills.
- HoDs hold the responsibilities of curriculum management, monitoring and providing support.
- Lack of formal preparation for HoDs about middle leadership.
- HoDs face different challenges; frequent shortcomings in teachers availability, demotivated teachers, workload and paperwork, leadership skills, curriculum knowledge, communication skills.

Recommendations

- It is recommended that Ministry of Education and ADEC to require schools to give the position of HoD only for those teachers with leadership qualification.
- Ministry of Education and ADEC are recommended to establish a course and approval for HoDs.
- Schools are recommended to hold frequent courses and conferences for HoDs and teachers.
- Head teachers are recommended to support HoDs with leadership trainings.
- Schools and HoDs to involve teachers in decision making and delegation.
- HoDs to communicate effectively with teachers by supporting and facilitating their work and as critical friends, so teachers would not see HoDs as fault hunters.

Limitations and Further Studies

This study uses a qualitative approach and its sample is just two international schools in Abu Dhabi, so its results and findings can't be generating to other types of schools or even other departments nor to other emirates or countries. I recommend that for future studies to increase the sample and use mixed research methodology to investigate the impact of HoDs of Arabic language on teaching and learning.

REFERENCES

- ADEC, (2017). Inspection Reports, [Retrieved 29-6-2017 from: <https://www.adec.ac.ae>]
- Ali, A.F. & Botha, N. (2006). The role, importance and effectiveness of Heads of department in contributing to school improvement in public secondary schools in Gauteng. Matthew Goniwe School of Leadership and Governance, Johannesburg.
- Bak, S. O. S. (2010). Competencies of secondary school Heads of department; Implications on continuous professional development, *European Journal of Social Sciences*, 14(3), 464-470.
- Bennett, N., Newton, W. Wise, C., Woods, P. A. & Economou (2003). Research report.

- Bush, T & Glover, D. (2002). *School Leadership: Concepts and Evidence*. Nottingham.
- Bush, T., 2003. *Theories of educational leadership and management*. Sage.
- Bush, T., 2007. Educational leadership and management: Theory, policy and practice. *South African journal of education*, 27(3), pp.391-406.
- Cohen, L., Manion, L. and Morrison, K., 2011. Surveys, longitudinal, cross-sectional and trend studies. *Research Methods in Education*, 7th edition. Abingdon: Routledge, pp.261-4.
- Creswell, J.W., 2012. Collecting qualitative data. *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Fourth ed. Boston: Pearson, pp.204-35.
- Earley, P. and Weindling, D., 2004. *Understanding school leadership*. Sage.
- Fletcher, L. and Bell, D., 1999. Subject leadership in the primary school: Views of subject leaders.
- Hoerr, T.R., 2005. *The art of school leadership*. ASCD.
- Hammersley-Fletcher, L. and Brundrett, M., 2005. Leaders on leadership: the impressions of primary school head teachers and subject leaders. *School leadership & management*, 25(1), pp.59-75.
- Heng, M.A. and Marsh, C.J., 2009. Understanding middle leaders: A closer look at middle leadership in primary schools in Singapore. *Educational Studies*, 35(5), pp.525-536.
- Kim, Y., 2011. The pilot study in qualitative inquiry: Identifying issues and learning lessons for culturally competent research. *Qualitative Social Work*, 10(2), pp.190-206.
- Kruger, A.G., 2003. Instructional leadership: the impact on the culture of teaching and learning in two effective secondary schools. *South African journal of education*, 23(3), pp.206-211.
- Leithwood, K. and Riehl, C., 2003. What do we already know about successful school leadership? Paper prepared for the AERA Division A Task Force on Developing Research in Educational Leadership.
- Jansen, J. and Vithal, R., 2001. Designing your first research proposal: A manual for researchers in education and the social sciences. *Lansdowne: Juta & Co, Ltd.*
- Poultney, V., 2007. The role of the effective subject leader: Perspectives from practitioners in secondary schools. *Management in Education*, 21(2), pp.8-14.
- Robinson, V.M., 2006. Putting education back into educational leadership. *Leading and managing*, 12(1), p.62.
- Rosenfeld, P., Ehrich, L.C. and Cranston, N., 2009. Changing roles of heads of department: a Queensland case.
- Spillane, J.P., Hallett, T. and Diamond, J.B., 2003. Forms of capital and the construction of leadership: Instructional leadership in urban elementary schools. *Sociology of Education*, pp.1-17.
- Stephenson, A., 2010. *An examination of the issues facing heads of departments in New Zealand secondary schools* (Master's thesis).
- Turner, C., 2000. Learning about leading a subject department in secondary schools: Some empirical evidence. *School Leadership & Management*, 20(3), pp.299-313.
- Yin, R.K., 2011. *Applications of case study research*. Sage.
- Yukl, G., 2006. & (2002)" Leadership in Organizations".
- Zepeda, S.J. and Kruskamp, B., 2007. High school department chairs-perspectives on instructional supervision. *The high school journal*, 90(4), pp.44-54.

Advantages and Disadvantages of Green Technology; Goals, Challenges and Strengths

Abolfazl Irvani
Master of Agricultural
Engineering
Azad University of Birjand
Birjand, Iran

Mohammad Hasan akbari
Master of Public
Administration (Governmental
Management)
Farabi Campus, University of
Tehran
Birjand, Iran

Mahmood Zohoori
Master of Environmental
Management
Putra University of Malaysia
Birjand, Iran

Abstract: The concept of green processes and technologies is the processes and technologies which are environmentally friendly, improved and utilized in such a way so that it doesn't disorganize the environment and conserve natural resources. Some people refer green technology as environmental technology and clean technology. The existing expectation is that this field will bring novelty and innovation changes in diurnal life of same magnitude of information technology. Besides, today due to the importance of this technologies, most of the governments takes initiatives to promote it. Therefore, governments recommended many financial incentives which generate electricity from renewable resources. The goals of green technologies are as follow: to meet the needs of society in the way without depleting or damaging natural resources on earth which is the major target of green technologies. The concept is to make products which can be fully reclaimed or reused. Furthermore, by changing patterns of production and consumption, steps are being taken into account to diminish waste and pollution as one of the most indispensable aims of green technologies. Many companies have committed for establishing manufacturing practices and business regarding green technologies. Besides, this kind of technology implies to a system which utilizes innovative techniques to create environmental friendly products. Predominantly, it contains the various everyday cleaning products, waste, inventions, energy sources, clothing and host of others. Going green or using technologies which are environmental friendly is amongst the many methods which countries are looking in order to spur economic growth and develop the lives of its citizens. Green processes and technologies use renewable and natural resources which never depletes. Besides, green technology utilizes innovative and new techniques in terms of energy generation. Furthermore, green nanotechnology which utilizes green chemistry and green engineering is one of the newest in green technologies. One of the most important factors for pollution of environment is the disposal of waste which green technology has the answers to it as well. This kind of technology can easily alter the waste pattern and production in a way which it does not deteriorate the earth and people can go green. Furthermore, among the conceivable areas where these creations and growth are expected to come from involve organic farming, green energy, green building construction, eco-textiles, and manufacturing of relevant products and materials to support green business. Because it is new to the industries. Besides, it is also expected to absorb new clients who will see too many advantages of using green technologies in their places and others. Therefore, the main goal is to utilize green technology which has no adverse effects on the planet. Nowadays there are huge concerns regarding environmental pollution which bring attentions on the utilization of green products and processes. There are a great amount of researchers who have been conducted and are being conducted in different industries with various scopes in this term. However, the essential point is whether green technology are able to adapt in various industries. Certainly, one of the major problems in the globe is pollution which has created a huge concern in relation to the future human life. Therefore, this paper concentrates on the advantages and disadvantages of green technology.

Keywords: Green technology, Environmental pollution, Renewable energy, green chemistry, eco-friendly technology, organic farming

1. INTRODUCTION

Nowadays industries consume more energy than what it is essential, so it leads to more pollution. That's why it is necessary to create a managerial system based on green processes and products to decrease the pollutions. Besides, the opportunities are provided in green technology. Governments, companies and industries all around the globe seek have been seeking for methods and

techniques to diminish the waste, because the earth's environment is not in a proper situation today in terms of pollution for instance: water contamination, global warming and forest disappearing which are main difficulties for environment. However, in roofed environment such as offices with mechanical ventilation, but without circulation, tools like computers may lead sensory pollution loads (Al-Ali et al.,

2010), (Zohoori et al., 2016). In point of fact, the personal computers (PCs) considered as a potent indoor pollution sources. Furthermore, when PCs are services for every three months, sensory pollution load of every singular one is 3.4 Olfactus (olf) (Bakó-Biró et al., 2004), (Zohoori et al., 2016).

Chemical analysis detects the pollutants emitted by PCs. The most remarkable chemicals involve phenol, toluene, 2-ethylhexanol, formaldehyde, and styrene (Al-Ali et al., 2010). Therefore, these types of pollutants include an indispensable adverse effect on the air quality, not only in the offices but also in many spaces like houses. In addition, (National Public Radio) NPR reported by Chris Arnold in 2004 from Environmental Protection Agency (EPA) officials said: Computers and their monitors in the United States have the responsibility for the unessential creation of millions of tons of greenhouse gases per year (Ravali et al., 2011). Besides, as the whole globe have been talking about going green, everybody can chip-in his/her bit for saving environment, energy and money. Commonly, PCs and other IT equipment consume a great amount of electricity and have high carbon emission levels. Moreover, the utilization of green technology are especially designed to minimize power consumption (Zohoori et al., 2016).

As the name implies green technology is one which has a green

purpose. Furthermore, green inventions are environmentally friendly inventions which often include energy efficiency, recycling health and safety concerns, renewables and more. The world has its fixed amount of natural resources which some of them are already depleted or destroyed. For instance: electronics and household batteries often involve hazardous chemicals which can contaminate the groundwater after disposal, polluting soil and water with chemicals which cannot be eliminated from the potable water supply and food crops grown on polluted soil. Moreover, the risks on human health are tremendous. So, every investor needs to think green and know that green inventions and clean technology are such proper business as well as its growing markets with growing benefits. Besides, from the point of view of the consumers it should be known that purchasing green inventions can diminish their energy bills as well as safer and healthier products (Zohoori et al., 2016).

2. Literature review

2.1. Definition of Technology

The word technology is being used to refer to a collection of skills, methods, processes and techniques utilized in the production of goods and services or in achieving of the goals like scientific investigation. Besides, technology is the knowledge of how to combine the resources to produce the desirable products, to solve the difficulties, fulfill the needs, satisfied wants.

Furthermore, it involves technical methods, proficiency, techniques, tools, raw materials and etc, or it can be embedded in machines, computers, devices and factories, which can be operated by peoples without detailed knowledge of the working of such things. Currently, the state of technology is the application of science, arts and math for the profit of life as it is well-known technology (Monu Bhardwaj et al., 2015).

2.2. What Is Green Technology?

Clean or green technology is the improvement and application of equipment, systems and products utilized to save the natural environment and resources which minimize and decrease the adverse effect of human activities (Monu Bhardwaj et al., 2015). Green technology satisfy the following criteria:

- a) It minimizes the deterioration of the environment;
- b) It lowers greenhouse gases (GHG) emission to zero as well as its utilization is safe and finally it enhances healthy and improved environment for all forms of life.
- c) It saves the use of natural resources and energy.
- d) It enhances the utilization of renewables.

2.3. Categories of Green technology

Green technology covers a vast area of production and consumption technologies. The adoption and

utilization of green technology include the exploitation of environmental technology for monitoring and evaluating, pollution prevention, control, remediation and restoration. Furthermore, monitoring and evaluating of technology are used to measure and track the condition of the environment, involving the release of natural or anthropogenic materials of a detrimental nature.

Prevention technologies refrain the production of hazardous materials or change human activities in the ways which minimize damages to the environment. Moreover, it encompasses product substitution or redesign of a whole production process rather than utilizing new pieces of equipment. Besides, control technologies render hazardous materials harmless before entering the environment. Furthermore, remediation and restoration technologies embody techniques and methods designed to develop the condition of ecosystems, degraded through naturally induced or anthropogenic effects (Sanjukta Banerjee et al., 2014).

One of the most famous examples of green technology is solar cell. A solar cell directly transforms the energy into light or electricity through the process of photovoltaic. Besides, generating electricity from solar energy means reduction in consumption of fossil fuels and greenhouse gases emissions and less pollution. Moreover, another ordinary invention which can be seen

green is the reusable of water bottle. Naturally, drinking lots of water is healthful, so reduction in the amount of plastic waste is excellent for the environment and wildlife. Therefore, reusable water bottles which can be refilled are health-promoting, eco-friendly, and as well as green (Sanjukta Banerjee et al., 2014).

2.3.1. Energy

Perhaps development of alternative fuels, new means of generating energy and energy efficiency are the most instant matter for green technology. In addition, renewable energy involves efficiency technology, water management and water purification, recycling technology, sewage treatment and solid waste management. In accordance to the IEA, World Energy Outlook, the world's first energy supply has ascended by 58 percent in 25 years, from roughly 7.2 billion TOE (tons of oil equivalent) in 1980 to around 11.4 billion TOE in 2005. Table 1 demonstrates the perspective of world energy demand (Source: IEA World Energy; Outlook 2007, 2008).

Table 1, Perspective of World Energy Demand

Item / Y	Energy Demand (M ton)				
	1980	2000	2005	2015	2030
Total primary energy demand	7,223	10,034	11,429	14,121	17,014
Petroleum oil	3,107	3,649	4,000	4,525	5,109
Transport	1,245	1,936	2,011	2,637	3,171
Petroleum	1,187	1,844	1,895	2,450	2,915
Biofuels	2	10	19	74	118
Other fuels	57	82	96	113	137

Green building or sustainable design, is the practice of rising the efficiency which buildings and their sites utilize energy, water and materials and their decreasing impacts on human health and the environment for the whole lifecycle of a building. The concepts of green building expand beyond the walls of buildings and involve site planning, community and land-use planning issues as well. The rise of the communities has a huge impact on natural environment. Furthermore, the manufacturing, design, construction and operation of the buildings are responsible for the consumption of natural resources (<http://www.wncgbc.org/about/importance-of-green-building>).

Besides, green building contains everything from the choice of materials to where a building is located for instance: sustainable building material and building performance technology (Sanjukta Banerjee et al., 2014).

2.3.2.1. Environmental profits of green building:

- Improve and protect biodiversity and ecosystems
- Enhance air and water quality
- Diminish waste streams
- Conserve and retrieve natural resources

2.3.2.2. Economic benefits of green building:

- Decline operation costs
- Enhance occupant productivity

- Improve asset value and benefits

- Optimize the economic performance of life-cycle

2.3.2.3. Social benefits of green building:

- Boost occupant wellness and easement
- Elevate indoor air quality
- Minimize strain on local utility infrastructure
- Develop whole quality of life

2.3.3. Environmentally preferred purchasing

Innovation contains the survey for products in which contents and techniques of production have the slightest possible effect on the environment, and mandates which these be the preferred products for government purchasing (Sanjukta Banerjee et al., 2014).

Besides, in many areas like North America, green technology is becoming the quickest growing segment of the economy. In addition, the field of green technology includes many various products and services within different industries such as transportation, management of waste, agriculture, energy and water supply. However, all of these technologies have something in common and that is implementation with a diversity of industries, which

not only optimize the operational efficiency but also reduce the negative impact regarding environment. In fact, green technology is the best solution when it comes to sustaining the business segment. Here are four elementary business goals of green technology which assist different organizations to maximize their operations (<http://www.powerhousegrowers.com/4-business-goals-of-green-technology/>).

2.3.3.1. Business goals of green technology

2.3.3.1.1. Sustainability Goals

The systematic shift from short-term gain which deteriorates natural resources to the long-term prosperity of future generations. This kind of shift is mindset for a lot of organizations.

2.3.3.1.2. Product Life Cycle Goals

Especially depending to manufacturers, performing life cycle evaluations finishes the “cradle to grave” cycle of production. Besides, products can be manufactured utilizing a life cycle evaluation to ascertain cradle to cradle cycles whereby products can be reused at the end of their life.

2.3.3.1.3. Product Efficiency Goals

Decreasing the pollution, waste and resources consumption which takes place during the manufacturing process at many various stages. This may contain post-production efficiency for instance diminishing impacts of shipping as well.

2.3.3.1.4. Closed-Loop Innovation

The whole technology controlled “smart systems” monitor consumption of resources and management of waste, while accounting for metrics which otherwise would never have been contained.

2.3.4. Green-chemistry

Green chemistry is called sustainable chemistry as well. Besides, it is a philosophy of chemical research and engineering which encourages the design of products and processes which minimize the utilization and generation of hazardous materials. Moreover, in 1990 the Pollution Prevention Act was passed in United States. In addition, this act assisted to create a modus operandi for dealing with pollution in an original and innovative way. Besides, it aims to refrain difficulties prior they take place. Moreover, green chemistry applies to organic chemistry, inorganic chemistry, biochemistry, analytical chemistry and even

physical chemistry. (Ghanshyam Das Soni 2015).

2.3.5. Green-nanotechnology

Nanotechnology includes the manipulation of matters at the scale of the nanometer which is one billionth of a meter. There are some researchers who believe that mastery of this issue is forthcoming which will convert the method which everything in the world is manufactured.

"Green-nanotechnology" is the application of green engineering and chemistry to this field (Ghanshyam Das Soni 2015).

3. Significance Green Technology

Green technology is an environmentally friendly technology which is improved and utilized in a way which conserves the environment and protects natural resources. The significance of green technology can't be ignored especially the part pertains to humanity. Besides, going green is the only option to help humanity come out of the current strict situation. Therefore, before the things turn for the worst, it is indispensable to realize the significance of green technology to solve the problems.

(www.ajcebeats.com/the-importance-of-green-technology/).

4. Goals of Green Technology

The aims of green technology are myriads. The major objective of green technology is to meet the needs of society in ways without damaging or depleting natural resources on the planet. In addition, the opinion is to meet the present needs without making any compromise. Besides, it is required to find the right destination to get all about the goals of this kind of technology. The concentration of green technology is to make products which can be fully reclaimed or reused. In addition, steps are being taken to decrease wastes and pollution as one of the most indispensable aims of green technology via changing patterns of production and consumption. Moreover, it is necessary to improve alternative technologies to hamper any further damage to environment and health. The solution is precipitation in the implementation of these kind of technologies to benefit and protect the earth. The important goals of green technology introduce sustainable living, develop renewable energy, decrease

production of waste, conserve the utilization of natural resources, creation of products which are reusable and recyclable, and inventing alternatives to the practices which adversely affect the human and environment (Monu Bhardwaj et al., 2015).

5. From Sustainability to Greenability

Sustainability is commonly considered from three dimensions including the social, the economic and the environmental which is provided by the United Nation (Coral Calero et al., 2015), IEEE (2014). As shown in figure 1, the third dimension is called green.

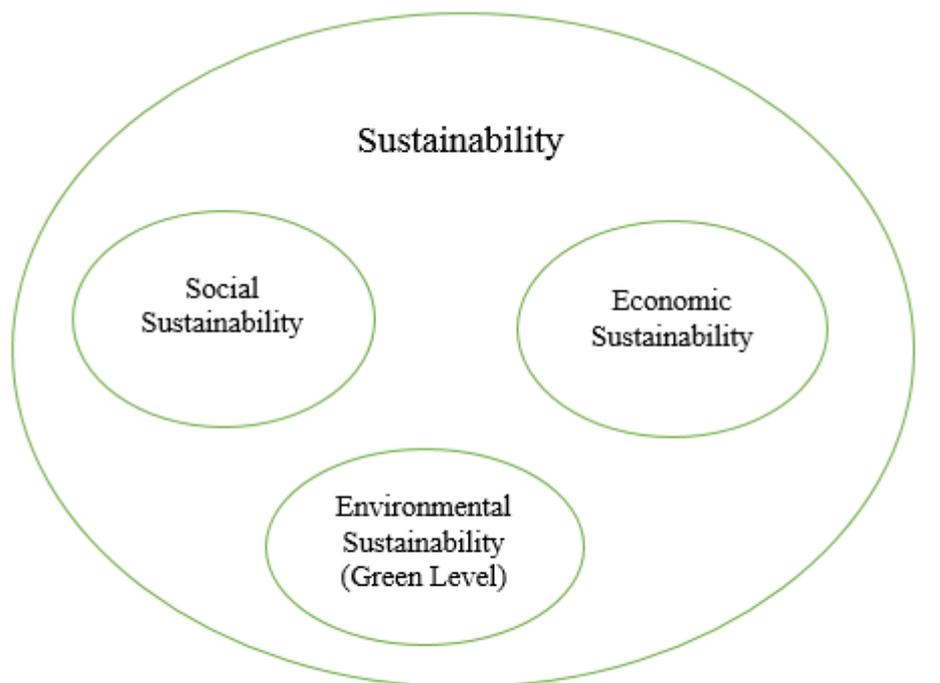


Figure 1: Sustainability dimensions

6. Challenges to Green Technology Adoption

In general, green technology is more expensive than the technology it aims to sub, because it accounts for the environmental costs which have externalized in many conventional production processes. This is a novel technology and there is many things in it which is unknown. In addition, the associated improvement and training costs make it even more costly in comparison with other established technologies. The perceived profits regarding this technology are also pertain to other factors for instance supporting infrastructure, technology readiness, human resource capabilities and geographic elements. Adoption and circulation of these technologies can be limited by a number of other obstacles. Some may be institutional like the lack of an appropriate regulatory framework, and others can be technological, financial, political, cultural or legal in nature. Besides, from company's view, the barriers to adopting green technology are high implementing costs, lack of data and information, no or lack of alternative chemical or raw material inputs, uncertainty regarding performance impacts, lack of human resources and finally, lack of skilled personnel. In addition, overcoming these barriers is a complicated process. Promoting green growth needs

identifying and removing these obstacles which prevent the large-scale dissemination of clean technology to improve countries (Ghanshyam Das Soni 2015).

7. Strengths from adopting green technology

- Ability to meet rigid product specifications in foreign markets: Manufacturers in developing countries generally require to meet more stringent environmental specifications and requirements to export their commodities to developed and industrialized countries and vice versa. The adoption of green technology may help exporting companies to achieve advantage and market share over competitors.
- Rebate of input costs: Green technology can develop production efficiency through the reduction for input costs, energy costs and maintenance and operating costs which can develop a company's competitive position
- Environmental image: adoption of green technology can enhance a company's environmental reputation which is essential if other rivals and consumers are becoming more environmentally conscious.
- Ability to meet more stringent environmental regulations in the future: companies which invest in green technology are more likely to be better equipped and ready for rigid environmental regulations as well as commodity specifications

which are expected to be imposed on them in the future.

8. Advantages of Green Processes and Technology

1. Does not release anything detrimental into atmosphere
2. Bring economic profits to certain areas
3. Need less maintenance
4. It is renewable which means will never run out
5. Slow the impacts of global warming by reducing CO₂ emissions

The advantage of using green energy sources is that it must be clean therefore there is no discharge or damage into the environment or atmosphere. Besides, it is also replenishable in contrast to oil. In addition, green energy facilities are difficult on the pocketbook to build, it demands a lesser amount of upkeep thus it lacks to spend some huge cash to work it. Moreover, this may also create economic advantages to some particular areas and even develop tourism industry. Even while these seem excellent, there are a few who believe there exists profits to use such technology.

Establishing these facilities additionally needs plenty of land so we might have to cut on farmland which explains what many are worried about if more wind generators have to be set up. A second negative aspect is the fact many of the green energy sources cannot really be installed in specific

places of the earth. As an example, wave energy can only be made use of if the waves from the sea attain at the least 16 feet. The utilization of geothermal energy only works in geologically unstable areas of the planet. But if we look at these kinds of arguments, areas that can't utilize one method of green energy source could be replaced for another.

If wind generators demand more room or space, they could be set up in the proximity of the coastline instead of positioning these on land. A study reveals you could get more electric power while these happen to be in the sea. As the weather is something we are not able to regulate, it is far from every day that there's a weather disruption so this too shall pass. If solar energy is being utilized and the sun is covered, the emergency generators will be stimulated and utilize up the power that was saved. Presently there exist ways around the misunderstandings put by a number of people which discourage the usage of green energy sources.

In truth, research is constant to try to use other means to generate the electrical power we need. A good example of this is known as ocean thermal energy. Energy is created by harnessing the diverse temperatures within the water. It is now being employed on a small scale both in Japan and Hawaii. In America, only 7% of green energy sources are used across the country. This was much higher 11 years ago and if we don't are limited to the money necessary

for oil or even reduce our dependency on it, we must invest more in this clean energy. We can get it from green energy sources such as biomass, biodiesel, geothermal, solar, water and the wind. These are things just about everyone has around us and all it takes is for another person to harness it as a substitute for depending on traditional nonrenewable means to turn out energy (Sanjukta Banerjee et al., 2014).

9. Disadvantages of Green Processes and Technology

Green processes and technology refers to making efforts to improve energy efficiency or reduce the pollution produced by your home, business and general living habits. The main purpose of this kind of processes and technology is to reduce the potential negative impact that energy consumption and pollution can have on the environment. While environmentally friendly living is a positive ideal, there are several possible disadvantages of Green processes and technology such as: high implementing costs, lack of information, no known alternative chemical or raw material inputs, no known alternative process technology, uncertainty about performance impacts, and lack of human resources and skills (Recent Research in Science and Technology 2014, 6(1): 97-100 ISSN: 2076-5061 Available Online: <http://recent-science.com>).

9.1. Initial Costs

Perhaps the greatest disadvantage of going green is that it often requires a large initial cost. For example, installing a new roof or new insulation to keep heat from escaping your home would be considered a green home improvement, but it would cost a large sum of money to get the work done. Similarly, buying a hybrid vehicle that gets good gas mileage can reduce energy consumption, but hybrid vehicles often cost many thousands of dollars more than similar vehicles without hybrid technology. Upfront costs present a large deterrent to going green.

9.2. Inadequate Savings

The aim of going green in many cases, such as building an energy-efficient home or purchasing a hybrid vehicle, is to reduce environmental impact while saving money in the long term. Green buildings and vehicles tend to use less energy, so initial costs can often be recouped over time through energy savings. The problem is that the savings generated by going green are often less than expected; they do not make up for the initial cost quickly enough to make them economically viable.

9.3. Competition

In the business world, going green can be an attractive goal to gain goodwill and consumer support, but unless green improvements are economically viable, it can put a

business at a competitive disadvantage. For instance, if one company decides to adhere to strict, self-imposed pollution standards which require the installation of new technology and workers, while another sets loose standards, the second company will be at an advantage since they will have lower production costs. Even if national standards were imposed to force businesses to go green, this could put them at a competitive disadvantage with respect to foreign companies.

9.4. Marginal Impact

While going green is focused on reducing harm to the environment, the impact that any specific individual can have on the environment by going green is often negligible. The theory is that if everyone were to go green, it would have a significant and noticeable impact, but not everyone can be convinced to go green and many believe that doing so has no real impact outside of the economics. This makes going green a personal choice for many, which does not necessarily result in concrete economic or environmental benefits (<https://www.sapling.com/6182126/disadvantages-going-green>).

10. Conclusion

Consumers request for green technology productions is on sharp increase. Besides, government consumers are highly mandated to purchase green where is available, and the spectrum of the products by such provisions is on the rise. As for

business customers, if it is illustrate a return on investment in green products, then request will materialize. The greatest opportunities are in commodities which decrease energy consumption. Even so, a growing number of business purchasers can be expected to be motivated by nothing more than the desire to be perceived as supporting environmental sustainability. Thus, change is coming. The green in technology products is being installed in the R&D phase. Products are being reconfigured to use fewer hazardous substances, require less shipping material, operate on less energy and promote end-of-life recycling. So in terms of environmental sustainability, the technology industries are embracing change. They are changing to avoid negative consequences or to meet green demand or to achieve both. Whatever their motivation, they are incontrovertibly shifting toward green.

11. References

Al-Ali, A. R., Imran Zualkernan, and Fadi Aloul. "A mobile GPRS-sensors array for air pollution monitoring." *Sensors Journal*, IEEE 10.10 (2010): 1666-1671.

Bako-Biro, Zsolt. Human perception, SBS symptoms and performance of office work during exposure to air polluted by building materials and personal computers. Diss. Department for Mechanical Engineering, Technical University of Denmark, 2004.

Calero, Coral, and Mario Piattini. "Introduction to Green in software engineering." Green in Software Engineering. Springer International Publishing, 2015. 3-27.

(<http://www.powerhousegrowers.com/4-business-goals-of-green-technology/>)

(<http://www.wncgbc.org/about/importance-of-green-building>)

IEA World Energy; Outlook 2007, 2008

IEEE (2014). SWEBOK V3.0. Guide to the Software Engineering Body of Knowledge. Bourque, P. and Fairley, R.E. (eds.), IEEE Computer Society.

Mahmood Zohoori, Samaneh Falaki., "Relationship between Information System Components, Trust, and User Satisfaction in terms of Using Green Processes and Technology" International Journal of Science and Engineering Applications (IJSEA) (Volume 5, Issue 7 September 2016).

Monu Bhardwaj et al. "The Advantages and Disadvantages of

Green Technology" Journal of Basic and Applied Engineering Research, Volume 2, Issue 22; October-December, 2015: pp. 1957-1960.

Ravali, K., and P. Ashok Kumar. "Techno-Pollution." Computer 1.4 (2011): 1416-1420.

(Recent Research in Science and Technology 2014, 6(1): 97-100 ISSN: 2076-5061 Available Online: <http://recent-science.com>).

Sanjukta Banerjee et al. "Advantages of green technology" Recent Research in Science and Technology 2014, 6(1): 97-100.

Soni, Ghanshyam Das. "ADVANTAGES OF GREEN TECHNOLOGY." Social Issues and Environmental Problems, Vol.3 (Iss.9:SE): Sep, 2015] ISSN- 2350-0530(O) ISSN- 2394-3629(P).

(<https://www.sapling.com/6182126/disadvantages-going-green>).

(www.ajcebeats.com/the-importance-of-green-technology/)

Modeling a Three-axle Truck and Vibration Analysis under Sinusoidal Road Surface Excitation

Seyed Mohammad Javad Zeidi
PhD Candidate, Department of
Mechanical and Aerospace
Engineering, University of
Florida
Gainseville, USA

Pedram Hoseini
MSc candidate, Department of
Mechanical Engineering,
Amirkabir University of
Technology
Tehran, Iran

Ali Rahmani
Assistant professor at Shahid
Rajaei University
Department of Mechanical
Engineering
Tehran, Iran

Abstract: In this research, ride quality of a multi-degree of freedom 3-axle rigid truck is investigated to understand its vibration specifications. The truck is a Benz 2624 model. The system is considered for an off-road duty. Current research concentrates on the modeling and simulating the truck. The linear model indicates cab and seat suspensions, rigid live axles, and suspension geometries. The Lagrange's equation is used to obtain the motion equations and system matrices, and the numerical central difference method is utilized to obtain the system responses subject to sinusoidal road excitations. Since physical parameters of the vehicle were not available, the truck is modeled in Solidworks CAD software to obtain the dynamic properties of its components. Then, a code is developed in MATLAB to calculate system time responses under different cases for the truck moving in high speed. The developed model can also be used in newer truck with some modifications. It is also necessary to have accurate information for input data in order to change the current model.

Keywords: Vibration analysis, Lagrange equations, System response, Multi-axles truck.

1. INTRODUCTION

Nowadays modeling plays an important role in engineering design in various fields of engineering such as civil, materials and mechanical engineering [1-22]. Vibration modeling and analyzing is one of the application of modeling in mechanical engineering in order to enhance the design of products, e.g. aerospace [23-25], automobile and transportation [26-27]. The most common goal is identification and suppression of unwanted vibration to improve product quality. For instance, Cellular materials such as aluminum foams can be employed to dissipate vibration in vehicles. Multi-axle truck is a real world example, which requires its vibration breakdown.

Interaction between vehicles wheels and road surface causes a dynamic excitation. The vehicle speed and the elevation of the road surface unevenness causes different vibration levels [9]. Heavy vehicles are found to produce the most perceptible vibrations. The vehicle models are consisted of discrete masses, springs, friction elements and dampers which are used to describe the dynamic behavior of vehicle [10-13, 28]. When a linear model of vehicle is used, by utilizing Frequency Response Functions the calculation of axle loads is facilitated [10, 11]. Local road unevenness is expressed by a deterministic function that shows the deviation of the travelled surface from a true planar surface. Global road unevenness can also be expressed in a stochastic way by use of a Power Spectral Density [29-34].

Many models such as quarter, bicycle, half and full models of vehicle with different numbers of DoF have been investigated in vehicle dynamics [35-38]. One of the most famous models for vehicles is eight-DoF model, including forward, lateral, yaw and rolling motion plus, four degree of freedom for travel of each wheel [39-40]. Multibody system dynamic models of vehicles have also been proposed in the literature. For instance, Rahmani Hanzaki et al. proposed a methodology for dynamic analysis of a multibody system with spherical joints. They considered a suspension system of a vehicle as an

example for that [41]. Applying this methodology on a three-axle truck complicates the calculation. Hence, other discrete models were employed for these trucks. For example, Tabatabaee developed a 16-DoF non-linear model for an articulated vehicle, which is validated experimentally [42]. It is also possible to reduce air pollutants specially CO₂ by acquisition of developed model by optimizing several components in the truck similar to the work done for the other systems which were successful. This paper presents a survey on the equations of motion utilizing Lagrange equations to determine system responses subject to sinusoidal road excitations of a complete 3-D rigid three-axle truck model, i.e., Benz 2624 model. This analysis is helpful for better understanding of the coupled motions of the wheels. The validation of our equations have been verified with ADAMS in our previous work [43]. The developed 19 DoF model can also be applied on many trucks by changing material properties and adding estimations. Previous defined equations has also been very useful in the current paper. Mathematical model which was developed and derived by Zeidi et al. is used during the current mathematical modeling and code writing in MATLAB [44-50].

2. MODELING THE THREE-AXLE TRUCK

Using experimental techniques to obtain mass properties of the components of a manufactured vehicle is reasonable but very costly; hence, in this work, Solidworks software is employed to model a three-axle truck and to find masses, centers of mass, moments of inertia etc. These physical properties are highly necessary for dynamic simulation of the truck. Figures 1 and 2 show two views of the assembled model of the truck, and some components of the truck, respectively. In this part, the weighty components of the truck such as chassis, tires, differentials, cabin, springs etc. are

modeled precisely. Non homogeneous material is assigned to this model since different material was utilized in the current model and it was very important to have a very precise model.

Blue springs are considered on behalf of tires, red springs as leaf springs of the suspensions systems. Green springs are counted for connecting cabin to the frame and finally, purple spring is used to suspend driver's seat with respect to the cabin. As the rests, W ,

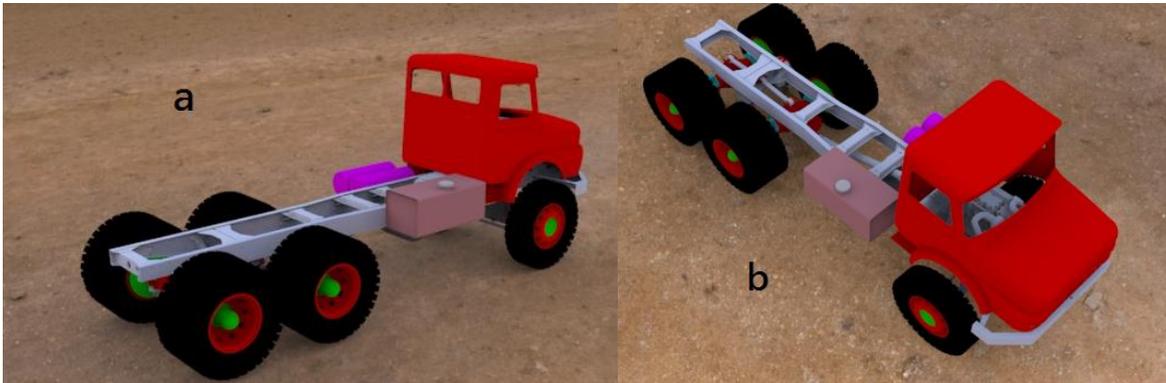


Figure 1. Two views of the CAD model from the three-axle truck;

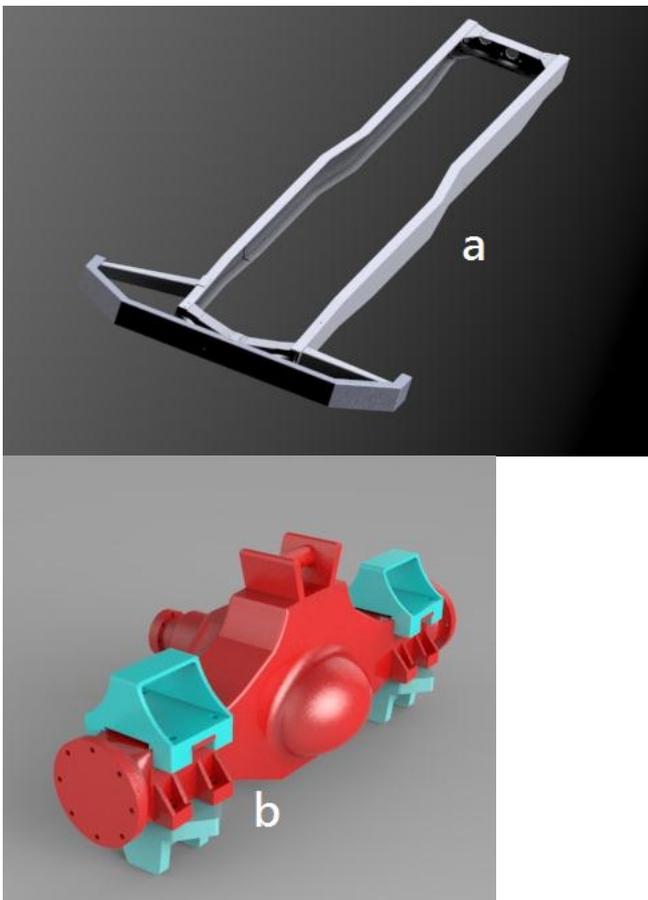


Figure 2. CAD models of two main components of the truck; a) chassis, b) axle with differential

3. GOVERNING EQUATIONS

Lagrange method is utilized to determine dynamic behavior of the mentioned three-axle truck. The truck is considered as a 19-DoF mathematical model. As shown in Figure 3. M_1 , M_2 and M_3 are the axles of the truck.

θ , and φ illustrate displacement, roll, and pitch of the truck in this dynamic analysis. Hence, the 19 DoFs are as follow:

- Driver seat bounce, one degree; w_{106} ;
- Cab bounce, pitch and roll, three degrees; orderly w_{104} , θ_{104} , φ_{104} ;
- Chassis bounce (sprung mass), pitch and roll, three degrees; w_{100} , φ_{100} , θ_{100} , respectively;
- Front axle, its bounce and roll, two degrees; orderly w_{101} , θ_{101} ;
- Intermediate axle, bounce and roll, two degrees; orderly w_{102} , θ_{102} ;
- Rear axle, bounce and roll, two degrees; orderly w_{103} , θ_{103} ;
- 6 bounce motion of the 6 wheels; w_1 , w_2 , w_3 , w_4 , w_5 , w_6 ; where w_1 and w_2 are the bounce of left and right steer wheels, respectively; w_3 and w_4 are the bounce of left and right wheels of the middle axle, correspondingly; w_5 and w_6 are the bounce of left and right wheels of rear axle, respectively.

The vector of coordinates for the vehicle is written as:

$$W_{19} = [w_{106} \ w_{104} \ \theta_{104} \ \varphi_{104} \ w_{100} \ \theta_{100} \ \varphi_{100} \ w_{101} \ \theta_{101} \ w_{102} \ \theta_{102} \ w_{103} \ \theta_{103} \ w_1 \ w_2 \ w_3 \ w_4 \ w_5 \ w_6]^T \quad (1)$$

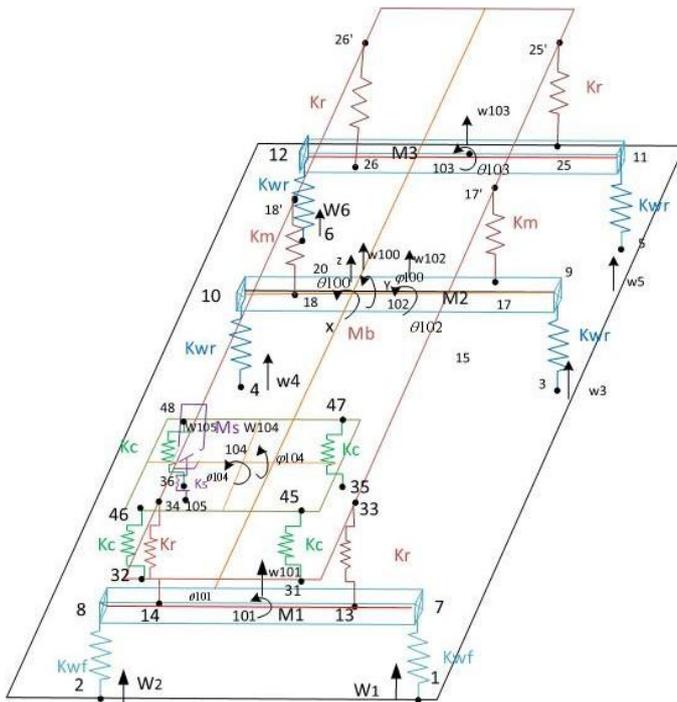


Figure 3. The scheme of the 19-DoF model for the truck

Figure 4(a) shows truck model in X-Z plane and distances between different important points. In addition, Figure 4(b) indicates the model in Y-Z plane and the related parameters.

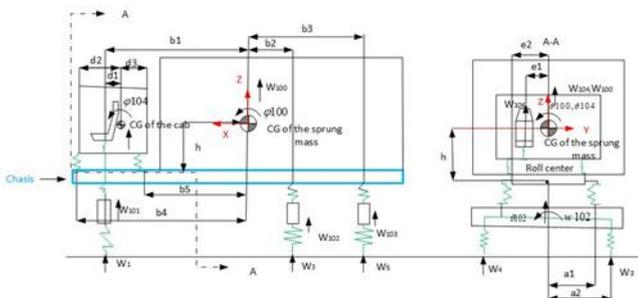


Figure 4. CGs (Center of gravity) and other essential distances of the model

4. EQUATIONS OF MOTION

The Lagrange equation is well-known in the following form for this system:

$$\frac{d}{dt} \left(\frac{dT}{d\dot{w}_{19}} \right) - \left(\frac{dT}{dw_{19}} \right) + \left(\frac{dP}{dw_{19}} \right) + \left(\frac{dR}{d\dot{w}_{19}} \right) = 0 \quad (2)$$

where T, P and R are the kinematic, potential and dissipation energies of the system, respectively.

The kinetic energy of the system is as follow:

$$T = \frac{1}{2} M_s (\dot{w}106)^2 + \frac{1}{2} M_c (\dot{w}104)^2 + \frac{1}{2} M_b (\dot{w}100)^2 + \frac{1}{2} M_1 (\dot{w}101)^2 + \frac{1}{2} M_2 (\dot{w}102)^2 + \frac{1}{2} M_3 (\dot{w}103)^2 + \frac{1}{2} I_{cx} (\dot{\theta}104)^2 + \frac{1}{2} I_{bx} (\dot{\theta}100)^2 + \frac{1}{2} I_{1x} (\dot{\theta}101)^2 + \frac{1}{2} I_{2x} (\dot{\theta}102)^2 + \frac{1}{2} I_{3x} (\dot{\theta}103)^2 + \frac{1}{2} I_{cy} (\dot{\theta}104)^2 + \frac{1}{2} I_{by} (\dot{\theta}100)^2 \quad (3)$$

Moreover, the potential energy of the system is obtained as:

$$P = \frac{1}{2} K_s (W106 - W105)^2 + \frac{1}{2} K_c (W45 - W31)^2 + \frac{1}{2} K_c (W46 - W32)^2 + \frac{1}{2} K_c (W47 - W35)^2 + \frac{1}{2} K_c (W48 - W36)^2 + \frac{1}{2} K_f (W33 - W13)^2 + \frac{1}{2} K_f (W34 - W14)^2 + \frac{1}{2} K_m (W17 - W17)^2 + \frac{1}{2} K_m (W18 - W18)^2 + \frac{1}{2} K_r (W25 - W25)^2 + \frac{1}{2} K_r (W26 - W26)^2 + \frac{1}{2} K_{wf} (W7 - W1)^2 + \frac{1}{2} K_{wf} (W8 - W2)^2 + \frac{1}{2} K_{wr} (W9 - W3)^2 + \frac{1}{2} K_{wr} (W10 - W4)^2 + \frac{1}{2} K_{wr} (W11 - W5)^2 + \frac{1}{2} K_{wr} (W12 - W6)^2 \quad (4)$$

And the dissipation energy of the system is:

$$R = \frac{1}{2} c_s (\dot{W}106 - \dot{W}105)^2 + \frac{1}{2} c_{c1} (\dot{W}45 - \dot{W}31)^2 + \frac{1}{2} c_{c2} (\dot{W}46 - \dot{W}32)^2 + \frac{1}{2} c_{c3} (\dot{W}47 - \dot{W}35)^2 + \frac{1}{2} c_{c4} (\dot{W}48 - \dot{W}36)^2 + \frac{1}{2} c_1 (\dot{W}33 - \dot{W}13)^2 + \frac{1}{2} c_2 (\dot{W}34 - \dot{W}14)^2 + \frac{1}{2} c_{e3} (\dot{W}17 - \dot{W}17)^2 + \frac{1}{2} c_{e4} (\dot{W}18 - \dot{W}18)^2 + \frac{1}{2} c_{e5} (\dot{W}25 - \dot{W}25)^2 + \frac{1}{2} c_{e6} (\dot{W}26 - \dot{W}26)^2 \quad (5)$$

By differentiating of T, P and R with respect to the coordinates and time according to eq. (2), equations of motion can be organized as:

$$M \cdot \ddot{W} + C \cdot \dot{W} + K \cdot W = 0 \quad (6)$$

In which M_{19} , K_{19} and C_{19} are orderly mass matrix, stiffness matrix and damping matrix of the 19 DoF of the truck-poster system model. In this equation, \ddot{W}_{19} , \dot{W}_{19} and W_{19} are acceleration vector, velocity vector and displacement vector of the 19 DoF truck-poster system model. In addition, system mass matrix, M_{19} which is a diagonal matrix, is calculated as follow:

$$M_{19} = \text{diag}[M_s \ M_c \ I_{cx} \ I_{cy} \ M_b \ I_{bx} \ I_{by} \ M_1 \ I_{1x} \ M_2 \ I_{2x} \ M_3 \ I_{3x} \ M_{01} \ M_{02} \ M_{03} \ M_{04} \ M_{05} \ M_{06}] \ C_{c4} \cdot d_3 \cdot e_2$$

Where, “diag” illustrates that the M_{19} is a diagonal matrix and M_s to M_{06} are located on the main diagonal of the matrix. In this relation, M_s and M_c are masses of the seat and the driver, and the cab, respectively; I_{cx} and I_{cy} are inertia of the cab about X and Y axes, correspondingly. In the following, M_b , I_{bx} , and I_{by} point to sprung mass, inertia of the sprung mass about X and Y axes, respectively; Also, 1, 2, and 3 as the indexes in order point to the front axle, middle axle, and the rear axle of the truck. Similarly, M_{01} to M_{06} indicate the masses of the front left to rear right wheels, as well. The 19 nonzero values have been obtained from the truck model in Solidworks software utilizing mass properties. Now, the system damping matrix and stiffness matrix can be written in the following form:

$$C_{19} = \begin{bmatrix} C_{1,1} & C_{1,2} & \dots & C_{1,19} \\ C_{2,1} & C_{2,2} & \dots & C_{2,19} \\ \vdots & \vdots & \ddots & \vdots \\ C_{19,1} & C_{19,2} & \dots & C_{19,19} \end{bmatrix}, \quad K_{19} = \begin{bmatrix} K_{1,1} & K_{1,2} & \dots & K_{1,19} \\ K_{2,1} & K_{2,2} & \dots & K_{2,19} \\ \vdots & \vdots & \ddots & \vdots \\ K_{19,1} & K_{19,2} & \dots & K_{19,19} \end{bmatrix}$$

The non-zero components of C_{19} and K_{19} are as follows:

$$C_{1,1} = C_s, \ C_{1,2} = C_{2,1} = -C_s, \ C_{1,3} = C_{3,1} = C_s \cdot e_1, \ C_{1,4} = C_{4,1} = C_s \cdot d_1$$

$$C_{2,2} = C_s + C_{c1} + C_{c2} + C_{c3} + C_{c4},$$

$$C_{2,3} = C_{3,2} = -C_s \cdot e_1 + C_{c1} \cdot e_2 - C_{c2} \cdot e_2 + C_{c3} \cdot e_2 - C_{c4} \cdot e_2$$

$$C_{2,4} = C_{4,2} = -C_s \cdot d_1 - C_{c1} \cdot d_2 - C_{c4} \cdot C_2 \cdot d_2 + C_{c3} \cdot d_3 + C_{c4} \cdot d_3$$

$$C_{2,5} = C_{5,2} = -C_{c1} - C_{c2} - C_{c3} - C_{c4},$$

$$C_{2,6} = C_{6,2} = C_{3,5} = C_{5,3} = -C_{c1} \cdot e_2 + C_{c2} \cdot e_2 - C_{c3} \cdot e_2 + C_{c4} \cdot e_2$$

$$C_{2,7} = C_{7,2} = C_{c1} \cdot b_4 + C_{c2} \cdot b_4 + C_{c3} \cdot b_5 + C_{c4} \cdot b_5;$$

$$C_{3,3} = C_s \cdot e_1^2 + C_{c1} \cdot e_2^2 + C_{c2} \cdot e_2^2 + C_{c3} \cdot e_2^2 + C_{c4} \cdot e_2^2$$

$$C_{3,4} = C_{4,3} = C_s \cdot d_1 \cdot e_1 - C_{c1} \cdot d_2 \cdot e_2 +$$

$$C_{3,6} = C_{6,3} = -C_{c1} \cdot e_2^2 - C_{c2} \cdot e_2^2 - C_{c3} \cdot e_2^2 - C_{c4} \cdot e_2^2$$

$$C_{3,7} = C_{7,3} = C_{c1} \cdot b_4 \cdot e_2 - C_{c2} \cdot b_4 \cdot e_2 + C_{c3} \cdot b_5 \cdot e_2 - C_{c4} \cdot b_5 \cdot e_2$$

$$C_{4,4} = C_s \cdot d_1^2 + C_{c1} \cdot d_2^2 + C_{c2} \cdot d_2^2 + C_{c3} \cdot d_3^2 + C_{c4} \cdot d_3^2$$

$$C_{4,5} = C_{5,4} = C_{c1} \cdot d_2 + C_{c2} \cdot d_2 - C_{c3} \cdot d_3 - C_{c4} \cdot d_3,$$

$$C_{4,6} = C_{6,4} = C_{c1} \cdot d_2 \cdot e_2 - C_{c2} \cdot d_2 \cdot e_2 - C_{c3} \cdot d_3 \cdot e_2 + C_{c4} \cdot d_3 \cdot e_2$$

$$C_{4,7} = C_{7,4} = -C_{c1} \cdot b_4 \cdot d_2 - C_{c2} \cdot b_4 \cdot d_2 + C_{c3} \cdot b_5 \cdot d_3 + C_{c4} \cdot b_5 \cdot d_3;$$

$$C_{5,5} = C_{c1} + C_{c2} + C_{c3} + C_{c4} + C_1 + C_2 + C_3 \cdot l_2^2/l_1 + C_4 \cdot l_2^2/l_1 + C_5 \cdot l_2^2/l_1 + C_6 \cdot l_2^2/l_1,$$

$$C_{5,6} = C_{6,5} = C_{c1} \cdot e_2 - C_{c2} \cdot e_2 + C_{c3} \cdot e_2 - C_{c4} \cdot e_2 + C_1 \cdot a_1 - C_2 \cdot a_1 + C_3 \cdot l_2^2/l_1 \cdot a_1 - C_4 \cdot l_2^2/l_1 \cdot a_1 + C_5 \cdot l_2^2/l_1 \cdot a_1 - C_6 \cdot l_2^2/l_1 \cdot a_1;$$

$$C_{5,7} = C_{7,5} = -C_{c1} \cdot b_4 - C_{c2} \cdot b_4 - C_{c3} \cdot b_5 - C_1 \cdot b_1 - C_2 \cdot b_1 + C_3 \cdot l_2^2/l_1 \cdot b_2 + C_4 \cdot l_2^2/l_1 \cdot b_2;$$

$$C_{5,8} = C_{8,5} = -C_1 - C_2,$$

$$C_{5,9} = C_{9,5} = C_{6,8} = C_{8,6} = -C_1 \cdot a_1 + C_2 \cdot a_1,$$

$$C_{5,10} = C_{10,5} = -C_3 \cdot l_2^2/l_1 - C_4 \cdot l_2^2/l_1;$$

$$C_{5,11} = C_{11,5} = C_{6,10} = C_{10,6} = -C_3 \cdot l_2^2/l_1 \cdot a_1 + C_4 \cdot l_2^2/l_1 \cdot a_1$$

$$C_{5,12} = C_{12,5} = C_{6,12} = C_{12,6} = -C_5 \cdot l_2^2/l_1 + C_6 \cdot l_2^2/l_1;$$

$$C_{5,13} = C_{13,5} = -C_5 \cdot l_2^2/l_1 \cdot a_1 + C_6 \cdot l_2^2/l_1 \cdot a_1, \\ C_{6,6} = C_{c1} \cdot e_2^2 + C_{c2} \cdot e_2^2 + C_{c3} \cdot e_2^2 + C_{c4} \cdot e_2^2 + C_1 \cdot a_1^2 + C_2 \cdot a_1^2 + C_3 \cdot l_2^2/l_1 \cdot a_1^2 + C_4 \cdot l_2^2/l_1 \cdot a_1^2 + C_5 \cdot l_2^2/l_1 \cdot a_1^2 + C_6 \cdot l_2^2/l_1 \cdot a_1^2;$$

$$C_{6,7} = C_{7,6} = -C_{c1} \cdot b_4 \cdot e_2 + C_{c2} \cdot b_4 \cdot e_2 - C_{c3} \cdot b_5 \cdot e_2 + C_{c4} \cdot b_5 \cdot e_2 - C_1 \cdot a_1 \cdot b_1 + C_2 \cdot a_1 \cdot b_1 + C_3 \cdot l_2^2/l_1 \cdot b_2 \cdot a_1 - C_4 \cdot l_2^2/l_1 \cdot b_2 \cdot a_1 + C_5 \cdot l_2^2/l_1 \cdot a_1 - C_6 \cdot l_2^2/l_1 \cdot a_1;$$

$$C_{6,9} = C_{9,6} = -C_1 \cdot a_1^2 - C_2 \cdot a_1^2, \\ C_{6,11} = C_{11,6} = -C_3 \cdot l_2^2/l_1 \cdot a_1^2 - C_4 \cdot l_2^2/l_1 \cdot a_1^2, \\ C_{6,13} = C_{13,6} = -C_5 \cdot l_2^2/l_1 \cdot a_1^2 - C_6 \cdot l_2^2/l_1 \cdot a_1^2,$$

$$C_{7,7} = C_{c1} \cdot b_4^2 + C_{c2} \cdot b_4^2 + C_{c3} \cdot b_5^2 + C_{c4} \cdot b_5^2 + C_1 \cdot b_1^2 + C_2 \cdot b_1^2 + C_3 \cdot l_2^2/l_1 \cdot b_2^2 + C_4 \cdot l_2^2/l_1 \cdot b_2^2 + C_5 \cdot l_2^2/l_1 \cdot b_3^2 + C_6 \cdot l_2^2/l_1 \cdot b_3^2;$$

$$C_{7,8} = C_{8,7} = C_1 \cdot b_1 + C_2 \cdot b_1, \\ C_{7,9} = C_{9,7} = C_1 \cdot a_1 \cdot b_1 - C_2 \cdot a_1 \cdot b_1, \\ C_{7,10} = C_{10,7} = -C_3 \cdot l_2^2/l_1 \cdot b_2 - C_4 \cdot l_2^2/l_1 \cdot b_2,$$

$$C_{7,11} = C_{11,7} = -C_3 \cdot l_2^2/l_1 \cdot b_2 \cdot a_1 + C_4 \cdot l_2^2/l_1 \cdot b_2 \cdot a_1, \\ C_{7,12} = C_{12,7} = -C_5 \cdot l_2^2/l_1 \cdot b_3 - C_6 \cdot l_2^2/l_1 \cdot b_3,$$

$$C_{7,13} = C_{13,7} = -C_5 \cdot l_2^2/l_1 \cdot b_3 \cdot a_1 + C_6 \cdot l_2^2/l_1 \cdot b_3 \cdot a_1, \\ C_{8,8} = C_1 + C_2, C_{8,9} = C_{9,8} = C_1 \cdot a_1 - C_2 \cdot a_1;$$

$$C_{9,9} = C_{9,8} = C_1 \cdot a_1^2 + C_2 \cdot a_1^2, \\ C_{10,10} = C_3 \cdot l_2^2/l_1 + C_4 \cdot l_2^2/l_1, C_{10,11} = C_{11,10} = C_3 \cdot l_2^2/l_1 \cdot a_1 - C_4 \cdot l_2^2/l_1 \cdot a_1;$$

$$C_{11,11} = C_3 \cdot l_2^2/l_1 \cdot a_1^2 + C_4 \cdot l_2^2/l_1 \cdot a_1^2, \\ C_{12,12} = C_5 \cdot l_2^2/l_1 + C_6 \cdot l_2^2/l_1, \\ C_{12,13} = C_{13,12} = C_5 \cdot l_2^2/l_1 \cdot a_1 - C_6 \cdot l_2^2/l_1 \cdot a_1$$

$$C_{13,13} = C_5 \cdot l_2^2/l_1 \cdot a_1^2 + C_6 \cdot l_2^2/l_1 \cdot a_1^2;$$

$$K_{1,1} = K_s, K_{1,2} = -K_s, K_{1,3} = K_s \cdot e_1, K_{1,4} = K_s \cdot d_1$$

;

$$K_{2,1} = -K_s, K_{2,2} = 4K_c + K_s, K_{2,3} = -K_s \cdot e_1, \\ K_{2,4} = K_c(2d_3 - 2d_2) - K_s \cdot d_1, K_{2,5} = -4K_c, \\ K_{2,7} = K_c(2b_5 + 2b_4);$$

$$K_{3,1} = K_s \cdot e_1, K_{3,2} = -K_s \cdot e_1, \\ K_{3,3} = 4K_c \cdot e_2^2 + K_s \cdot e_1^2, K_{3,4} = K_s \cdot e_1 \cdot d_1;$$

$$K_{4,1} = K_s \cdot d_1, \\ K_{4,2} = -K_s \cdot d_1 - 2K_c \cdot d_2 + 2K_{c3} \cdot d_3, \\ K_{4,3} = K_s \cdot d_1 \cdot e_1, \\ K_{4,4} = K_s \cdot d_1^2 + 2K_c(d_2^2 + d_3^2), \\ K_{4,5} = 2K_c(d_2 - d_3), K_{4,6} = -2K_c \cdot d_3 \cdot e_2, \\ K_{4,7} = -2K_c \cdot d_2 \cdot b_4 + 2K_c \cdot d_3 \cdot b_5;$$

$$K_{5,2} = -4K_c, K_{5,4} = -2K_c \cdot d_3 \\ K_{5,5} = 2K_f + 2K_m + 2K_r + 4K_c, \\ K_{5,6} = 2(K_f + K_m + K_r) \cdot a_1 + 2K_c \cdot e_2, \\ K_{5,7} = -2K_f \cdot b_1 + 2K_m \cdot b_2 + 2K_r \cdot b_3 - 2K_c \cdot b_4, \\ K_{5,8} = -2K_f, K_{5,10} = -2K_m, K_{5,11} = 2K_m \cdot a_1 \\ K_{5,12} = -2K_r;$$

$$K_{6,2} = -2K_c \cdot e_2, K_{6,3} = -2K_c \cdot e_2^2, \\ K_{6,4} = -2K_c \cdot e_2 \cdot d_3, \\ K_{6,5} = 2(K_f + K_m + K_r) \cdot a_1 + 2K_c \cdot e_2, \\ K_{6,6} = 2(K_f + K_m + K_r) \cdot a_1^2 + 4K_c \cdot e_2^2, \\ K_{6,7} = -2K_f \cdot a_1 \cdot b_1 - 2K_m \cdot a_1 \cdot b_2 + 2K_r \cdot a_1 \cdot b_3 - 2K_c \cdot e_2 \cdot b_4 \\ K_{6,8} = -2K_f \cdot a_1, K_{6,12} = -2K_r \cdot a_1;$$

$$K_{7,2} = 4K_c \cdot b_4, K_{7,4} = -2K_c \cdot b_4 \cdot d_2 + 2K_c \cdot b_5 \cdot d_3, \\ K_{7,5} = -2K_f \cdot b_1 + 2K_m \cdot b_2 + 2K_r \cdot b_2 - 2K_c \cdot b_4 - 2K_c \cdot b_5 \\ K_{7,6} = -2K_f \cdot a_1 \cdot b_1 + 2K_m \cdot a_1 \cdot b_3 + 2K_c \cdot e_2 \cdot b_4, \\ K_{7,7} = 2K_f \cdot b_1^2 + 2K_m \cdot b_2^2 + 2K_r \cdot b_3^2 + 2K_c \cdot b_4^2 + 3K_c \cdot b_5^2 \\ K_{7,8} = 2K_f \cdot b_1, K_{7,10} = -2K_m \cdot b_2, \\ K_{7,11} = 2K_m \cdot b_2 \cdot a_1, K_{7,12} = -2K_r \cdot b_3;$$

$$K_{8,6} = -2K_f \cdot a_1, \quad K_{8,7} = 2K_f \cdot b_1,$$

$$K_{8,8} = 2K_f + 2K_{wf};$$

$$K_{9,9} = 2K_{wf} \cdot a_2^2 + 2K_1 \cdot a_1^2 \quad K_{9,14} = -K_{wf} \cdot a_2,$$

$$K_{9,15} = K_{wf} \cdot a_2;$$

$$K_{10,5} = -2K_m, \quad K_{10,6} = -2K_m \cdot a_1,$$

$$K_{10,7} = -2K_3 \cdot b_2, \quad K_{10,10} = 2K_{wr},$$

$$K_{10,11} = -2K_3 \cdot a_1, \quad K_{10,16} = -K_{wr},$$

$$K_{10,17} = -K_{wr};$$

$$K_{11,5} = 2K_m \cdot a_1, \quad K_{11,7} = 2K_m \cdot b_2 \cdot a_1,$$

$$K_{11,10} = -2K_m \cdot a_1,$$

$$K_{11,11} = 2K_m \cdot a_1^2 + 2K_{wr} \cdot a_2^2,$$

$$K_{11,16} = -K_{wr} \cdot a_2, K_{11,17} = K_{wr} \cdot a_2;$$

$$K_{12,5} = -2K_r, \quad K_{12,6} = -2K_5 \cdot a_1,$$

$$K_{12,7} = -2K_r \cdot b_3, \quad K_{12,12} = 2K_{wr},$$

$$K_{12,18} = -2K_{wr};$$

$$K_{13,13} = 2K_{wr} \cdot a_2^2 + 2K_5 \cdot a_1^2,$$

$$K_{13,18} = -K_{wr} \cdot a_2, K_{13,19} = -K_{wr} \cdot a_2;$$

$$K_{14,8} = -K_{wf}, K_{14,9} = -K_{wf} \cdot a_2, K_{14,14} = K_{wf};$$

$$K_{15,8} = -K_{wf}, K_{15,9} = K_{wf} \cdot a_2, K_{15,15} = K_{wf};$$

$$K_{16,10} = -K_{wr}, \quad K_{16,11} = -K_{wr} \cdot a_2,$$

$$K_{16,16} = K_{wr};$$

$$K_{17,10} = -K_{wr}, K_{17,11} = K_{wr} \cdot a_2, K_{17,17} = K_{wr};$$

$$K_{18,12} = -K_{wr}, K_{18,13} = K_{wr} \cdot a_2, K_{18,18} = K_{wr};$$

$$K_{19,12} = -K_{wr}, K_{19,13} = -K_{wr} \cdot a_2, K_{19,19} = K_{wr};$$

In which, C_s and K_s are the damping coefficient and stiffness of spring of driver seat; C_c and K_c are the damping and stiffness of each spring of cab suspension; C_1, C_2 are front suspension damping; C_{3-6} are the drive suspension coefficient; C_e is the effective damping coefficient of drive axle suspension; K_f is the stiffness of each spring of front axle suspension; K_m , and K_r are defined for stiffness of every spring for the middle axle and the rear axle, respectively; K_{wf} is also considered for the equivalent stiffness of each of the front tires, while K_{wr} plays the same role for the tires of middle

and rear wheels. Other variables and constants were illustrated in the previous sections.

The dynamic model developed here is 19 DoF which includes both the truck and 6 wheels. However, for analyzing under sinusoidal road surface excitation, the truck will be placed on the road. In this case, the motions of the 6 wheels is affected by the excitations of the road surface. Therefore, the 19 DoF model stiffness matrix and the proper model, simplifies to a 13 degrees of freedom system.

Let the excitations profile of road surface which applies to the wheels, be the sinusoid inputs as follow:

$$w_i = A_r \sin(\omega_{dr} t + \phi_i)$$

1,2, ...,6

(6)

$$\omega_{dr} = 2\pi \left(\frac{v}{L}\right)$$

(7)

Where A_r is road roughness magnitude in meter, ω_{dr} is drive frequency in rad/s, v is truck forward speed in m/s, L is Road surface wave length in meter and ϕ_i is the phase angle of the n th wheel in rad.

The equation of motion is:

$$M \cdot \ddot{W} + C \cdot \dot{W} + K \cdot W = f(t)$$

(8)

Where M is system mass matrix, C is damping matrix, K is stiffness matrix, \ddot{W} is acceleration vector, \dot{W} is velocity vector, W is displacement vector, all of the 13 DoF truck model and $f(t)$ is road excitation vector, which has the form of:

$$f(t) = \begin{bmatrix} 0 \\ \vdots \\ 0 \\ k_{w1} A_r \sin(\omega_{dr} t + \phi_1) + k_{w2} A_r \sin(\omega_{dr} t + \phi_2) \\ k_{w1} a_2 A_r \sin(\omega_{dr} t + \phi_1) - k_{w2} a_2 A_r \sin(\omega_{dr} t + \phi_2) \\ k_{w3} A_r \sin(\omega_{dr} t + \phi_3) + k_{w4} A_r \sin(\omega_{dr} t + \phi_4) \\ k_{w3} a_2 A_r \sin(\omega_{dr} t + \phi_3) - k_{w4} a_2 A_r \sin(\omega_{dr} t + \phi_4) \\ k_{w5} A_r \sin(\omega_{dr} t + \phi_5) + k_{w6} A_r \sin(\omega_{dr} t + \phi_6) \\ k_{w5} a_2 A_r \sin(\omega_{dr} t + \phi_5) - k_{w6} a_2 A_r \sin(\omega_{dr} t + \phi_6) \end{bmatrix}_{(13 \times 1)}$$

So as mentioned system matrices in Equation (8) is 13×13 and the vector G (gravity vector) does not appear

because the initial positions are chosen as the system equilibrium positions.

Central difference method has been used for numerical solution and dynamic simulation, as bellow:

$$\ddot{W} \approx \frac{W_{t+\Delta t} - 2W_t + W_{t-\Delta t}}{(\Delta t)^2}$$

$$\dot{W} \approx \frac{W_{t+\Delta t} - W_{t-\Delta t}}{2\Delta t}$$

(10)

The road profile that is used in the current simulation has a continuous sinusoidal variation as depicted in figure 5.

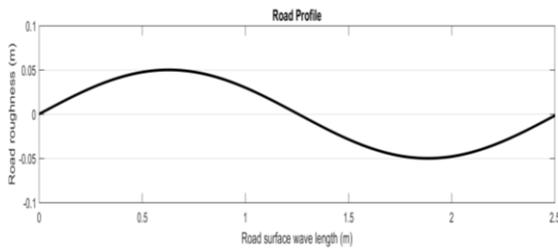


Figure 5. Profile of the road

In the current work, one drive frequency will be used to simulate a typical road condition. A high drive frequency is chosen which is 12 Hz. The phase angle ϕ is selected for two cases. The first case is that the left steer wheel and the right steer wheel have no phase difference which means $\phi_{12} = 0$ and the second case is that we have 90 degrees' phase lag for the right steer wheel compared to the left one and similarly this means that $\phi_{12} = \pi/2$. For comparison, the two phase angle cases are depicted in Figure 6.

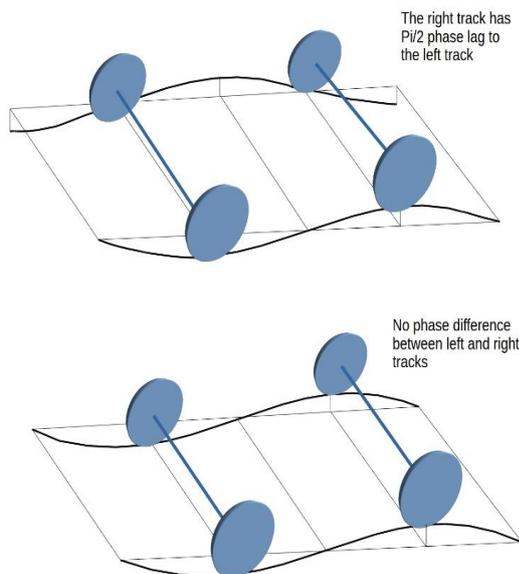


Figure 6. Excitation phase angle between the left and the right wheel for two cases

Subject to the assumed two phase angles, the phase angle of the nth wheel ϕ_n is described as following:

$$\begin{aligned} \phi_1 &= 0, \\ \phi_2 &= \phi_1 - \phi_{12}, \phi_3 = \phi_1 - \phi_{13}, \phi_4 = \phi_2 - \phi_{24} \\ \phi_5 &= \phi_1 - \phi_{15}, \phi_6 = \phi_2 - \phi_{26} \end{aligned}$$

Where $\phi_{12}, \phi_{13}, \dots$ are the phase angle difference between wheel 1 and 2, wheel 1 and 3, etc. As following:

$$\begin{aligned} \phi_{12} &= 0 \text{ or } \frac{\pi}{2} \text{ (depend on case of study);} \\ \phi_{13} &= \frac{2\pi(b_1+b_2)}{L}, \\ \phi_{15} &= \frac{2\pi(b_1+b_3)}{L}, \phi_{24} = \phi_{13}, \phi_{26} = \phi_{15} \end{aligned}$$

L is the road surface wave length in meter and b_1, b_2, b_3 are some geometric distance that can be seen in figure 4.

The drive frequency can be explained in two ways. For a specific road with a constant wave length of L, the higher drive frequency is the higher speed the running truck, while the lower drive frequency, means that the truck is running at a lower speed. Similarly, if we consider that the truck speed is constant, the higher drive frequency means that the road surface possesses short wavelength characteristics, while, the lower drive frequency means that the road surface possesses long wavelength characteristics. So, the explanation of simulation results is strongly related to conditions and assumptions of the simulation. In this paper, we have considered that the road wave length is fixed and the truck speed is set to a high value of 30m/s, and considering two different ϕ_n settings, gives us two cases in total, for both cases we have a high drive frequency, $A_r = 0.05m$ and $\omega_{dr} = 12Hz$, for case 1, ϕ_{12} is equal to zero and for case 2, ϕ_{12} is equal to $\pi/2$.

Finally, the simulation is performed by programming the equations in MATLAB software.

5. RESULTS

The following figures indicate the system time responses under two cases.

➤ Case 1:

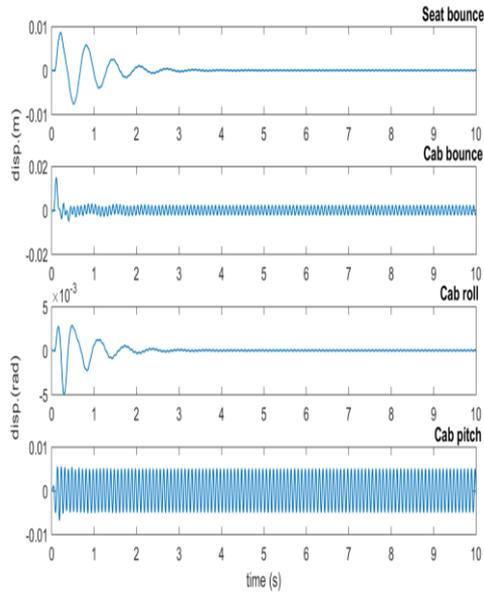


Figure 7. System time response for seat and cab in case 1

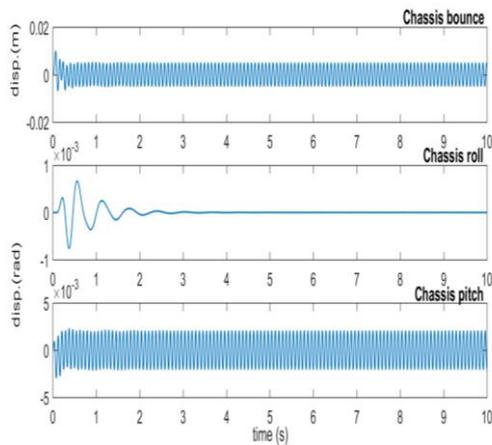


Figure 8. System time response for chassis in case 1

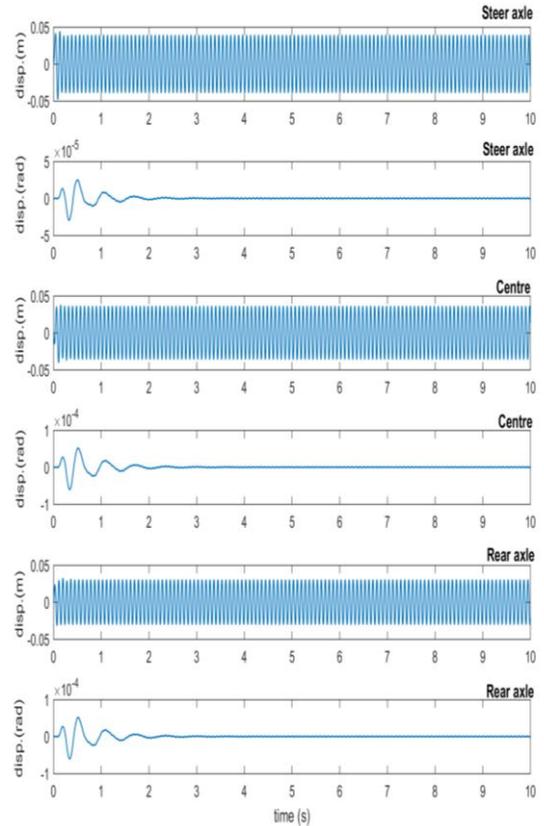


Figure 9. System time response for axles in case 1

In this case, the seat bounce and all of the roll DoFs take a relatively long time for settling to steady-state and hence shows a long transient state. However, the amplitudes of the roll motions are slight, this indicates insufficient damping especially about the roll axis.

➤ **Case 2:**

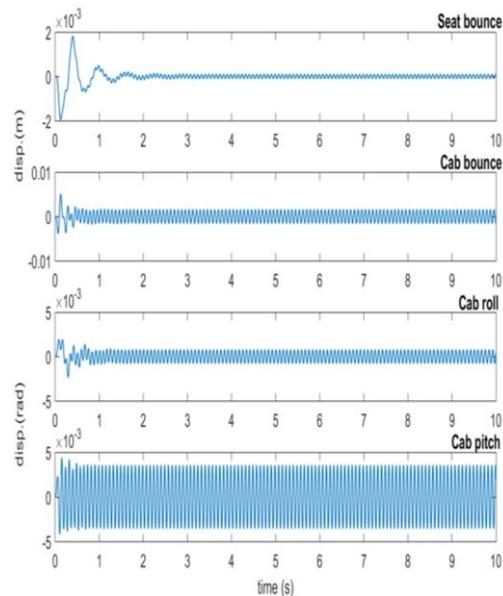


Figure 10. System time response for seat and cab in case 2

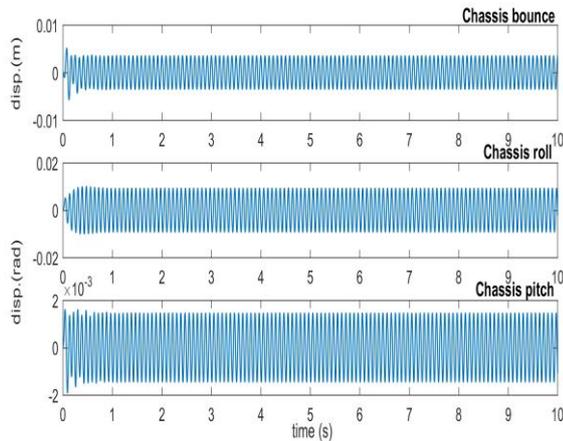


Figure 11. System time response for chassis in case 2

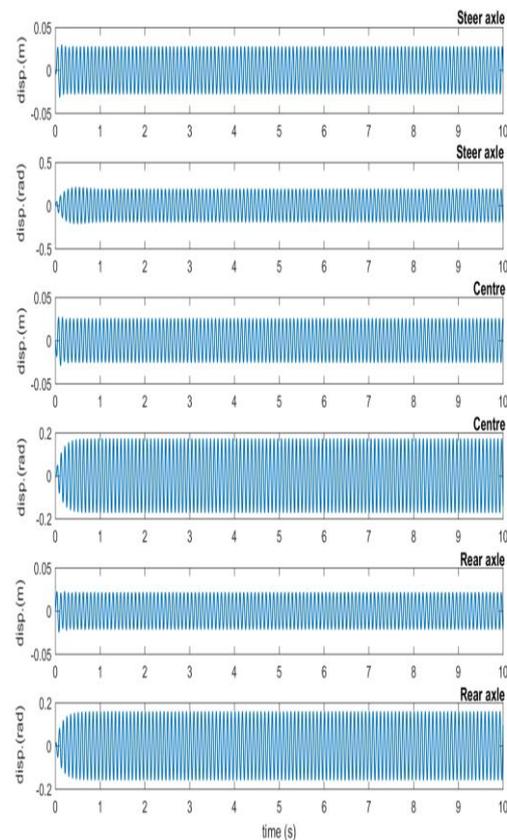


Figure 12. System time response for axles in case 2

In this case, the seat bounce, cab roll and chassis roll still have relatively long transient states. However, the 3 axles and the roll motions of the unsprung masses have been rapidly stabilized to the steady-state, because of the asymmetrical road excitations, it is clear that there are significant roll motions of the unsprung mass.

6. CONCLUSION

A 19-DoF system has been chosen in order to model a three-axle truck. Although this model, is a linear model, it has some unique features including the seat suspension, the cab suspension and the suspension geometry, which are vital for ride modeling of heavy vehicles but are often ignored. Physical properties of the truck are calculated using a model in Solidworks software. Lagrange equations are utilized for deriving equations of motion and the numerical central difference method is adopted to obtain the system responses subject to sinusoidal road excitations. Finally, system's time responses under two cases for the truck in high speed motion have been obtained, which are useful to know the vibrating component of the truck. Although some of them may only be effective to this particular truck model, they help better understanding the characteristics of this kind of vehicles and helps to understand the development of a more realistic nonlinear model.

7. REFERENCES

- [1] Kadkhodapour, J. and S. Raeisi, Micro-macro investigation of deformation and failure in closed-cell aluminum foams. *Computational Materials Science*, 2014. 83: p. 137-148.
- [2] Rahmani, A., Mirmohammadi, A., Zeidi SMJ, Shojaei, S., (2015). Numerical Approach toward Calculation of vibration Characteristics of the Multi Axles Truck Using Lagrange Method, *Journal of Modern Processes in Manufacturing and Production*, vol. 4(1), pp. 57-64.
- [3] Shojaei S., Zeidi SMJ, Rahmani, Mirmohammadi A., (2015). Analytical Analysis Approach to Study of the Vibration Characteristics of the Multi Axles Truck and its Validation. *Proceedings of the International Conference in New Research of Industry and Mechanical Engineering*.
- [4] Hamed, A., Malekmohammadi, I., Mansoori, A., & Roshanaei, H. (2012). Energy Dissipation in Stepped Spillway Equipped with Inclined Steps Together with End Sill. *Fourth International Conference on Computational Intelligence and Communication Networks*. IEEE.
- [5] Hamed, A., Fuentes, H.R. (2016). New Relationship between a Vertical Gate Opening and Downstream Flow Stability: Experimental Development. *World Environ. Water Resour. Congr*, pp. 47-57.
- [6] Hamed, A., Fuentes, H.R. (2015). Comparative Effectiveness and Reliability of NEXRAD Data to Predict Outlet Hydrographs Using the GSSHA and HEC-HMS Hydrologic Models. *World Environmental and Water Resources Congress*, pp. 1444-1453.
- [7] Hamed, A., Hajigholizadeh, M., & Mansoori, A. (2016). Flow Simulation and Energy Loss

- Estimation in the Nappe Flow Regime of Stepped Spillways with Inclined Steps and End Sill: A Numerical Approach. *Civil Engineering Journal*, 2(9), 426-437.
- [8] Hamed, A., Ketabdar, M. (2016). Energy Loss Estimation and Flow Simulation in the skimming flow Regime of Stepped Spillways with Inclined Steps and End Sill: A Numerical Model. *International Journal of Science and Engineering Applications*, 5(7), 399-407.
- [9] Ketabdar, M. Hamed, A. (2016). Intake Angle Optimization in 90-degree Converged Bends in the Presence of Floating Wooden Debris: Experimental Development. *Florida Civil Engineering Journal*, 2, 22-27.
- [10] Watts GR (1987) Traffic-induced ground-borne vibrations in dwellings. Research Report 102, Transport and Road Research Laboratory, Crowthorne, Berkshire
- [11] Hunt HEM (1991) Modelling of road vehicles for calculation of traffic-induced ground vibrations as a random process. *J Sound Vib* 144(1):41–51. doi:10.1016/0022-460X(91)90731-X
- [12] Cebon D (1993) Interaction between heavy vehicles and roads. Warrendale (USA): Society of Automotive Engineers, SP 951: ISBN: 1-56091-336-3
- [13] Mamlouk MS (1997) General outlook of pavement and vehicle dynamics. *J Transport Eng* 123(6): 515-517. ISSN: 0733-947X
- [14] Liu C, Herman R (1998) Road profiles, vehicle dynamics, and human judgement of serviceability of roads: spectral frequency domain analysis. *J Transport Eng* 124(2):106–111. doi:10.1061/(ASCE)0733-947X(1998)124:2(106)
- [15] Noghrehabadi, Aminreza, Ehsan Izadpanahi, and Mohammad Ghalambaz. "Analyze of fluid flow and heat transfer of nanofluids over a stretching sheet near the extrusion slit." *Computers & Fluids* 100 (2014): 227-236.
- [16] Ghalambaz, M., E. Izadpanahi, A. Noghrehabadi, and A. Chamkha. "Study of the boundary layer heat transfer of nanofluids over a stretching sheet: Passive control of nanoparticles at the surface." *Canadian Journal of Physics* 93, no. 7 (2014): 725-733.
- [17] Noghrehabadi, Aminreza, Mohammad Ghalambaz, Ehsan Izadpanahi, and Rashid Pourrajab. "Effect of magnetic field on the boundary layer flow, heat, and mass transfer of nanofluids over a stretching cylinder." *Journal of Heat and Mass Transfer Research (JHMTR)* 1, no. 1 (2014): 9-16.
- [18] Noghrehabadi, Aminreza, Rashid Pourrajab, and Ehsan Izadpanahi. "Similarity Solution of Boundary Layer Flow over a Nanofluid-Saturated Stretching Cylinder." *International Journal of Energy for a Clean Environment* 16.1-4 (2015).
- [19] Chamkha, A. J., Doostanidezfuli, A., Izadpanahi, E., & Ghalambaz, M. (2017). Phase-change heat transfer of single/hybrid nanoparticles-enhanced phase-change materials over a heated horizontal cylinder confined in a square cavity. *Advanced Powder Technology*, 28(2), 385-397.
- [20] Ghalambaz, M., Doostani, A., Izadpanahi, E., & Chamkha, A. J. (2017). Phase-change heat transfer in a cavity heated from below: The effect of utilizing single or hybrid nanoparticles as additives. *Journal of the Taiwan Institute of Chemical Engineers*, 72, 104-115.
- [21] Sheikholeslami, A. and L. Azizi, (2010). "Safety Analysis of Constructed U-turns in the City of Tehran", *Journal of Transportation Research* 7 (223), 167-184.
- [22] Azizi, L. and A. Sheikholeslami, (2013). "Safety effect of U-turn Conversions in Tehran: Empirical Bayes Observational Before and After Study and Crash Prediction Models", *Journal of Transportation Engineering* 139 (1), 101-108.
- [23] Sheikholeslami, A and L. Azizi, (2010) Observational Before-After Study of the Safety Effect of U-turns Conversions Using the Empirical Bayes Method, 15th International Conference on Road Safety CMRSC-XX
- [24] Mardanpour, P., Izadpanahi, E., Rastkar, S., & Hodges, D. H. (2017). Nonlinear Aeroelastic Gust Suppression and Engine Placement. *Journal of Aircraft*.
- [25] Mardanpour, P., E. Izadpanahi, S. Rastkar, and D. H. Hodges. "Effects of Engine Placement on Nonlinear Aeroelastic Gust Response of High-Aspect-Ratio Wings." In *AIAA Modeling and Simulation Technologies Conference*, p. 0576. 2017.
- [26] Mardanpour, P., E. Izadpanahi, S. Rastkar, S. A. Fazelzadeh, and D. H. Hodges. "Geometrically-exact, fully intrinsic analysis of pretwisted beams under distributed follower forces." In *58th AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference*, p. 1986. 2017.
- [27] Azizi, L., MS. Iqbal and M.Hadi,(2018), Estimation of Freeway Platooning Measures Using Surrogate Measures Based on Connected Vehicle Data, Presented at 97st Annual Meeting of Transportation Research Board, Washington DC.
- [28] Azizi, L., M.Hadi and Y.Xiao, (2018), Combination of Data from Multiple sources as Part of Dynamic Origin Destination Matrix Estimation (ODME) Process., *Transportmetrica A: Transport Science*.
- [29] Melcer J (2006) Vehicle-road interaction, analysis in a frequency domain. *Slovak J Civil Eng* 3: 48–52. ISSN: 1210-3896
- [30] Dodds CJ, Robson JD (1973) The description of road surface roughness. *J Sound Vib* 31(2):175–183. doi:10.1016/S0022-460X(73)80373-6
- [31] Wambold JC, Defrain LE, Hegmon RR, Macghee K, Reichert J, Spangler EB (1981) State of the art

- of measurement and analysis of road roughness. *Transport Res Rec* 836: 21–29. ISSN: 0361-1981
- [32] ISO 8608 (1995) Mechanical vibration, road surface profiles. Reporting of Measured Data
- [33] Andren P (2006) Power spectral density approximations of longitudinal road profiles. *Int J Veh Des* 40(1/2/3):2–14. doi:[10.1504/IJVD.2006.008450](https://doi.org/10.1504/IJVD.2006.008450)
- [34] Elson MJ, Bennet JM (1995) Calculation of the power spectral density from surface profile data. *Appl Opt* 34:201–208. doi:[10.1364/AO.34.000201](https://doi.org/10.1364/AO.34.000201)
- [35] Feng T, Yu-Fen H, Shun-Hsu T, Wes SJ (2006) Generation of random road profiles. *CSME: B04-001: 1373-1377*
- [36] Wong. J, Y., "Theory of ground vehicles". *John Wiley & Sons*, Canada. (2001)
- [37] Jazar, R., "Advanced Vibrations: A modern Approach", *Springer*, New York. (2013).
- [38] Jazar, R., "Vehicle Dynamics: Theory and Application", *Springer*, New York. (2010).
- [39] Gillespie, T, D., "Fundamentals of Vehicle Dynamics", *SAE publishing group*, United States of America. (1992).
- [40] Yang, X., Zengcai, W., Weili, P., "Coordinated Control of AFS and DYC for Vehicle Handling and Stability Based on Optimal Guaranteed Cost Theory," *Vehicle System Dynamics*, 47, pp. 57-79 (2009).
- [41] Zheng, S., Tang, H., Han, Z., Zhang, Y., "Controller Design for Vehicle Stability Enhancement," *Control Engineering Practice*, 14, pp. 1413-1421 (2006).
- [42] A. Rahmani-Hanzaki, S. K. Saha, and P. V. M. Rao, An improved recursive dynamic modeling of a multibody system with spherical joint, *Int, J, of Multibody system dynamics*, 21, pp. 325-345, (2009).
- [43] Tabatabaee, S.H., "Integrated control to improve directional stability and maneuverability of the articulated heavy vehicle", PhD Thesis, K. N. Toosi University of Technology Faculty of Mechanical Engineering, (2013).
- [44] Zeidi SMJ, Hoseini A, Rahmani A, 2017, "Study of vibration specifications of a three-axle truck using Lagrange method", *International journal of science and engineering investigations*.
- [45] Zeidi, SMJ, Mahdi, M., (2015). Evaluation of the physical forces exerted on a spherical bubble inside the nozzle in a cavitating flow with an Eulerian/Lagrangian approach, *European journal of physics*, 136(6).
- [46] Zeidi SMJ, Mahdi M, (2014). Investigation of viscosity effect on velocity profile and cavitation formation in Diesel injector nozzle, *Proceedings of the 8th International Conference on Internal Combustion Engines*.
- [47] Zeidi SMJ, Mahdi M, (2015). Effects of nozzle geometry and fuel characteristics on cavitation phenomena in injection nozzles, *Proceedings of the 22st Annual International Conference on Mechanical Engineering-ISME*.
- [48] Zeidi SMJ, Mahdi M, (2015). Investigation effects of injection pressure and compressibility and nozzle entry in Diesel injector nozzle's flow. *J. Appl. Comp. Mech.* 2 83–94.
- [49] Azizi, L., A. Sheikholeslami and F.B. Khalili. (2012). Safety Analysis of Unconventional U-Turn Using Neural Network and Crash Prediction Model, 10th International Congress on Advances in Civil Engineering, 17-19 October 2012 Middle East Technical University, Ankara, Turkey, ACE.
- [50] Zeidi SMJ, Hoseini P, Rahmani A, "Study of vibrations specifications of a three axle truck using Lagrange method", *Journal of Modern Processes in Manufacturing and Production*, vol. 6(1), pp. 83-95.