ISSN 1913-1844 (Print)
ISSN 1913-1852 (Online)

MODERN APPLIED SCIENCE

Vol. 16, No. 2 May 2022

CANADIAN CENTER OF SCIENCE AND EDUCATION

Editorial Board

Contents

Modern Applied Science; Vol. 16, No. 2; 2022
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

Divorce and Its Psychological and Social Effects on the Children of Divorced People from Their Viewpoint in the Jordanian Society

Safia M Jabali[1] & Sami Salameh AL-Massarweh[2]

[1] Faculty of Educational Sciences Department of Child Education, Isra University, Jordan

[2] Faculty of Arts, Department of Psychology, Isra University, Jordan

Correspondence: Safia M Jabali, Faculty of Educational Sciences Department of Child Education, Isra University, Jordan.

Received: June 6, 2021 Accepted: February 7, 2022 Online Published: February 11, 2022

doi:10.5539/mas.v16n2p1 URL: https://doi.org/10.5539/mas.v16n2p1

Abstract

This study aimed to identify the psychological and social effects of divorce on children from their viewpoint, and to achieve the aim of the study A questionnaire was developed consisting of (17) items that were distributed to a sample of (100) children of the divorced, and they were randomly selected. The researchers used the descriptive and analytical method for the study. The study concluded that feeling fear and anxiety about the future and the accumulation of worries and diseases is one of the most psychological effects that children of divorced men are exposed to, and it leads the individual to a feeling of inferiority and lack of self-esteem. While the most social factors affecting the members of the study sample were that divorce leads children to bad company due to poor family control over them. Then society viewed them as an inferior view that they are not socially qualified. The results of the study also showed that there were no statistically significant differences attributed to the age or gender variable, while statistically significant differences appeared due to the scientific qualification variable.

Keywords: divorce, children of divorced people, psychological and social effects, Jordanian society, family disintegration

1. Introduction

Divorce is a social phenomenon since the emergence of humanity and the rise of ancient human civilizations, and its names have multiplied, such as separation, divorce, abandonment, neglect and others. Although divorce is a big problem that works to disintegrate the family and marital life, but sometimes it is a solution to marital problems for fear of exacerbating them and leading to crimes such as violence, suicide, rape and other sex. Project, mental illness, depression and other crimes and diseases are present in all societies, whether Arab or Western, and also in different religions (Al-Janabi, 1983). The social, economic, political and technological changes have played a major role in the disintegration of marital life and the increase in divorce cases, which generate negative effects on the individual, the family and society. The children of divorced people are the victims of divorce and family disintegration, as they face many problems such as frustration, anxiety and psychological diseases. And the phenomenon of divorce is not limited to a particular social class, but has become occurring in all classes, whether poor, rich, educated or uneducated, especially after the emergence of modern technology such as (the Internet, Facebook, Twitter) and other social networking sites that have played a prominent role in the instability of life. Marital status and the increase in divorce rates every year, both in the Arab community in general and the Jordanian society in particular as the cases of divorce for the year 2020 reached (22780) in the Jordanian society, according to what was stated by the Chief Justice Dr. Abdel-Hafez Al-Rabtah on Wednesday 3/2/2021 in a press conference. And that this phenomenon has become threatening the stability of the family and society, both in terms of social, economic and psychological (Khudair, 2004). Especially on the life of children, their upbringing, their care and their psychological, cognitive and behavioral development, and for this reason the phenomenon of divorce has become in need of treatment and attention through educational, social, psychological and legal studies carried out by a team of specialists and those interested in this field to work on rehabilitating and educating young people coming to marriage about the concept of marriage and its importance and the rights of each one They are for the sake of family cohesion and the success of marital life, which reduces divorce cases in society.

1.1 Study Problem

The problem of divorce has become in the increase in divorce cases in the Arab community in general and the Jordanian society in particular, according to the statistics issued by official and private institutions in Jordan, and it has become a social, psychological and economic problem due to its negative effects on society, the family and children, and the problem of studying is summarized by knowing the psychological and social effects of divorce Which is reflected on the children from the point of view of the study sample.

1.2 Importance of the Study

This study derives its importance in theory in preserving the cohesion and cohesion of society by studying the phenomenon of divorce, which has become a major problem as a result of the rapid changes, cultural risks and revolution in the world of communication and technology, which leave negative effects on society and the children of divorced people as a result of family disintegration stemming from divorce. In practice, the results of this study will contribute to presenting a clear picture by knowing the most important psychological and social implications of divorced children, which helps decision-makers and officials who have a relationship with the issue of family and divorce in developing strategies and counseling and awareness programs for young people and couples to reduce divorce and make them aware of its effects and damages on the family and children And society.

1.3 Study Questions

1) What are the most important psychological effects of divorce that affect the children of divorced people?
2) What are the most important social effects of divorce that affect the children of divorced people?
3) Is there a statistically significant effect of the demographic variables (gender, age, educational qualification) from the viewpoint of the study sample individuals regarding the fields of study?

1.4 Objectives of the Study

1) Identify the most important psychological effects of divorce that affect the children of divorced people.
2) Identify the most important social effects of divorce that affect the children of divorced people.
3) Knowing is there a statistically significant effect of the demographic variables (gender, age, educational qualification) from the viewpoint of the study sample individuals regarding the fields of study.

2. Limitations of the Study

2.1 Time Limit

The study is limited to the psychological and social effects of divorce from the viewpoint of the children of divorced women for the 2020/2021 academic year.

2.2 Place and Objective Limit

This research is limited to determining the psychological and social effects of divorce, Capital Governorate (Amman).

2.3 The Human Limit

This research is limited to the children of divorced people in the Capital Governorate (Amman).

The results of the study are determined by the nature of the tool and its validity and reliability indications.

3. Procedural Concepts

Divorce: is the separation of the husband from the wife through verbal or writing, and its official approval by the Sharia judge and its registration.

Psychological effects: every negative behavior that affects the psyche of the child as a result of divorce.

Social effects: all social behavior affected by the child's marital status as a result of divorce.

Divorced: They are the husband and wife separated from each other officially by the judge of the Sharia court.

Children of divorced: They are the children of the husband and wife separated from each other officially by the judge of the Sharia court.

4. Idiomatic Concepts

Sharia divorce: raising the marriage immediately or in the event with a specific wording, in other words meaning: dissolving the marriage bond and ending the marital relationship, and divorce is called single will (Al-Sartawi, 2012: 169).

The definition of the United Nations: A court ruling separating the spouses gives each of them the right to remarry according to the laws followed in their countries (Al-Shalabi, 1992).

5. Theoretical Framework and Previous Studies

5.1 Factors Leading to Divorce

A. Cultural and social factors: Cultural and social factors are represented by values, customs, traditions, religion, language, social systems, ethics, economic, social, cultural, political and technological changes that play an important role in destabilizing the social structure and family disintegration that generates divorce through the different concepts of the spouses, such as the difference in character, socialization, interference of the couple's family and bad relationship, Whereas, the bad relationship between husband and wife may be one of the reasons leading to divorce, especially when each husband or wife tries to impose their views on the other and the difference in the role of women through increasing educational and work opportunities and the emergence of feminist movements to demand equality between men and women, as there are also other factors that lead to Divorce, such as poor choice, moral corruption, marital infidelity, frigidity in the husband or wife, work of women, neglect of marital duties, non-procreation, social class differences, etc. (Shukri et al., 2011).

B. Psychological factors: These are the psychological variables that are related to the human personality of the individual mainly, especially the motives, emotions, instincts, the absence of feelings of love, affection, and affection between them, and the coercion in choosing a husband or wife, and early marriage may generate psychological effects on the spouses such as quarrels and tensions between them and the lack of satisfaction of sexual desire as a result of the psychological effects that occur when Husband to hate her body after her birth or pregnancy without Considerate the physiological changes that happens to the wife and perhaps bad words from both parties, or the disease of the husband or wife.

C. Economic factors: The poor economic situation and family unemployment may prevent the continuation of married life because of the living requirements that the spouses cannot provide, especially since most women have the desire to buy and shop in imitation of girlfriends, relatives and celebrities, which makes them look for work to help the husband, and this may lead to neglecting the affairs of her home And her children at the expense of her new social position at work, the failure of marriage to be based on sound foundations, and the difference between husband and wife in their outlook on life and the level of culture and social status (Al-Khashab, 1985).

D. Technological factors: The modern means of communication and social media sites such as Facebook, Twitter and the Internet have played a major role in the disintegration of marital relations and divorce despite their importance, especially among groups of young people who have become rebellious through them against the behaviors, values and social trends recognized, generating depression and isolation (Al-Zubaidi et al., 2009). It also led in many cases to the disintegration of social and family relations and distrust between the spouses, causing separation from each other, and some studies indicated that the high rate of divorce was due to the use of social networking sites through messages and pictures of sexual and emotional temptation, introverted isolation and suspicion between the spouses (Al-Khaqani, 2015).

5.2 Psychological and Social Effects on Divorced Children

Psychological effects: Children may be born as a result of divorce worries and their feeling of fear and anxiety about the future and the society's view of them as divorced children, and there have been cases as a result of this feeling of fear and others subjected to psychological problems such as introversion and isolation from people as well as losing the sympathy of tenderness as a result of being away from the mother's tenderness if they are with the father and the tenderness of the father If they are with the mother, the divorce also affects the psychological and physical health of the children, especially if they are five or six years old this is due to the lack of interest of their parents in them as a result of family problems, and viewing of both parties or one of them is through family and social centers and institutions, which leads to a decline in children's morale, such as crying, despair, anxiety, trouble and the need for financial matters this is because the father and mother lose their livelihood (Khudair, 2004).

The child as a result of divorce is affected by problems and ruptures that have a negative impact on the child, family and society. Among these effects: The child has internal conflicts as a result of the breakdown of family

life, so this child carries aggressive motives towards parents and the rest of society. In many cases, the child moves from the headquarters of the broken family to live strangely with his father or mother, and thus faces great difficulties in adapting to the stepmother or stepfather. The child may make several comparisons between his parents and the new parents, which makes him in a state of continuous psychological disorder. According to this new situation, the child must adapt to different home environments in terms of economic, social and cultural levels which affects the child's personality greatly he creates a personality unstable, and oscillating. like parents, the child bears the burden of constantly thinking about the problem of separation. The child draws continuous comparisons between his disintegrating family and the family life that the rest of the children live, which generates a feeling of frustration, or it may win him an aggressive tendency towards everyone, especially children of healthy families. The child is exposed to disorder and anxiety as a result of his lack of awareness of the underlying goals of the conflict between the parents or the reasons for trying to use it - by his parents - to launch an attack on each other and use it as a tool to achieve victory over the other side. This disorder in childhood leads to a disturbance in the emotional and mental development of the child, so that a person with a shaky or ailing personality emerges to society, which harms the entire society (Al-Jaafari, 1999).

Social effects: Divorced children may be affected by the negative view of society towards them in terms of behavior, behavior, disappointment and frustration expected for them in the future, which increases them only complication and fear of the future, and the separation of the father from the mother may affect the early socialization of children in the first years of his life that leads to disintegration and homelessness As a result of the lack of direct supervision of children by parents and living in the streets, homelessness, delinquency, and their loss of a sense of security, protection and stability, and this makes them think as a result of these conflicts, dropping out of schools, deviation in behavior, weak self-confidence, inability to intellectual development and social interaction with their friends, and their deprivation of proper social upbringing They resort to homelessness and the use of drugs and intoxicants to keep away from the concerns of the family, and all of this is one of the negative effects that divorce leaves on the children (Ahmed, 2001).

Among the most important social effects on children is also family disintegration, which works to loosen the bonds of family building, weak social interactions between family members, disturbance of expectations of their roles, feelings of alienation and insecurity, and this is the result of the social changes that society is going through (Al-Shabiki, 2006). Divorce also generates negative effects on children, such as losing the breadwinner and financial source, increasing economic pressures, and also the parental life of guidance, knowledge, counseling and assistance through parents, as children who live with their parents have more financial expenses than the spouses are separated as a result of limited income and financial resources after divorce. For both spouses, this will affect the livelihood of the children in terms of education, quality of schools, housing, health care, and relationship with friends (Teachman and Paasch, 1994).

6. Previous Studies

Al-Zahrani (2021), this study aimed to identify the relationship of emotional divorce with psychological stress and self-efficacy among a sample of couples in Jeddah, Saudi Arabia. The researcher used the descriptive correlative approach, the emotional divorce scale, the spouses' psychological stress scale, and the self-efficacy scale. The study sample consisted of (198 husbands and wives), and the results of the study found a positive relationship between psychological stress and emotional divorce. While there was a negative relationship between self-efficacy and emotional divorce, and there were also differences between the averages of both husbands and wives in being affected by psychological stress in favor of the wives' sample. There are no differences between husbands and wives in the level of self-efficacy. And the presence of a significant effect of the high level of psychological stress, And the low level of self-efficacy in predicting the emergence of emotional divorce in spouses. Najdawi's study (2018) aimed to try to understand the phenomenon of emotional divorce in Jordanian society, where the study was conducted on an intentional sample consisting of (17) women who reported emotional divorce. The researchers used the qualitative approach through an in-depth interview to collect data one of the results of this study was that emotional divorce exists in Jordan and it is difficult to accurately identify its numbers. One of the reasons for this divorce was the difference in expectations in marriage for both spouses, the concept of marriage for men and women, cultural factors, and the prevalence of individualism among men. And one of the reasons that pushed the woman to accept the matter reality and continuation of this marriage not to request an official divorce is to preserve the social image and fear for the future of children and parents. Rababaa study (2015) aims to find out the causes of divorce and its treatment in Jordan from the point of view of divorced people and legal judges. The study sample consisted of and (30) legal judges and (60) divorced people in all governorates of Jordan. The researchers used the descriptive, analytical and interview method to collect information the results of the study concluded that the most important factors for

divorce are poor choice at a rate of (83%), interference by the wife's family by (77%), interference by the husband's family by (70%) and failure to perform the wife's rights to the husband at a rate of (63%). A Kheira Study (2015) It aimed to identify the self-image of children of divorce by highlighting the defect that children of divorce suffer in their perception of their self-image by studying this phenomenon on three cases of adolescents who are victims of the divorce of their parents through the application of a set of tools from observation, interview and GPS testing one of the most important results of this study was that children of divorce suffer from a feeling of anxiety, tension, excitement, feelings of deprivation, a sense of inferiority and insecurity, and the feeling of difference creates a feeling that makes them think that people look at them differently this makes the teenager frustrated and lack of confidence in social relationships, especially if he was at a young age. A study (Vitanen, 2014) in the United States of America, entitled The Divorce Revolution and Generalized Trust: Evidence from the United States 1973 - 2010, the study clarified the relationship between marriage laws and trust in society. As easy as what is known as the culture of easy divorce, whenever individuals have less confidence in society, which in turn will be reflected in social cohesion on the one hand, and affiliation and loyalty to society on the other hand. The issue of trust, whether on the individual level (self-confidence) or on the social level (confidence in society), its value and criteria are extremely important, and therefore the results of this study are in agreement with many studies conducted in the United States on confidence in society and the factors affecting it. A study (Valenzuela et al., 2014) Social network sites, marriage well-being and divorce Survey and state-level evidence from the United States: This study aimed to reveal the relationship between the use of social networks and marital happiness on the one hand, and divorce rates on the other hand, and its correlation with social networks. The results showed that the increased use of social networks has a negative relationship on marital happiness. And it works to increase and raise the level of problems in marital relations, and thinking about the divorce decision. The results of this study are in agreement with the results of the national study that was titled Facebook from 2008-2010. The study found that the increase in social media websites increases divorce rates directly in various parts of the United States with different factors causing divorce, and the two studies also focused on how to convert negative factors for social communication into positive factors. Masoud's study (2013) aimed to identify the most important (social, economic and psychological damages resulting from divorce for girls in the early stage of marriage in slums, And testing the practice of the meaning treatment model with Islamic content in the service of the individual to mitigate the harms resulting from divorce for girls in the early stage of marriage in slum areas, and The researchers relied on more than one tool consistent with the nature and quality of the study, such as the questionnaire and the interview, and the study community was one of the divorced women who hesitated to the Model Association for Service. The individual, family and society, and the study sample consisted of 127 cases who meet the conditions, The researchers reached several results, the most important of which are: The problems dealt with in that study within the framework of the meaningful treatment model for social problems due to poor relations with her family, frequent blame for her and family monitoring of her actions, and economic problems such as the financial burdens that the family bears on the newly married divorced woman as a result of separation from the husband. Divorce, psychological problems, and psychological stress that falls on divorced women and isolation as a result of society's view of them. The study of the Sheikh and others (2013) aimed at identifying the causes of the phenomenon of divorce and its implications, and the proposed solutions to treat this phenomenon. The study tool was questionnaires distributed on a sample consisting of (62) divorced (husband and wife) from the community of Medina, The most important results of this study: The most important social reasons for divorce are the lack of dialogue within the family in a democratic manner, as well as marriage imposed by families, and culturally the main reason for divorce is to watch programs contrary to customs and values through the media, and the most important psychological reasons leading to divorce It is infidelity, and the most important religious reason was the failure to respect the rights of the spouses to marital rights and duties.

6.1 What Distinguishes the Study from Previous Studies

Previous studies talked about divorce and its factors, and the implications for both spouses and children, such as the study (Sheikh et al., 2013; Masoud, 2013), and the studies also showed the most important effects on children of divorce, such as the study (Khaira, 2015). The current study agreed with most of the studies on the factors leading to divorce, such as (Al-Najdawi study 2018, and the fourth in 2015) and the implications for children, such as the study (Khair, 2015). This study was distinguished from previous studies by knowing the implications for children due to divorce.

7. Method and Procedures

7.1 Study Methodology

The researchers used the descriptive and analytical approach to conduct this study, due to its blameness with the nature of the study.

7.2 Study Population

The study population consisted of children of divorced people of different genders, groups and age qualifications in the Capital Governorate (Amman).

7.3 Study Sample

A random sample of 100 children of divorced people was selected in the Capital Governorate (Amman). directly and also through social media via electronic questionnaire It is as follows:

Table 1. Study sample members according to demographic variables

Variable	Categories	Iteration	Percentage
Sex	Male	54	54%
	Females	46	46%
Lifetime	Under 18 years of age	44	44%
	18-25 years	20	20%
	More than25 years	36	36%
scientific qualification	Secondary and below	56	56%
	bachelor's degree	30	30%
	Graduate	14	14%

7.4 Study Tool

The study tool consisted of a questionnaire containing (17) paragraphs that were applied to a number of divorced children in order to find out the psychological and social effects of divorce on children by reviewing the theoretical concepts and previous studies that are related to the topic. The level of the answer for each paragraph will be graded according to (the five Likert scale) And defining them in five levels as follows: very agree and give (5) grades and a level in agreement and gives (4) degrees and a neutral level and gives (3) degrees and a level that does not agree and gives (2) two degrees and a level that does not agree strongly and gives (1) one degree, and a scale Judging the results divided into (high, medium, low), depending on the tool categories.

7.5 Tool Validation

The researchers carried out to verify the validity of the tool presenting the tool to a number of arbitrators specialized in the field of psychology, education, Islamic law and sociology, in order to know what the paragraphs measure, and the extent of the scale's relevance to the variables to be measured.

Tool stability:

The values of stability transactions (Cornbach Alpha) were extracted for the study areas and were as follows:

Table 2. Stability transaction values (Cornbach Alpha) for study areas

NO	Field	Stability factor
1	Psychological effects	0. 77
2	Social implications	0. 84
The tool as a whole.		0. 73

The results of the study showed a rise in stability transaction ratios, showing a high consistency between single-field paragraphs and the paragraphs of the tool as a whole. This makes them acceptable for scientific research purposes.

7.6 Study Procedures

The questionnaire was distributed to the study sample after explaining its objectives, and that their answers will be treated with complete confidentiality, and will be used only for scientific research purposes only.

7.7 Statistical Treatment

For the purpose of answering the research questions and achieving the desired goals, the following statistical treatments were used:

1) To answer the first and second questions, the arithmetic means and standard deviations were extracted.
2) To answer the third question to extract the effect of gender, the T-Test was used for two independent samples. To extract the effect of age and scientific qualification, the One Way ANOVA test was used.
3) To extract the stability of the tool, the stability factor (Cornbach Alpha) was used.
4) Frequencies and percentages of sample count were extracted.

8. Study Results and Discussion

8.1 The Answer to the First Question: What are the Most Important Psychological Effects of Divorce that Affect Children of Divorced People

The mean and standard deviations of the answers of the study sample individuals were related to the field of: Psychological effects, and the results were as follows:

Table 3. Mathematical averages and standard deviations of the responses of study sample members to paragraphs that measure psychological effects

No	Paragraph	Arithmetic average	Standard deviation	Rank	Grade
2	Fear and anxiety about the future and the accumulation of worries and diseases.	4. 42	1. 07	(1)	High
4	It leads the individual to feel inferior and unappreciated.	4. 4	0. 70	2	High
3	The individual becomes vulnerable to people's ambitions and accusations of moral deviations, leading him to isolation.	4. 34	0. 82	3	High
7	Divorce increases the likelihood of depression and frustration.	4. 24	0. 77	4	High
5	The individual takes a negative reaction to future engagement and marriage.	4. 16	1. 09	5	High
1	Divorce is a direct cause of children losing confidence in themselves.	4. 08	0. 97	6	High
8	The individual feels after security, protection and stability.	4. 06	0. 84	7	High
6	The individual tends to be more violent and nervous as a solution to most of the problems and obstacles they face.	3. 96	1. 07	8	High
9	The individual feels independent and free from parental control.	3. 82	1. 24	9	High
College degree		4. 16	. 63		High

It appears from the previous table that the arithmetic averages were high for the items according to the answers of the individuals of the study sample, and the total arithmetic mean came (4. 16), with a standard deviation of (. 63). The previous table shows Paragraph No. (2) which states “a feeling of fear and anxiety about the future and the accumulation of worries and diseases” came in first place with an arithmetic average of (4.42), while each of Paragraph No. (4), which states “leads the individual to a feeling of inferiority.” And not appreciating himself "in the second rank with an arithmetic average of (4.40), Paragraph No. (5) comes in the penultimate rank, which states “The individual tends to be more violent and nervous as a solution to most of the problems and obstacles he faces,” with a mean arithmetic of (3. 96), Paragraph No. (9) comes in the last rank, which states that “the individual feels independence and freedom away from parental control,” with a mean of (3.82).

8.2 The Answer to the Second Question: What are the Most Important Social Effects of Divorce that Affect the Children of Divorced People

The arithmetic averages and standard deviations were extracted for the answers of the study sample individuals with regard to the second domain, which states: Social effects, and the results were as follows:

Table 4. Mathematical averages and standard deviations of the responses of study sample members to paragraphs that measure social impacts

No	Paragraphs	Arithmetic average	Standard deviation	Rank	Grade
7	Divorce leads children to bad company because of poor control over them.	4. 4	0. 70	1	high
5	The individual (male and female) finds it difficult to bond in the future.	4. 36	1. 08	2	high
6	Society views divorced children as socially ineligible	4. 34	0. 85	3	high
3	Divorce leads to habits that are unacceptable to society.	4. 2	0. 90	4	high
1	Emotional deprivation and lack of tenderness lead to the deviation of children.	4. 08	0. 97	5	high
4	The individual feels unacceptable and socially isolated.	3. 98	0. 96	6	high
8	Divorce and lack of compassion for children lead to a tendency towards violence.	3. 94	1. 08	7	high
2	There is an atmosphere of tension, discord and differences between divorced children.	3. 88	1. 30	8	high
College degree		4. 15	. 56		high

It appears from the previous table that the arithmetic averages were high for the items according to the answers of the individuals of the study sample, and the total arithmetic mean came (4. 15), with a standard deviation of (0.56).

The table shows that Paragraph No. (7) which states that “divorce leads to bad company of children due to poor supervision over them,” came first with an arithmetic average of (4.40), While each of Paragraph No. (5), which states that “the individual (males and females) finds it difficult to relate in the future,” came in the second rank with an arithmetic mean of (4.36), and it came in the rank before The last paragraph No. (8), which states that “divorce and lack of affection in children lead to delinquency towards violence,” with an average arithmetic of (3.94), and came in the last rank, Paragraph No. (2) Which states, "An atmosphere of tension, discord and disagreements prevails between divorced children," Arithmetic average It reached (3. 88).

8.3 The Answer to the Third Question: Is There A Statistically Significant Effect of Demographic Variables (Gender, Age, Educational Qualification)

8.3.1 First: Sex

The T-test was used for two independent samples, and the results were as follows:

Table 5. Calculation averages, standard deviations and value (t) to test the differences between the study sample answers attributable to the sex variable

Field	Sex	Arithmetic average	Standard deviation	Value T	Indication level
Psychological effects	male	3.92	.65	.014	.912
	female	4.36	.56		
Social effects	male	4.00	.62	.098	.301
	female	4.26	.49		

Field The results of the study indicate that there are no statistically significant differences between the answers of the male and female respondents with regard to the different answers of the study sample individuals according to gender. Where the value of the level of significance in all areas of the study was not statistically significant at the level of significance ($\alpha \leq 0.05$).

8.3.2 Second: Age

Arithmetic averages were extracted for the answers of the study sample individuals according to the age variable, and the answers were as follows:

Table 6. Calculation averages and standard deviations of the responses of study sample members according to age variable

Field	Categories	Arithmetic average	Standard deviation
Psychological effects	Under 18 years of age	4.02	0.69
	18-25years	4.41	0.28
	More than 25 years	4.37	0.54
	Under 18 years of age	4.16	0.63
Social effects	18-25 years old	4.08	0.65
	More than 25 years	4.15	0.49

It appears from the table that there are apparent differences between the average answers of the study sample individuals depending on the age variable.

To find out if these differences are statistically significant or not, a One Way ANOVA analysis was performed, and the results were as follows:

Table 7. OneWay ANOVAanalysis to show the impact of age variable on the answers of study sample members

Field	Source of contrast	Total squares	Degrees of freedom	Average squares	Value(F)	Level of significance
Psychological effects	Between groups	1.525	52	.762	1.976	.150
	Inside groups	18.136	97	.386		
	Total	19.660	99			
	Between groups	.391	52	.195	.617	.544
Social effects	Inside groups	14.881	97	.317		
	Total	15. 72	99			

It appears from the table that the differences between the answers of the study sample members according to age were not statistically significant at the level of significance ($\alpha \leq 0.05$) This indicates that there are no statistically significant differences between the answers of the study sample individuals due to the age variable.

8.3.3 Third: Academic Qualification

Arithmetic averages were extracted for the answers of the study sample according to the scientific qualification variable, and the answers were as follows:

Table 8. Mathematical averages and standard deviations of the responses of the study sample members according to the variable of scientific qualification

Field	Categories	Arithmetic average	Standard deviation
Psychological effects	Secondary and below	3.59	.51
	bachelor's degree	4.41	.43
	Graduate	4.05	.75
	Secondary and below	4.16	.63
Social effects	bachelor's degree	3.82	.37
	Graduate	4.41	.33

It appears from the table that there are apparent differences between the averages of the responses of the study sample individuals depending on the scientific qualification variable, To find out if these differences are statistically significant or not, a One Way ANOVA analysis was performed, and the results were as follows:

Table 9. Single Contrast Analysis (One Way ANOVA) to show the impact of the scientific qualification variable on the answers of the study sample members

Field	Source of contrast	Total squares	Degrees of freedom	Average squares	Value (F)	Level of significance
Psychological effects	Between groups	4.064	52	2.032	6.123	.004
	Inside groups	15.596	97	.332		
	Total	19.660	99			
	Between groups	3.361	52	1.681	6.631	.003
Social effects	Inside groups	11.911	97	.253		
	Total	15.272	99			

It appears from the table that the differences between the answers of the study sample members according to the difference in scientific qualification were statistically significant at the level of significance ($\alpha \leq 0.05$) This indicates the existence of statistically significant differences between the answers of the study sample individuals due to the scientific qualification variable. To find out the source of these differences, a procedure was carried out shafih test, and the results were as follows:

Table 10. Xavier remote test to find out in favor of which categories were the differences between the members of the study sample according to the categories of the variable scientific qualification

Field	scientific qualification	Arithmetic average	Secondary and below	bachelor's degree	Graduate
Psychological effects	Secondary and below			.007*	.208
	bachelor's degree				.142
	Graduate				
	Secondary and below			.033*	0.011*
Social effects	bachelor's degree				.914
	Graduate				

It appears from the table that the statistically significant differences were between My classes are secondary and below and bachelors degrees in the first field, As for the second field, the differences were between the secondary and lower categories, the bachelors degree, the secondary and lower categories, and the higher studies.

9. Discussing the Results

The results of the study concluded that the psychological factors that most affect the children of divorced people are the feeling of fear and anxiety about the future and the accumulation of worries and diseases. Then comes the individual's feeling of inferiority and lack of self-appreciation. The results of the study also found that the most social factors affecting the study sample members as a result of divorce are bad company due to poor control over them, difficulty in future association, and society's inferiority view towards divorced children as not being socially qualified. The results of the study also showed that there were no statistically significant differences due to the age or gender variable, while statistically significant differences appeared due to the scientific qualification variable.

10. Study Recommendations

1) Activating the role of family, social and educational institutions in directing and guiding those who are about to get married, such as family reform offices in Sharia courts in Jordan.
2) Educating young people about the rights of spouses in marital life and the negative effects of divorce on spouses, children and society.
3) Educating spouses about the importance of confidentiality and privacy in marital life, especially with regard to marital cohabitation.
4) Accustom the spouses to solve family disputes and problems on their own without the intervention of the spouses' family or reformers except in the case of necessity.
5) Rational thinking in choosing a husband or wife without the influence of family or friends in the selection process away from emotions, sexual instincts and shame when making the decision to approve the marriage.
6) Giving religion, morals, and social and educational values of great importance in the process of choosing a husband or wife.

References

Ahmed, Soheir Kamel. (2001). *Children's mental health*. Alexandria Book Center, Alexandria, Egypt.

Al Khaqani, Laith. (2015). *Social media and its role in family disintegration*. Retrieved from https://annabaa.org/arabic/informatics/1400

Al-Jaafari, & Abd al-Rahman bin Muhammad. (1999). The relationship of some family variables to juvenile delinquency in the Eastern Province of the Kingdom of Saudi Arabia. *Journal of Security Research*.

Al-Janabi, Aida. (1983). *The social and cultural variables of the phenomenon of divorce*. Department of Cultural Affairs and Publishing, Publications of the Ministry of Culture and Information, National Library, Baghdad.

Al-Khashab, & Mustafa. (1985). *Studies in family sociology* (1st ed.). Arab Renaissance Publishing House, Beirut.

Al-Najdawi, Anne Musa. (2018). Emotional divorce in Jordanian society: A qualitative study. *Social Sciences and Humanities Studies, 45*(4). University of Jordan, Jordan.

Al-Sartawi, Mahmoud. (2012). *Jurisprudence of Personal Status (1)* (9th ed.). Al-Quds Open University.

Al-Shabiki, Al-Jazi Bint Muhammad. (2006). *Social Problems of Poor Women in Saudi Society*. Master Thesis - King Abdulaziz University, Saudi Arabia.

Al-Shalabi, Fahum. (1992). *Divorce in the Ramallah district*. Social statistical study, Center for the Study and Documentation of Palestinian Society, Bir Zeit, Palestine.

Al-Sheikh, Radwan Fadl Al-Rahman et al. (2013). The phenomenon of divorce in the society of Medina: the causes, implications, and proposed solutions from the point of view of divorced people. *Arab studies in education and psychology, 37*(2), 211-260.

Al-Zahrani, Ali Mohammad Abdullah. (2021). Emotional divorce and its relationship both psychological stress and self-efficacy among a sample of couples in Jeddah. *College of Social Work for Social Studies and Research, 23*(2), 473-429.

Al-Zubaidi, Muhammad Omar et al. (2009). *The Divorce Problem and Education Technology*. Study under the supervision of Dr. Zakaria bin Yahya Lal, Training Courses Center, College of Education, Umm Al-Qura University, Makkah, Saudi Arabia.

Kheira, Obese. (2015). *Self-image among children of divorce*. Unpublished MA Thesis, Faculty of Humanities and Social Sciences, University of Mohamed Khaider, Biskra, Algeria.

Khudair, alqadi Maher Elyan. (2004). *Divorce, the effects and disadvantages*. Judge of the Sharia Court of Appeal, Palestinian National Information Center, Wafa, Gaza, Palestine.

Masoud, Mohamed Abdel Halim. (2013). Exercising a model of meaning therapy in the service of the individual to mitigate the damages resulting from divorce in the early stage of marriage. *The 26th International Scientific Conference on Social Work*, Part 6, pp. 2275-2285, Helwan University, Egypt.

Rababaa Omar Abdel-Rahim, & Salem rafqat khulif. (2015). The reasons for divorce and the proposed solutions to deal with them from the point of view of divorced, divorced women, and Sharia judges in Jordan. *College of Education Journal, 34*(1620). Al-Azhar University, Egypt.

Shukry et al. (2011). *Family Sociology*. Dar Al-Masirah for Publishing, Distribution and Printing, Al-Abdali, 2nd floor, p. 68, Amman.

Teachman, J. D., & Paasch, K. M. (1994). Financial Impact of Divorce on Children and Their Families. *The Future of Children, 4*(1), 63-83. https://doi.org/10.2307/1602478

Sebastian Valenzuela, Daniel Halpern, & Katz James. (2014). Social network sites, marriage well-being and divorce Survey and state-level evidence from the United States. *Computers in human behavior, 36*, 94-101. https://doi.org/10.1016/j.chb.2014.03.034

Tarja K. Viitanen. (2014). The divorce revolution and generalized trust: Evidence from the United States 1973-2010. *International review of law and economics, 38*, 25-32. https://doi.org/10.1016/j.irle.2014.02.001

Copyrights

Modern Applied Science; Vol. 16, No. 2; 2022
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

DDoS Attacks Detection in the IoT Using Deep Gaussian-Bernoulli Restricted Boltzmann Machine

Gafarou O. Coli[1], Segun Aina[1], Samuel D. Okegbile[1], Aderonke R. Lawal[1] & Adeniran I. Oluwaranti[1]

[1] Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria

Correspondence: Segun Aina, Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria.

Received: February 5, 2022 Accepted: March 16, 2022 Online Published: April 2, 2022

doi:10.5539/mas.v16n2p12 URL: https://doi.org/10.5539/mas.v16n2p12

Abstract

Distributed denial of service (DDoS) attack is generally known as one of the most significant threats to the internet of things (IoT). Current detection technologies of DDoS attacks are not adequate for IoT systems because of the peculiar features of IoT such as resource constraint nodes, specific network architecture, and specific network protocols. Providing adequate DDoS attacks detection systems to IoT, however, becomes a necessity since IoT is ubiquitous. This study hence developed a deep learning-based model for detecting DDoS in IoT, while considering its peculiarities. The proposed deep learning-based model was formulated using a deep Gaussian-Bernoulli restricted Boltzmann machine (DBM) because of its capability to learn high-level features from input following the unsupervised approach and its ability to manage real-time data that is common in the IoT network. Furthermore, the SoftMax regression was used for classification. The accuracy of the proposed model on the network socket layer-knowledge discovery in databases was obtained as 93.52%. The outcome of the study shows that the proposed DBM can efficiently detect DDoS attacks in IoT.

Keywords: Boltzmann machine, deep learning, DDoS, IoT, nsl-kdd

1. Introduction

The Internet of Things (IoT), is generally a self-configuring network of small sensor nodes in which nodes communicate with one another to sense, supervise, comprehend the physical world and provide services (Aris et al., 2015). Because of its ubiquitous and pervasive characteristics, its applications have appeared in a variety of domains, including health care, fitness, home energy management, classroom automation, smart cities, and many more (Alqahtani et al., 2020). IoT is now receiving wide adoption in many sectors that require things to interchange via the internet to process chores smartly with little or no human involvement. Unfortunately, security in IoT has gained considerable concern in recent times. The distributed denial of service (DDoS) attack represents the most important threat to IoT (Arnaboldi & Morisset, 2017; Robert & Wang, 2020). This denial of service (DoS) is a class of cyberattacks whose aim is to destruct or deny the use of services, such as environmental monitoring or services accessible remotely. An attack might come from one source - DoS or multiple sources - referred to as DDoS (Robert and Wang, 2020). In a study conducted by Kaspersky Labs in 2017, the consequences of DDoS on organizations have increased considerably and is, on average between $120 thousand and $2 million, which implies the incapability to run businesses, insurance premium increases, loss of contracts, and opportunities. In addition, the appraisal reveals that 70% of IoT devices are very easy to attack (Denise, 2020).

Despite the existence of various DDoS detection techniques based on traditional methods, current solutions are limited for IoT systems, because of IoT's peculiar features that affect detection system development. First, finding nodes in IoT networks that can support detection system agents is difficult. In fact, nodes are generally resourced constraints in IoT networks. The second peculiar feature is the architecture. Communications in IoT networks often follow the multi-hop method and nodes can simultaneously forward packets while working as end devices. The last feature is related to IoT's network protocols. Network protocols used in IoT are not common (for instance, IEEE 802.15.4, 6LoWPAN, RPL, CoAP, etc.). New protocols bring new vulnerabilities and require novel detection systems. Encryption and authentication are insufficient to protect IoT systems (Kasinathan et al., 2013). By inheriting Internet protocol (IP) technologies and low-power wireless links, IoT systems inherit the security vulnerabilities and issues of these technologies (Sarigiannidis et al., 2015). The heterogeneity and the dispersed nature of the nodes render traditional intrusion detection systems (IDS) difficult to implement (Fu et al., 2011;

Chen et al., 2009). Existing detection systems are not conceived for these problems and there are no universal IDS for DDoS in IoT (Kasinathan et al., 2013; Raza et al., 2013).

Meanwhile, the deep learning (DL) method has been earlier used to provide solutions to many interesting problems in the big data field and offers a unique opportunity for DDoS security mechanisms in IoT. Although the use of the DL method is primarily restrained to big data, the latest findings on network traffic classification and intrusion detection systems in (Diro & Chilamkurti, 2018; Elsaeidy et al., 2019; Javaid et al., 2016; Kang & Kang, 2016; Li et al., 2015) show that DL can have new applications in identifying attacks in IoT. The main benefit of DL is its ability to extract high-level features, the absence of manual feature engineering, unsupervised pre-training, and compression capabilities. These benefits are now encouraging the use of DL in resource constraint networks such as IoT (Vincent et al., 2010). In this paper, taking the advantage of the DL, we develop a DDoS attack detection model in IoT using a deep Gaussian-Bernoulli restricted Boltzmann machine (DBM). To do so, in section 2, we present relevant literature reviews regarding intrusion detection and IoT. The contribution to the knowledge of this study - an established blueprint and a deep learning based-model for detecting distributed denial of service attacks in IoT considering the peculiarities of IoT systems - is exposed in section 3. Section 4 discusses the system implementation, data description, and the experimental environment. Section 5 detailed the results of this work, while the last section presents some concluding remarks.

2. Related Works

The DL approach was employed in (Li et al., 2015) to detect malicious code in information technology systems, where an auto-encoder was used for features extraction and data dimensionality reduction by converting complicated high-dimensional data into low dimensional codes with nonlinear mapping. A deep belief network (DBN) was used for classification while considering a centralized anomaly-based detection approach. The model was simulated using the knowledge discovery in databases cup 99 (KDD-Cup99) dataset and an accuracy of 92.10% was obtained. Illustrative results showed that the proposed model performed better than a single DBN. The work supports that deep networks are better at identifying cyber-attack than simple machine learning algorithms.

Another study based on the DL approach was conducted in (Javaid et al., 2016). The authors used sparse auto-encoders along with a backpropagation (BP) algorithm for feature extraction following an unsupervised approach. They simulated the proposed model using the network socket layer-knowledge discovery in databases (NSL-KDD) dataset. The learned features were classified using a softmax regression function. The study employed a cross-validation technique based on n-fold for performance evaluation, and the accuracy of the developed model was 88.39%. A deep neural network (DNN) based IDS was also adopted in (Kang & Kang, 2016) to improve the security of an in-vehicular network. During the simulation phase, sensors placed in the controlled area network (CAN) bus were used to analyze the traffic entering and leaving the vehicle. They used a DBNs with the conventional stochastic gradient descent algorithm for feature extraction on the in-vehicular network packets. Then, DNN was used as a classifier to provide the accuracy of each class to distinguish normal packets from hacked ones. Experimental results showed 98% in terms of accuracy and showed that the developed method can give a quick response to any attack on the vehicle.

In Ma et al. (2016), spectral clustering deep neural network (SCDNN) - a combination of spectral clustering (SC) and DNN algorithms was proposed. The dataset was first split using cluster centers, as in SC; and similarity amongst features was used to measure the distance between data points both in testing and training set. The KDD-Cup99, NSL-KDD, and sensor network dataset (SND) were used to test the model. The outcomes showed that the SCDNN classifier outperformed back propagation neural network (BPNN), support vector machine (SVM), random forest (RF), and Bayes tree models in terms of detection accuracy. Haddadpajouh et al. (2020) proposed a multi-kernel support vector machine (SVM) for IoT cloud-edge gateway malware hunting, using the grey wolf optimization (GWO) algorithm. In Yadav & Subramanian (2016), a stack of auto-encoders was used to study features in the application-layer DDoS (AL-DDoS) attack dataset - an artificial DDoS dataset. To classify the input into normal and intrusion traffic, logistic regression was used. The average detection rate and false-positive rates were 98.99% and 1.27% respectively. These results were used to benchmark the proposed method with the existing ones, such as hidden Markov models (HMM), hierarchical clustering, and random walk graph. They concluded that the proposed technique outperformed the existing ones.

Pang et al., 2021 reviewed the various models that have been employed for anomaly detection while (Li et al., 2020) surveyed different random forest models used in IDS with a variety of datasets using different features and classes. In Diro & Chilamkurti (2018), a distributed anomaly-based IDS was developed to detect DDoS attacks in IoT systems using a DL model for feature extraction and softmax regression for classification. The developed model was also simulated using the NSL-KDD dataset. The model achieved 99% in terms of accuracy, while the

distributed detection approach was shown to outperform the centralized one. In addition, the results showed that deep network-based models were more effective against DDoS attacks than shallow neural networks. However, the deep learning model used for feature extraction in the work was not specified. Latif et al. (2020) also proposed an approach using convolutional neural networks (CNN) to classify botnet attacks. They further split the dataset into four (4) separate parts, the same model was trained and tested on the data separately for binary classification. The research in Imamverdiyev & Abdullayeva (2018) proposed a Gaussian-Bernoulli type restricted Boltzmann machine (RBM) for detecting DDoS attacks. They used seven additional layers between the visible and the hidden layers of the RBM for feature extraction and features classification. They simulated the model using the NSL-KDD dataset with Matlab and the detection accuracy was 78%. The results analysis of the developed model showed it performed better compared to the other type of RBM.

Latif et al., 2020 in their work developed a deep random neural network (DRaNN) and they trained the model using the UNSW-NB15 dataset. Their model could achieve an accuracy of 99.54%. In Elsaeidy et al. (2019), DDoS attack detection for the smart city using an RBMs based smart city intrusion detection system for feature extraction was proposed. Four classifier including feed-forward neural network (FFNN), automated FFNN, RF, and SVM, were used. Classifiers were selected and trained. The accuracy of the developed method was tested and benchmarked using a dataset from a smart water distribution plant. The best accuracy (98%) was achieved with SVM as a classifier. The outcomes showed the performance of the developed method in detecting DDoS attacks.

3. System Model

The developed model for detecting DDoS attacks in IoT systems is made of the softmax regression for attack detection and deep Gaussian-Bernoulli restricted Boltzmann machine (DBM) for feature learning. Fog nodes were used to host the developed attack detection system to unload storage and computation from IoT nodes. Parallelly, each fog node hosts data training using the DBM. Holdout set validation method was used to build the final model with the training dataset for training (70%), validation (10%), and testing (20%).

3.1 Deep Gaussian-Bernoulli Restricted Boltzmann Machine

DBM is a stack of RBMs. The first RBM in the stack is a Gaussian-Bernoulli RBM, a type of RBM that handles real data and is suitable to the data generated by IoT systems (Elsaeidy et al., 2019). DBM is a generative model with symmetrically coupled stochastic units and no-intralayer connections between the units. Connections in the deep RBM exist only between units of neighboring layers. The deep RBM learns complex internal representations and is effective in resolving IoT network traffic analysis problems. Complex representations can be constructed from a large amount of unlabelled IoT network traffic and some labeled sensory data can then be employed to fine-tune the model. Typically, a DBM is made of a set of visible units $\boldsymbol{v} \in \{0,1\}^D$ and a set of hidden units $h \in \{0,1\}^P$. Consider a DBM with two hidden layers $\{h^1, h^2\}$ and one visible layer v, the conditional distributions over the visible and the two sets of hidden units are given by (Salakhutdinov & Hinton, 2019)

$$p\left(h_j^1 = 1 | \boldsymbol{v}, h^2, \theta\right) = sigm\left(\sum_i \frac{1}{\sigma_i^2} v_i w_{ij} + \sum_k h_k^2 w_{jk}^1 + b_j^1\right), \quad (1)$$

$$p(h_k^2 = 1 | h^1, \theta) = sigm\left(\sum_j h_j^1 w_{jk}^1 + b_k^2\right), \quad (2)$$

$$p(v_i = 1 | h^1, \theta) = N\left(\sum_j h_j^1 w_{ij} + b_i, \sigma_i^2\right) \quad (3)$$

where $\theta = \{w_{ij}, w_{jk}^1, b_i, b_j^1, b_k^2\}$ are the model parameters; *sigma (x)* is the sigmoid function $\left(\frac{1}{1+e^{-x}}\right)$; w_{ij} are the weights between v and h^1; w_{jk}^1 the weights between h^1 and h^2; b is the biases of v, b^1 is the biases of h^1, b^2 is the biases of h^2 and σ_i is the standard–deviations of v. $N(\mu, \sigma_i^2)$ is a probability density of Normal distribution with a mean μ a standard deviation σ_i.

The learning of the DBM model was done using (4). The first term on the right side is called the data-dependent expectation and the second one is called the expectation of the model.

$$\frac{\partial \log p(v, \theta)}{\partial \theta} = Ep(h^1, h^2 | v)\left[\frac{\partial E(v, h^1, h^2 | \theta)}{\partial \theta}\right] - Ep(v, h^1, h^2)\left[\frac{\partial E(v, h^1, h^2 | \theta)}{\partial \theta}\right] \quad (4)$$

The data-dependent expectation and the model's expectation can only be approximated. Because of that, persistent contrastive divergence (PCD) through mean-field approximation (Salakhutdinov & Hinton, 2019), (Cho et al., 2013) was used to estimate the data-dependent expectation and Gibbs sampling through Markov chain Monte Carlo method (Salakhutdinov & Hinton, 2019; Cho et al., 2013) was used to approximate the model's expectation.

i. *Gibbs sampling*: States of the neurons in the hidden layers are calculated using probability functions $p(h_j^1 = 1|\, v, h^2, \theta)$ in (1) and $p(h_k^2 = 1|\, h^1, \theta)$ in (2). Once these values are available, the other function $p(v_i = 1|\, h^1, \theta)$ presented as (3) is used to predict new input values for the visible layer. This process can be repeated *m–times*. In the end, vectors ($\tilde{v}^{m}$, $\tilde{h}^{1,m}$, $\tilde{h}^{2,m}$) which were recreated from original input values ($v_0, h^{2,0}$) were obtained.

ii. *PCD*: The state of each hidden neuron h_j^1 and h_k^2 is calculated using its probability of being active μ_j^1 and μ_k^2 respectively. PCD shown in (7) - (9) was then used along with the vectors ($\tilde{v}^{m}$, $\tilde{h}^{1,m}$, $\tilde{h}^{2,m}$) obtained at the Gibbs sampling stage to update parameters.

$$\mu_j^1 = sigm(\sum_i \frac{1}{\sigma_i^2} v_i w_{ij} + \sum_k h_k^2 w_{jk}^1 + b_j^1 \tag{5}$$

$$\mu_k^2 = sigm(\sum_j h_j^1 w_{jk}^1 + b_k^2) \tag{6}$$

$$\Delta w_{ij} = \alpha(\frac{1}{N}\sum_{n=1}^{N} v^n (\mu^{1,n})^T - \frac{1}{M}\sum_{m=1}^{M} \tilde{v}^{1,m} (\tilde{h}^{1,m})^T) \quad (9) \tag{7}$$

$$\Delta w_{jk}^1 = \alpha(\frac{1}{N}\sum_{n=1}^{N} \mu^{1,n} (\mu^{2,n})^T - \frac{1}{M}\sum_{m=1}^{M} \tilde{h}^{1,m} (\tilde{h}^{2,m})^T) \tag{8}$$

$$\theta_{new} = \theta_{old} + \Delta\theta \tag{9}$$

To initialize the parameters of the DBM, a stack of two RBMs were trained on the training data and its parameters were used to initialize the parameters of the three-layer DBM during the training process (Salakhutdinov & Hinton, 2019; Cho et al., 2013). The overall learning procedure of the DBM is shown in Algorithm 1.

Algorithm 1. The training procedure of the DBM

1) **Input:** Training set $\{v\}_{n=1}^N$, *n*umber of Markov particles *M,* Iterations *m*
2) **Output**: A trained DBM model with parameters $\{w_{ij}, w_{jk}^1, b_i, b_j^1, b_k^2\}$.
3) Use $\{v\}_{n=1}^N$ to pre-train the DBM, and get the initial parameters of DBM $\{w_{ij}, w_{jk}^1, b_i, b_j^1, b_k^2\}$.
4) **for** *ite*=0 to *m* **do**
5) For each training sample v^n, use mean field approach (Equations 5 and 6) to get the variational parameters μ^n.
6) For each Gibbs sampling step, use equations 1, 2, and 3 repeatedly to obtain the state ($\tilde{v}^{m}$, $\tilde{h}^{1,m}$, $\tilde{h}^{2,m}$)
7) Update the parameters of DBM with PCD using equations 7, 8 and 9
8) **end**

3.2 Softmax Regression

The softmax regression is mathematically defined in (10) and was used as a classifier.

$$\phi_{\text{softmax}}(z^{(i)}) = p(y = j|z^{(i)}) = \frac{e^{z^{(i)}}}{\sum_{j=0}^{k} e^{z_k^{(i)}}}, \tag{10}$$

given that $z = w_1x_1 + ... + w_mx_m + b = \sum_{l=1}^{m} w_l x_l + b = w^T x + b$, where *w* the weight vector. The feature vector of one training sample is represented as *x* while *b* is known as the bias unit. The SoftMax function computes the probability that the training sample $x^{(i)}$ belongs to class *j* given the weight and net input $z^{(i)}$. The probability $p(y = j|x^{(i)};\, w_j)$ for each class label in *j=1,..., k* was then computed.

4. Model Implementation

Next, we provide the details of the system implementation, data description, and presented the experimental environment.

4.1 System Implementation

We deployed sniffers in the fog nodes and gateways' network. These monitor and gather the information exchanged amongst nodes. Since an important quantity of data can be extracted from packets, directly processing

it might decrease the performance of the DDoS attack detection system and can be resource-consuming. Therefore, the collected network traffic was used to feed a data pre-processing module, which included feature transformation and normalization. These operations entailed, amongst others, the inspection and selection of important features from the large-scale data, and the conversion of data into numeric features. The output of the pre-processing was used to train and develop the DBM for DDoS attack detection in the IoT environment. Finally, the SoftMax regression was used to classify traffics as "normal" or "attack".

4.2 Data Description

The NSL-KDD (Tavallaee et al., 2009) dataset which is a fundamental dataset for the evaluation of DDoS IDS was used to benchmark the developed model. The dataset involved normal traffics and attack traffic, including DoS, probing, user-to-root (U2R), and root-to-local (R2L) as described in Table 1.

Table 1. NSL-KDD distribution

Traffic		**Training**	**Test**
Normal		67343	9711
	DoS	45927	7458
	U2R	52	67
Attack	R2L	995	2887
	Probe	11656	2421
Total		**125973**	**22544**

The NSL-KDD dataset has 41 features (03 are nominal, 04 are binary, and the remaining 34 are continuous). We labeled the features as normal or a specific type of attack. The training data contained 23 traffic classes (22 attacks and 01 normal) and the test data contained 38 traffic classes (21 attacks from the training data, 16 novel attacks, and 01 normal). We also divided the attacks into four categories (DoS, Probing, U2R, and R2L) according to their purpose.

4.3 Data Pre-Processing

Before training the model, features that an algorithm cannot immediately process were encoded into discrete features using a one-hot-encoding (1-of-N) technique. The one-hot-encoding is known as the method of splitting the column containing numerical categorical data into many columns, depending on the number of categories present in that column. Each column contains "0" or "1" which is corresponding to the column it has been placed. This is accomplished using the OneHotEncoder Class of the Python library for data pre-processing Scikit-learn. Columns that were categorical and converted to binary are protocol_type (3 categories), service (70 categories), flag (11 categories). Because of encoding, 122 input features were obtained. The obtained dataset was scaled and centered using the StandardScaler Class of Scikit-learn library to avoid features with large values that may weigh too much in the results.

4.4 Experimental Environment

We trained the multilayer RBM on a normalized dataset. During the training, labels of the dataset were not used. For the simulation, 2-classes (normal vs attack) and 5-classes (normal, DoS (Denial of Service attacks), Probe, R2L (Root to Local attacks), and U2R (User to Root attack) were considered. After hyper-parameter optimizations, the model used 122 input features, 200 first layer neurons, 100-second layer neurons, and the last SoftMax layer with neurons equal to the number of classes. To train the network, 3 epochs were used.

We carried the experimental aspect of this study using Ubuntu x86 18.04.3 LTS installed on an HP-Pavillon-Dv6 with 6 GB memory, processor Intel® Core™ i5-2450M CPU @ 2.50GHz x 4. The PC had a graphics card Intel® Sandybridge Mobile with 4GB available. The model was simulated using the Integrated Development Environment (IDE) Spyder 3.3.3 under Anaconda 4.7.10 version 2019.03 installed with Python 3.7.3 version, SciPy library 1.2.1, Keras 2.2.4, and TensorFlow 1.14.0 backend. Scikit-learn 0.20.3, Pandas 0.24.2, NumPy 1.16.2, and Matplotlib 3.0.3 libraries were all installed to provide a robust simulation environment.

4.5 Evaluation Method

Evaluation of the performance of the developed model was carried out using accuracy, precision (P), recall (R), F-measure, and Throughput. The mentioned performance criteria were computed as follows:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{11}$$

$$Precision = \frac{TP}{TP + FP} \tag{12}$$

$$Recall = \frac{TP}{TP + FN} \tag{13}$$

$$F - measure = \frac{2.P.R}{P+R} \tag{14}$$

Where TP represents true positive and is defined as the case where the network attack types are correctly distinguished, TN represents the true negative, defined as cases where normal network data were correctly classified as normal. Similarly, FN represents a false negative defined as the case where an attack was classified as normal dataflow, while FP represents a false positive defined as cases where normal cases were classified as attacks.

Accuracy hence shows the overall correct detection accuracy of the dataset, while precision denotes the ratio of correctly detected attacks to total detected attacks. Recall signifies the degree of attacks that were correctly detected among all cases classified as attacks. Finally, the weighted average of Precision and Recall was captured by the F-measure. A good performance is indicated by higher accuracy and recall.

5. Results

In this subsection, we present the result of the proposed model. We first present the performance of the system using the selected evaluation methods which were followed by the comparative analysis.

5.1 Performance Evaluation

Table 3 shows the effectiveness of the DBM based on various metrics. Thus, the accuracy of the DBM in classifying traffic records as an attack or normal was 93.52%. Precision, Recall, and F-measure in the same context were 93%. For the classification of network traffics as "Normal" and four different attack categories (probe, U2R, R2L, DoS), the accuracy of the DBM was 91.69%.

Table 2. Evaluating the effectiveness of the methods

Class	Accuracy	Precision	Recall	F-measure
2-classes (Normal and attack)	93.52%	93%	93%	93%
5-classes (Normal and 4 attacks)	91.69%	92%	92%	91%

In the same scenario, the precision and the recall were 92% and the F-measure was 91%. It was concluded that the DBM efficiently detected DDoS attacks in the IoT environment. Figure 1 and Figure 2 visually show the confusion matrices of the two different classification with details over the reparation of the TP, TN, FP, and FN in each situation. The occurrence of DoS, U2R, R2L, probe, normal classes, and the ability of the developed DBM to detect these points respectively for each type of classification is also pictured in Figure 1 and Figure 2.

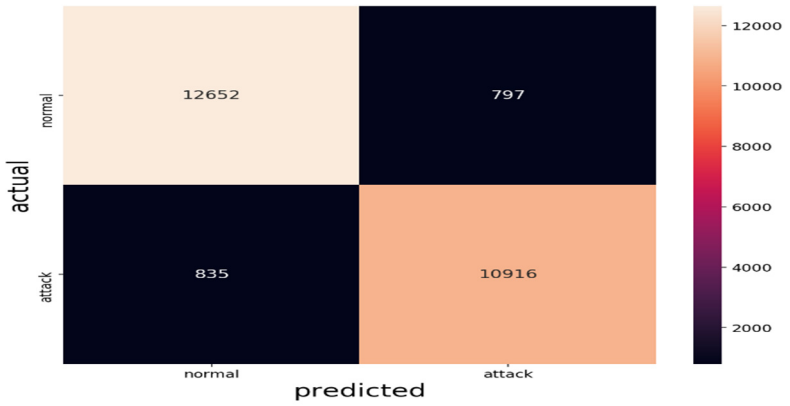

Figure 1. 2-classes (Normal and Attack)

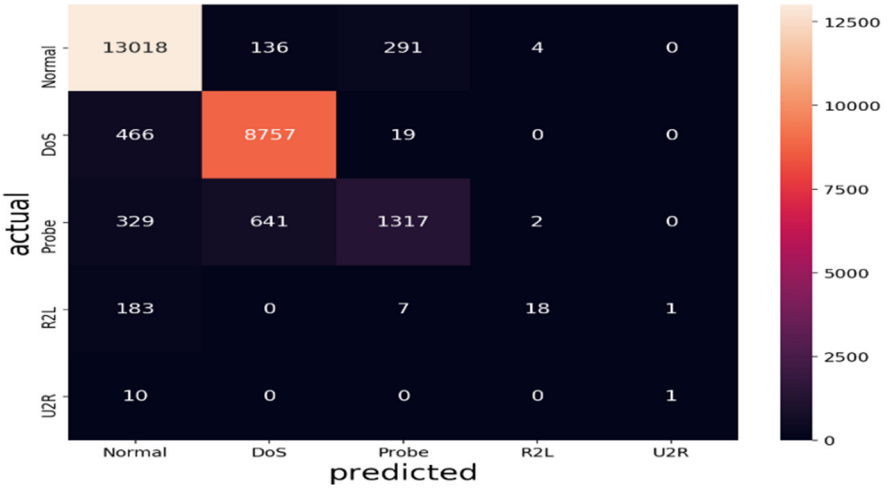

Figure 2. Confusion matrix: 5-classes (1 Normal and 4 Attacks: DoS, Probe, U2R, R2L)

Experiments related to the accuracy dynamics with respect to the number of epochs and the training time were also conducted (as shown in Figure 3, Figure 4, and Figure 5). Based on the number of epochs, the detection accuracy dynamics of the DBM are depicted in Figure 3. As illustrated, the DBM's DDoS attack detection accuracy gradually decreases as the number of epochs increases from 30 to 100. But the DBM's DoS attack detection accuracy gradually increases as the number of epochs increases from 3 to 30. As seen from Figure 3, when the number of iterations over the data decreases, the model detects DDoS attacks with high precision, but as the number of iterations increases, the accuracy of the model for DDoS attacks detection gradually falls. Figure 4 depicts the time consumption of the training with respect to the number of epochs. As given, the time consumption increases as the number of epochs increase from 3 to 30. Starting from 30 epochs, the computation time did not evolve anymore as the epoch increased. This, as well as the observations mentioned above, are due to the fact that the best model's parameters were obtained around this point and the system stopped learning.

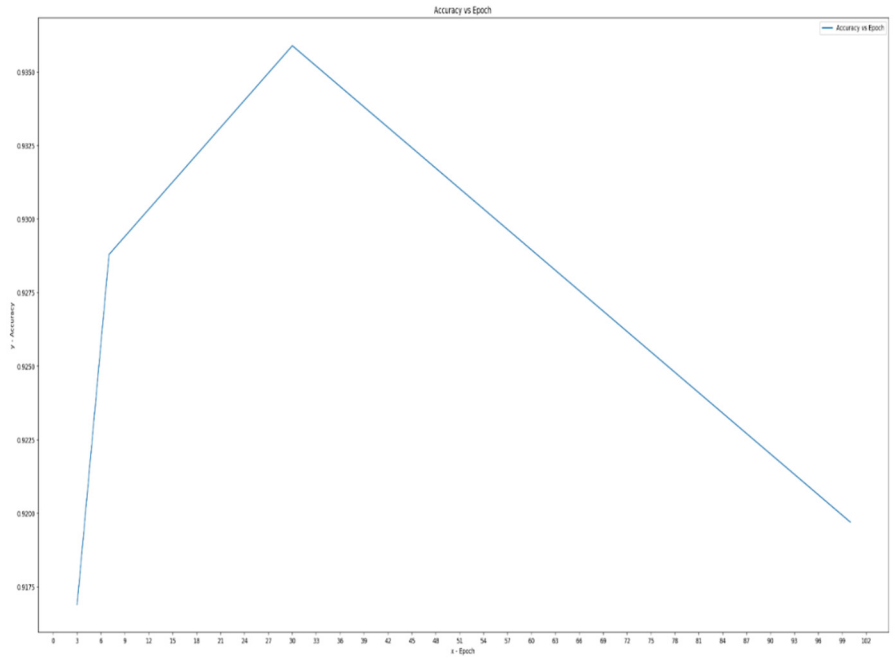

Figure 3. Detection rate dynamics of the DBM by number of epochs

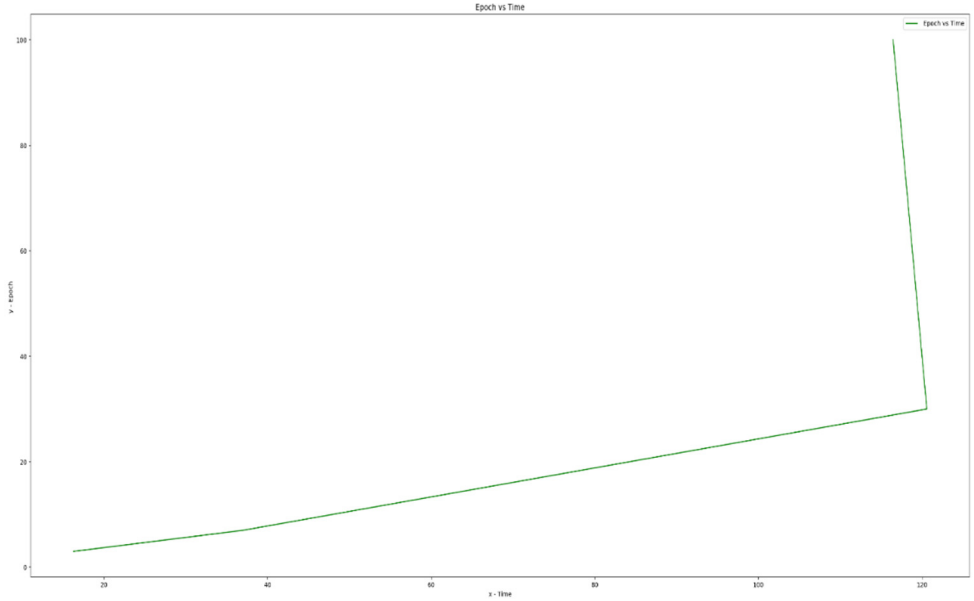

Figure 4. Epoch rate dynamics of the DBM over time consumption

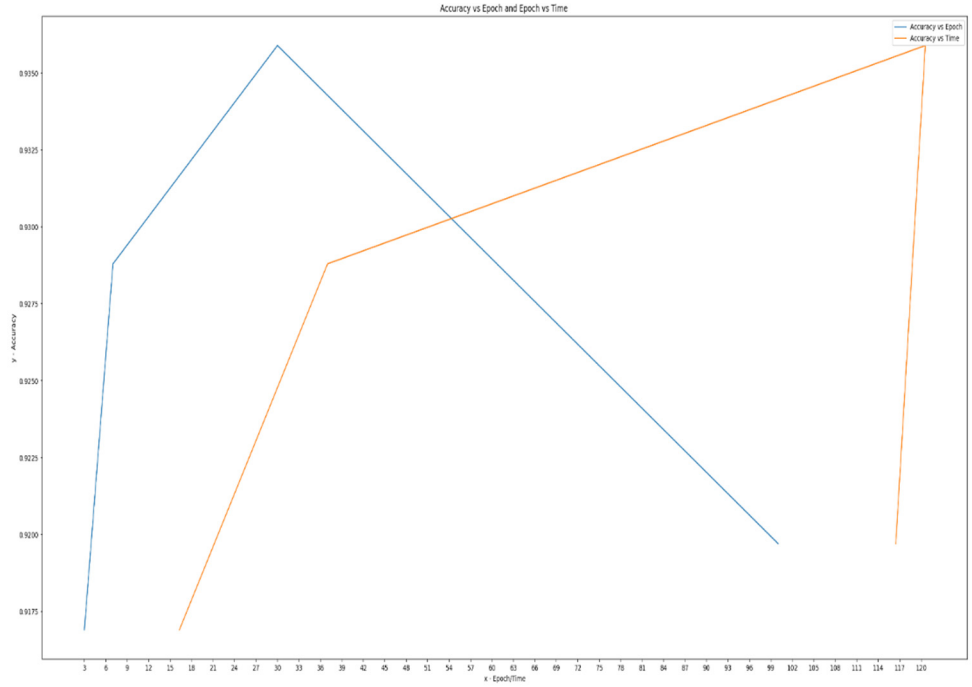

Figure 5. Accuracy dynamics as a function of Epochs and Time consumption

5.2 Results of Comparative Analysis

The performance of the proposed DBM for detecting DDoS attacks is evaluated using knowledge discovery in databases cup 99 (KDDCUP99) (Tavallaee et al., 2009) dataset, which is the detection of another DDoS attack benchmark dataset different from the NSL-KDD dataset used during the training of the proposed model. We passed kDDCUP99 to the developed model to observe and comparing performances. In Table 4 and Table 5, comparative analysis of the proposed DBM results on the NSL-KDD dataset with existing methods using NSL-KDD as a benchmark dataset on one hand and the proposed DBM results on the KDDCUP99 dataset with existing methods using KDDCUP99 as benchmark dataset, on the other hand, is described. The proposed DBM results on NSL-KDD outperform the results of the methods in (Javaid et al., 2016) and (Imamverdiyev & Abdullayeva, 2018). The accuracy of the proposed DBM was 93.52% while the model in (Imamverdiyev & Abdullayeva, 2018) had an accuracy of 78%, and (Javaid et al., 2016) had an accuracy of 88.39%. The proposed DBM results on KDDCUP99 performed better than the results of the method in (Li et al., 2015). The model in

(Sarigiannidis et al., 2015) achieved better performance on NSL-KDD than the developed model though the details of the DL model adopted in (Sarigiannidis et al., 2015) were not mentioned.

Table 3. Evaluation of the effectiveness of the proposed model on the NSL-KDD dataset with existing

Author	Method	Accuracy on NSL-KDD
[12]	Sparse autoencoder + Softmax	88.39%
[18]	Deep Restricted Boltzmann Machine	78%
[10]	Deep networks + Softmax	99%
The model developed in this study	**DBM + Softmax**	**93.52%**

Table 4. Evaluation of the effectiveness of the proposed model on KDDCUP99 dataset with existing

Author	Method	Accuracy on KDDCUP99
[14]	AutoEncoder + DBN	92.10%
Model developed in this study	**DBM + Softmax**	**97.95%**

6. Conclusion and Future Work

Internet of Things (IoT) is ubiquitous and providing adequate security to IoT is inevitable. This study explored the ability of Deep Learning approaches to detect DDoS attacks in IoT networks with regard to IoT peculiarities. In particular, we investigated it whether applying fog computing principles could make it possible to employ Deep Learning algorithms in IoT. Thus, a deep learning based-model for detecting distributed denial of service attacks in the Internet of Things was developed and hosted on fog nodes. The results of the simulation experiments showed that the proposed DBM efficiently detects DDoS attacks and outperforms previously reported works. This study contributes to knowledge by establishing a blueprint and a deep learning based-model for detecting distributed denial of service attacks in IoT.

The developed IDS with DBM for DDoS in IoT evaluation was limited to two different datasets. More datasets could be used to evaluate the proposed model in future works. Moreover, more improvement in the accuracy of the DBM by fine-tuning its parameters can be considered. Experimenting with the behavior of the developed model in a network with more nodes can be attempted. The developed model was also limited to DDoS attacks. It may also be expanded to consider more cybersecurity attacks such as Wormhole attacks, Sinkhole attacks, Sybil attacks, Selective Forwarding Attacks, etc all of which jeopardize the existence of IoT.

References

Alqahtani, B., & AlNajrani, B. (2020, October). A Study of Internet of Things Protocols and Communication. In *2020 2nd International Conference on Computer and Information Sciences (ICCIS)* (pp. 1-6). IEEE. https://doi.org/10.1109/ICCIS49240.2020.9257652

Arış, A., Oktuğ, S. F., & Yalçın, S. B. Ö. (2015, May). Internet-of-Things security: Denial of Service Attacks. In *2015 23rd Signal Processing and Communications Applications Conference (SIU)* (pp. 903-906). IEEE. https://doi.org/10.1109/SIU.2015.7129976

Arnaboldi, L., & Morisset, C. (2017, September). Quantitative Analysis of DoS attacks and Client Puzzles in IoT Systems. In Livraga G. & Mitchell C. (Eds.), *Security and Trust Management.* STM 2017. Lecture Notes in Computer Science, vol 10547. Springer, Cham. https://doi.org/10.1007/978-3-319-68063-7_16

Chen, X., Makki, K., Yen, K., & Pissinou, N. (2009). Sensor Network Security: A Survey. *IEEE Communications surveys & tutorials, 11*(2), 52-73. https://doi.org/10.1109/SURV.2009.090205

Cho, K. H., Raiko, T., & Ilin, A. (2013, August). Gaussian-Bernoulli Deep Boltzmann Machine. In *The 2013 International Joint Conference on Neural Networks (IJCNN)* (pp. 1-7). IEEE. https://doi.org/10.1109/IJCNN.2013.6706831

Denise, B. (2020). DDoS Breach Costs Rise to over $2M for Enterprises finds Kaspersky Lab Report. Retrieved from https://usa.kaspersky.com/about/press-releases/

Diro, A. A., & Chilamkurti, N. (2018). Distributed Attack Detection Scheme Using Deep Learning Approach Internet of Things. *Future Generation Computer Systems, 82*, 761-768. https://doi.org/10.1016/j.future.2017.08.043

Elsaeidy, A., Munasinghe, K. S., Sharma, D., & Jamalipour. A. (2019). Intrusion Detection in Smart Cities Using Restricted Boltzmann Machines. *Journal of Network and Computer Applications, 135*, 76-83. https://doi.org/10.1016/j.jnca.2019.02.026

Fu, R., Zheng, K., Zhang, D., & Yang, Y. (2011). An Intrusion Detection Scheme Based on Anomaly Mining in Internet of Things. In *IET International Conference on Wireless, Mobile and Multimedia Networks*, Beijing, Nov. 2011, pp. 315-320.

Haddadpajouh, H., Mohtadi, A., Dehghantanaha, A., Karimipour, H., Lin, X., & Choo, K. K. R. (2020). A Multikernel and Metaheuristic Feature Selection Approach for IoT Malware Threat Hunting in the Edge Layer. *IEEE Internet of Things Journal, 8*(6), 4540-4547. https://doi.org/10.1109/JIOT.2020.3026660

Imamverdiyev, Y., & Abdullayeva, F. (2018). Deep Learning Method for Denial of Service Attack Detection Based on Restricted Boltzmann Machine. *Big data, 6*(2), 159-169. https://doi.org/10.1089/big.2018.0023

Javaid, A., Niyaz, Q., Sun, W., & Alam, M. (2016). A Deep Learning Approach for Network Intrusion Detection System. *EAI Endorsed Transactions on Energy Web, 16*(9). https://doi.org/10.4108/eai.3-12-2015.2262516

Kang, M. J., & Kang, J. W. (2016). A Novel Intrusion Detection System Using Deep Neural Network for In-vehicle Network Security. In *2016 IEEE 83rd Vehicular Technology Conference (VTC Spring)*. https://doi.org/10.1109/VTCSpring.2016.7504089

Kasinathan, P., Pastrone, C., Spirito, M. A., & Vinkovits, M. (2013, October). Denial-of-Service Detection in 6LoWPAN Based Internet of Things. In *2013 IEEE 9th international conference on wireless and mobile computing, networking and communications (WiMob)* (pp. 600-607). IEEE. https://doi.org/10.1109/WiMOB.2013.6673419

Latif, S., Idrees, Z., Zou, Z., & Ahmad, J. (2020, August). DRaNN: A Deep Random Neural Network Model for Intrusion Detection in Industrial IoT. In *2020 International Conference on UK-China Emergin Technologies (UCET)* (pp. 1-4). IEEE. https://doi.org/10.1109/UCET51115.2020.9205361

Li, Y., Ma, R., & Jiao, R. (2015). A hybrid Malicious Code Detection Method Based on Deep Learning. *International Journal of Security and Its Applications, 9*(5), 205-216. https://doi.org/10.14257/ijsia.2015.9.5.21

Li, Y., Xu, Y., Liu, Z., Hou, H., Zheng, Y., Xin, Y., ... & Cui, L. (2020). Robust Detection for Network Intrusion of Industrial IoT Based on Multi-CNN Fusion. *Measurement, 154*, 107450. https://doi.org/10.1016/j.measurement.2019.107450

Ma, T., Wang, F., Cheng, J., Yu, Y., & Chen, X. (2016). A Hybrid Spectral Clustering and Deep Neural Network Ensemble Algorithm for Intrusion Detection in Sensor Networks. *Sensors, 16*(10), 1701. https://doi.org/10.3390/s16101701

Pang, G., Shen, C., Cao, L., & Hengel, A. V. D. (2021). Deep Learning for Anomaly Detection: A review. *ACM Computing Surveys (CSUR), 54*(2), 1-38. https://doi.org/10.1145/3439950

Raza, S., Wallgren, L., & Voigt, T. (2013). SVELTE: Real-time Intrusion Detection in the Internet of Things. *Ad hoc networks, 11*(8), 2661-2674. https://doi.org/10.1016/j.adhoc.2013.04.014

Robert J., & Wang, E. (2020). Distributed Denial of Service (DDoS) Attacks and IoT Security. Retrieved from https://www.grin.com/document/371086

Salakhutdinov, R., & Hinton, G. (2019). *Deep Boltzmann Machines, Artificial Intelligence and Statistics* (pp. 448-455).

Sarigiannidis, P., Karapistoli, E., & Economides, A. A. (2015, June). VisIoT: A Threat Visualisation Tool for IoT Systems Security. In *2015 IEEE International Conference on Communication Workshop (ICCW)* (pp. 2633-2638). IEEE. https://doi.org/10.1109/ICCW.2015.7247576

Tavallaee, M., Bagheri, E., Lu, W., & Ghorbani, A. A. (2009, July). A Detailed Analysis of the KDD CUP99 data set. In *2009 IEEE symposium on computational intelligence for security and defense applications* (pp. 1-6). IEEE. https://doi.org/10.1109/CISDA.2009.5356528

Vincent, P., Larochelle, H., Lajoie, I., Bengio, Y., Manzagol, P. A., & Bottou, L. (2010). Stacked Denoising Autoencoders: Learning Useful Representations in a Deep Network with a local denoising criterion. *Journal of machine learning research, 11*(12).

Yadav, S., & Subramanian, S. (2016, March). Detection of Application Layer DDoS attack by Feature Learning using Stacked AutoEncoder. In *2016 international conference on computational techniques in information and communication technologies (ICCTICT)* (pp. 361-366). IEEE. https://doi.org/10.1109/ICCTICT.2016.7514608

Modern Applied Science; Vol. 16, No. 2; 2022
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

Maximum and Minimum Works Performed by $\widetilde{T}_n$

Pokalas P. Tal[1], M. S. Mahmud[1], M. A. Mbah[2] & R. U. Ndubuisi[3]

[1] Department of Mathematics and Statistics, Federal University of Kashere, Gombe, Nigeria

[2] Department of Mathematics and Statistics, Federal University Lafiya, Nigeria

[3] Department of Mathematics, Federal University of Technology, Owerri, Nigeria

Correspondence: Pokalas P. Tal, Department of Mathematics and Statistics, Federal University of Kashere, Gombe, Nigeria.

Received: February 10, 2022 Accepted: April 18, 2022 Online Published: April 22, 2022

doi:10.5539/mas.v16n2p23 URL: https://doi.org/10.5539/mas.v16n2p23

Abstract

Let X_n and X_n^* be the finite sets $\{1, 2, 3, \ldots, n\}$ and $\{\pm 1, \pm 2, \pm 3, \ldots, \pm n\}$ respectively. A map $\alpha: X_n \to X_n$ is called a transformation on X_n. We call α a signed transformation if $\alpha: X_n \to X_n^*$. Let T_n and $\tilde{T}_n$ be the sets of full and signed full transformations on X_n respectively. The work, $w(\alpha)$ performed by a transformation α is defined as the sum of all the distances $|i - i\alpha|$ for each $i \in dom(\alpha)$. In this paper, we present a range for the values of $w(\alpha)$ for all $\alpha \in T_n$. Further, we characterize elements of $\tilde{T}_n$ that attain minimum and maximum works and provide formulas for the values of these minimum and maximum.

Keywords: transformation, full transformation, signed full transformation, work

1. Introduction

Let $X_n = \{1, 2, 3, \ldots, n\}$ and $X_n^* = \{\pm 1, \pm 2, \pm 3, \ldots, \pm n\}$ be finite sets. A transformation α on X_n is a map $\alpha: X_n \to X_n$. α is a full transformation if its domain ($dom(\alpha)$) is the entire X_n. We denote by T_n the set of all full transformations on X_n. Now, if $\alpha: X_n \to X_n^*$, α will be called a signed transformation and in the same way, if $dom(\alpha) = X_n$, α will be called a signed full transformation. Here we denote the set of all signed full transformation on X_n by $\tilde{T}_n$ and the image of $i \in dom(\alpha)$ by $i\alpha$.

The work performed by a transformation semigroup was studies in East and McNamara (2011). It was stated in East and McNamara (2011) that if the elements of X_n are thought of as points, equally spaced, then the point $i \in X_n$ has been moved a distance of $|i - i\alpha|$ units. Summing these values as i varies over the $dom(\alpha)$ gives the (total) work performed by α and denoted by $w(\alpha)$. Although East and McNamara (2011) considered various subsemigroups of the partial transformation semigroup, it is noteworthy that the operation that qualifies the set of transformation to be a semigroup is not playing any role when calculating the work performed by any semigroup. Hence, their work can still be done in the sets of transformations. It is in this regard that Imam and Tal (2019) studied maximum work performed by elements of the sets of full and partial transformations. They characterized elements of the full and partial transformations that perform maximum work with respect to other elements in the sets. They found a formula for these maximums and further determined the number of maps that attain the maximum.

Researchers have over the years discussed concepts that is related to work although with slight variations. It was noted in Imam and Tal (2019) that Knuth (1973) considered the total displacement of a permutation π and defined it by $\sum_{i=1}^{n} |i - \pi(i)|$ where $i \in dom(\pi)$. Concepts closely related to work were discussed by Diaconis and Graham (1977), Aitken (1999), (Gallero, Montorsi, Benedetto & Cancellieri, 2001) and Ravichandran and Srinivasan (2003). The study on signed full transformation semigroup, $\tilde{T}_n$ was initiated in Richard (2008) which is the semigroup analogue of the signed symmetric group, $\tilde{S}_n$ that was studied in James and Kerber (1981).

In this paper, we extend the work of Imam and Tal (2019) to the signed full transformation since here also, the operation that makes $\tilde{T}_n$ a semigroup isn't playing any role in our study. The next sections will be for preliminary definitions and results while we present in the third section the findings of this paper.

2. Preliminaries

We present below existing definitions and results needed to understand the result of this paper.

Definition 2.1 (East and McNamara, 2011) The work performed by a (partial) transformation $\alpha \in P_n$ in moving a point $i \in dom(\alpha)$ is defined to be:

$$w_i(\alpha) = \begin{cases} |i - i\alpha| \; if \; i \in dom(\alpha) \\ 0 \qquad otherwise, \end{cases}$$

The (total) work performed by α is given by

$$w(\alpha) = \sum_{i \in X_n} w_i(\alpha)$$

Definition 2.2: Let $X_n = \{1, 2, 3, \ldots, n\}$ and $X_n^* = \{\pm 1, \pm 2, \pm 3, \ldots, \pm n\}$ be finite sets. A mapping $\alpha: X_n \to X_n$ is called a transformation on X_n. If $dom(\alpha) = X_n$, α is called a full transformation. The set of all full transformations on X_n is denoted by T_n. If the codomain of α is equal to $X_n^* = \{\pm 1, \pm 2, \pm 3, \ldots, \pm n\}$, and $dom\ (\alpha) = X_n$, α will be called a signed full transformation on X_n and the set of all signed full transformations on X_n is denoted by $\tilde{T}_n$.

The result that follows presents a description of maps in T_n that performs maximum work when $n \in \mathbb{N}$ is either even or odd. It tells us about the value of this maximum and the number of maps that attain these maximums.

Theorem 2.1 (Imam and Tal, 2019) Let $\alpha \in T_n$. Then,

a. If n is even, α performs maximum work in T_n if and only if for each $i \in dom(\alpha)$,

$$i\alpha = \begin{cases} \text{n} & \text{if } 1 \le \text{i} \le \frac{\text{n}}{2}, \\ 1 & \text{if } (\frac{\text{n}}{2}) + 1 \le \text{i} \le \text{n}. \end{cases}$$

b. If n is odd, α performs the maximum work in T_n if and only if for each $i \in dom(\alpha)$,

$$i\alpha = \begin{cases} \text{n} & \text{if } 1 \le \text{i} \le \frac{\text{n}-1}{2}, \\ \text{n or } 1 & \text{if i} = (\frac{\text{n}-1}{2}) + 1, \\ 1 & \text{if } (\frac{\text{n}-1}{2}) + 2 \le \text{i} \le \text{n}. \end{cases}$$

Moreover,

c. $$\begin{cases} \frac{\text{n}}{4}(3\text{n} - 2) & \text{if n is even}, \\ \frac{1}{4}(\text{n} - 1)(3\text{n} + 1) & \text{if n is odd}. \end{cases}$$

Finally, if

$\Delta(\text{S}) = |\{\alpha \in \text{S}: \text{w}(\alpha) \text{ is maximum}\}|$. Then

d. $$\Delta(T_n) = \begin{cases} 1 & \text{if n is even}, \\ 2 & \text{if n is odd}. \end{cases}$$

The proof to this result can found in (Imam and Tal, 2019).

3. Results

We present in this section the findings of this work. We begin by a result which is a consequence of theorem 2.1(c) and (d).

Theorem 3.1: If n is even, then $0 \le w\ (\alpha) \le {}^{n}/_{4}\ (3n - 2), \forall \alpha \in T_n\ (n \in \mathbb{N})$.

Proof:

Let n be even and $\alpha \in T_n$. Suppose $\forall i \in dom(\alpha), i\alpha = i$, it follows from definition 2.1 that $w\ (\alpha) = 0$. Now, since $\alpha \in T_n$ is unique, it follows that we cannot find any $\beta \in T_n$ for which $w\ (\beta) \le w(\alpha)$. Thus, if $\forall i \in dom\ (\alpha), i\alpha = i$, such α attains minimum work in T_n with the value 0.

Further, let $\alpha \in T_n$ be as in theorem 2.1 (a). We notice that by theorem 2.1 (c), its work, $w\ (\alpha) = {}^{n}/_{4}\ (3n - 2)$. Now, by the uniqueness of such $\alpha \in T_n$ (theorem 2.1 (d)), we cannot find any $\gamma \in T_n$ for which $w\ (\gamma) \ge w\ (\alpha)$. Moreover, if $\alpha \in T_n$ is not such that $i\alpha = i, \forall i \in dom(\alpha)$, and the map $\alpha \in T_n$ as in theorem 2.1 (a), then $0 < w\ (\alpha) < {}^{n}/_{4}\ (3n - 2)$. This follows that $\forall \alpha \in T_n$, $0 \le w\ (\alpha) \le {}^{n}/_{4}\ (3n - 2)$.

Theorem 3.2: If n is odd, then $0 \leq w(\alpha) \leq {}^{1}/_{4}(n-1)(3n+1), \forall \alpha \in T_n$ $(n \in \mathbb{N})$.

Proof:

Let n be odd and $\alpha \in T_n$. Suppose $\forall i \in dom(\alpha), i\alpha = i$, it follows from definition 2.1 that $w(\alpha) = 0$. Now, since $\alpha \in T_n$ is unique, it follows that we cannot find any $\beta \in T_n$ for which $w(\beta) \leq w(\alpha)$. Thus, if $\forall i \in dom(\alpha), i\alpha = i$, such α attains minimum work in T_n with the value 0.

Now, by the characterization in theorems 2.1 (b) and by theorem 2.1 (c), two maps $\alpha_1, \alpha_2 \in T_n$ will attain maximum work in T_n with $w(\alpha_1) = w(\alpha_2) = {}^{1}/_{4}(n-1)(3n+1)$. It follows by this that we cannot find any $\xi \in T_n$ for which $w(\alpha_1) \leq w(\xi) \geq w(\alpha_2)$. Notice that if $\alpha \in T_n$ is not such that $i\alpha = i, \forall i \in dom(\alpha)$, and the map $\alpha \in T_n$ as in theorem 2.1 (a), then $0 < w(\alpha) < {}^{1}/_{4}(n-1)(3n+1)$. This follows that $\forall \alpha \in T_n$, $0 \leq w(\alpha) \leq {}^{n}/_{4}(3n-2)$.

The above results provide a range for values of work performed by every map in T_n in the even and odd cases respectively.

The next result characterizes elements of the signed full transformation that attain maximum work.

Theorem 3.3: Let $\alpha \in \tilde{T}_n$. α performs the maximum work in $\tilde{T}_n$ if and only if for each $i \in dom(\alpha)$, $i\alpha = -n$.

Proof:

Let $\alpha \in \tilde{T}_n$. Suppose α performs maximum work in $\tilde{T}_n$, then it follows by the definition of work performed by $\alpha \in \tilde{T}_n$, that for each $i \in dom(\alpha)$,

$$w(\alpha) = \sum_{i=1}^{n} |\, i - i\alpha \,|$$

Now, it is easy to notice that maximum $w(\alpha)$ can only be achieved when $|i - i\alpha|$ is made as large as possible for each $i \in dom(\alpha)$. Thus, we can clearly achieve this maximum if,

$$max\,|\, i - i\alpha| \;=\; |i - (-n)| \;=\; i + n, \quad \text{for each } i \in dom(\alpha).$$

We can easily deduce from above that $i\alpha = -n$.

Conversely, suppose $\alpha \in \tilde{T}_n$ is such that $i\alpha = -n$, then for each $i \in dom(\alpha)$, $|i - i\alpha|$ will clearly be at maximum for each $i \in dom(\alpha)$. This ultimately makes $w(\alpha)$ to be at maximum. And so $\alpha \in \tilde{T}_n$ performs maximum work in $\tilde{T}_n$.

It is not hard to see by the result above that $\alpha \in \tilde{T}_n$ will attain maximum work if and only if it is a constant map whose image is $-n$ $(n \in \mathbb{N})$.

Next, we present the maximum value $\alpha \in \tilde{T}_n$ will attain for any n.

Theorem 3.4: Suppose $\alpha \in \tilde{T}_n$ is such that $i\alpha = -n \; \forall i \in dom(\alpha)$, then $w(\alpha) = \frac{3n^2+n}{2}$, $n \in \mathbb{N}$.

Proof:

Suppose $\alpha \in \tilde{T}_n$ is such that $i\alpha = -n$, for each $i \in dom(\alpha)$, then by definition, the work $\alpha \in \tilde{T}_n$

Will perform is given by

$$\begin{aligned} w(\alpha) &= \sum_{i=1}^{n} |\, i - i\alpha \,| \\ &= \sum_{i=1}^{n} |\, i - (-n) \,| \\ &= \sum_{i=1}^{n} |\, n + i \,| \\ &= (n+1) + (n+2) + (n+3) + \ldots + 2n. \\ &= n^2 + \frac{n(n+1)}{2} \\ &= \frac{3n^2 + n}{2}. \end{aligned}$$

The result above provides us with the maximum value (formula) $\alpha \in \tilde{T}_n$ (as in theorem 3.3) will attain for any $n \in \mathbb{N}$.

Example 3.1:

Let $\alpha = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ -5 & -5 & -5 & -5 & -5 \end{pmatrix} \in \tilde{T}_5$

Now, $w(\alpha) = \sum_{i=1}^{n} |i - i\alpha| = |1-(-5)| + |2-(-5)| + |3-(-5)| + |4-(-5)| + |5-(-5)|$

$= 6 + 7 + 8 + 9 + 10 = 40.$

Since $n = 5$, we can verify Theorem 3.4,

$$w(\alpha) = \frac{3n^2 + n}{2} = \frac{3 \times 5^2 + 5}{2} = \frac{80}{2} = 40.$$

Example 3.2:

Let $\alpha = \begin{pmatrix} 1 & 2 & 3 & 4 \\ -4 & -4 & -4 & -4 \end{pmatrix} \in \tilde{T}_4$

Now, $w(\alpha) = \sum_{i=1}^{n} |i - i\alpha| = |1-(-4)| + |2-(-4)| + |3-(-4)| + |4-(-4)|$

$= 5 + 6 + 7 + 8 = 26.$

To verify Theorem 3.4,

$$w(\alpha) = \frac{3n^2 + n}{2} = \frac{3 \times 4^2 + 4}{2} = \frac{52}{2} = 26.$$

Example 3.3:

Let $\alpha = \begin{pmatrix} 1 & 2 & 3 \\ -3 & -3 & -3 \end{pmatrix} \in \tilde{T}_3$

Now, $w(\alpha) = \sum_{i=1}^{n} |i - i\alpha| = |1-(-3)| + |2-(-3)| + |3-(-3)||$

$= 4 + 5 + 6 = 15.$

Theorem 3.4 can be verified as in examples 3.1 and 3.2.

Consider,

$\tilde{R}_n = \{\alpha \in \tilde{T}_n | i\alpha < 0, \forall i \in dom(\alpha), n \in \mathbb{N}\}$. $\tilde{R}_n$ is the set of all transformations in $\tilde{T}_n$ whose images are negative.

Remark 1: $\alpha \in \tilde{T}_n$ such as described by theorem 3.3 will attain maximum work in $\tilde{R}_n$ since such $\alpha \in \tilde{R}_n$. This is not hard to see.

We explore therefore in the next result and the one after next the nature of the map in $\tilde{R}_n$ that performs the minimum work, and the value (formula) for this minimum respectively.

Theorem 3.5: Let $\alpha \in \tilde{R}_n$. α performs minimum work in $\tilde{R}_n$ if and only if for each $i \in dom(\alpha)$, $i\alpha = -1$.

Proof:

Let $\alpha \in \tilde{R}_n$. Suppose α performs minimum work in $\tilde{R}_n$, then we know by the definition of work performed by $\alpha \in \tilde{R}_n$, that for each $i \in dom(\alpha)$,

$$w(\alpha) = \sum_{i=1}^{n} |i - i\alpha|$$

Now, we can achieve this minimum $w(\alpha)$ only when $|i - i\alpha|$ is made as small as possible for each $i \in dom(\alpha)$. This is thus possible if,

$$min\,|i - i\alpha| = |i - (-1)| = i + 1, \quad \text{for each } i \in dom(\alpha).$$

We can easily deduce from above that $i\alpha = -1$.

Conversely, suppose $\alpha \in \tilde{R}_n$, is such that $i\alpha = -1$, then for each $i \in dom(\alpha)$, $|i - i\alpha|$ will clearly be at minimum for each $i \in dom(\alpha)$, compared to any $\lambda \in \tilde{R}_n$ different from $\alpha \in \tilde{R}_n$. This clearly makes $w(\alpha)$ to be at minimum, and so $\alpha \in \tilde{R}_n$, performs minimum work in $\tilde{R}_n$.

By theorem 3.5, $\alpha \in \tilde{R}_n$ will attain minimum work if and only if it is a constant map whose image is -1.

Theorem 3.6: Suppose $\alpha \in \tilde{R}_n$ is such that $i\alpha = -1$, for all $i \in dom(\alpha)$, then $w(\alpha) = \frac{n^2+3n}{2}, n \in \mathbb{N}$.

Proof:

Suppose $\alpha \in \tilde{R}_n$ is such that $i\alpha = -n$, for each $i \in dom(\alpha)$, then by definition, the work $\alpha \in \tilde{R}_n$ will perform is given by

$$\begin{aligned} w(\alpha) &= \sum_{i=1}^{n} |i - i\alpha| \\ &= \sum_{i=1}^{n} |i - (-1)| \\ &= \sum_{i=1}^{n} |1 + i| \\ &= (1+1) + (1+2) + (1+3) + \ldots + (1+n). \\ &= n + \frac{n(n+1)}{2} \\ &= \frac{n^2 + 3n}{2}. \end{aligned}$$

Let $\alpha = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ -1 & -1 & -1 & -1 & -1 \end{pmatrix} \in \tilde{R}_5 \in \tilde{T}_5$.

Now, $w(\alpha) = \sum_{i=1}^{n} |i - i\alpha| = |1-(-1)| + |2-(-1)| + |3-(-1)| + |4-(-1)| + |5-(-1)|$

$$= 2 + 3 + 4 + 5 + 6 = 20.$$

Since $n = 5$, we can verify using $\frac{n^2+3n}{2}$ we obtain the value 20.

Example 3.5:

Let $\alpha = \begin{pmatrix} 1 & 2 & 3 & 4 \\ -1 & -1 & -1 & -1 \end{pmatrix} \in \tilde{R}_4$

Now, $w(\alpha) = \sum_{i=1}^{n} |i - i\alpha| = |1-(-1)| + |2-(-1)| + |3-(-1)| + |4-(-1)|$

$$= 2 + 3 + 4 + 5 = 14.$$

Since $n = 4$, we can verify using $\frac{n^2+3n}{2}$ we obtain the value 14.

Example 3.6:

Let $\alpha = \begin{pmatrix} 1 & 2 & 3 \\ -1 & -1 & -1 \end{pmatrix} \in \tilde{R}_3$

Now, $w(\alpha) = \sum_{i=1}^{n} |i - i\alpha| = |1-(-1)| + |2-(-1)| + |3-(-1)|$

$= 2 + 3 + 4 = 9.$

We can verify $\frac{n^2+3n}{2}$ as in examples 3.4 and 3.5.

Remark 2: We remark here that the paper of Imam and Tal (2019) on maximum work performed by elements of T_n can be carried out in $\tilde{T}_n$ since $T_n \subset \tilde{T}_n$. The implication is that the identity map in $\tilde{T}_n$ will perform the minimum work in $\tilde{T}_n$. With this together with remark 1 in mind, we conclude thus:

Theorem 7:

(a). for all $\alpha \in \tilde{T}_n$, $0 \leq w(\alpha) \leq \frac{3n^2+n}{2}$.

(b). for all $\alpha \in \tilde{R}_n$, $\frac{n^2+3n}{2} \leq w(\alpha) \leq \frac{3n^2+n}{2}$.

Proof:

The proof to (a) and (b) will follow the same pattern as the proof of theorem 3.1.

4. Conclusion

This study provides a consequence to the result of East and McNamara (2011) by providing a range for the values of the work performed by all $\alpha \in T_n$. We further characterized elements of $\tilde{T}_n$ and $\tilde{R}_n$ that attain maximum and minimum and generalized the values of the maximum and minimum for any $n \in \mathbb{N}$.

References

Aitken, W. (1999). Total Relative Displacement of Permutations. *Journal of Combinatorial Theory, 87*(1), 1-21. https://doi.org/10.1006/jcta.1998.2943

Diaconis, P., & Graham, R. L. (1977). Spearman's Footrule as a Measure of Disarray. *Journal of the Royal Statistical Society: Series B (Methodological), 39*(2), 262-268. https://doi.org/10.1111/j.2517-6161.1977.tb01624.x

East, J., & McNamara, P. J. (2011). On the Work Performed by a Transformation Semigroup. *Australasian Journal of Combinatorics, 49*, 95-109.

Gallero, R., Montorsi, G., Benedetto, S., & Cancellieri, G. (2001). Interleaver Properties and their Applications to the Trellis Complexity Analysis of Turbo Codes. *IEEE Transactions on Communications, 49*(5), 793-807. https://doi.org/10.1109/26.923803

Imam, A. T., & Tal, P. P. (2019). On Maximum Works and Stretches Performed by Transformations of a Finite Set. *Journal of the Nigerian Association of Mathematical Physics, 53*, 21-28.

James, G. D., & Kerber, A. (1981). *The Representation Theory of the Symmetric Group*. Addison-Wesley, Reading, M.A.

Knuth, D. E. (1973). *The Art of Computer Programming-3, Sorting and Searching*. Addison-Wesley Publishing Company.

Ravichandran, V., & Srinivasan, N. (2003). Measures for Displacement of Permutations Used for Speech Scrambling. *Journal of Indian Acad. Mathematics, 25*(2), 251-259.

Richard, F. P. (2008). *Transformation Semigroups over Group*. Ph. D dissertation Submitted to Graduate Faculty of North Carolina State University. pp 1-89.

Copyrights

Modern Applied Science; Vol. 16, No. 2; 2022
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

Impairment and Traumatization as Crucial Factors for Didactics and Pedagogy of Adolescent Refugees

Martin Kölbel[1]

[1] Hoffeld, Aspang, Austria

Correspondence: Martin Kölbel, Hoffeld, Aspang, Austria.

Received: April 11, 2022 Accepted: April 25, 2022 Online Published: April 29, 2022

doi:10.5539/mas.v16n2p30 URL: https://doi.org/10.5539/mas.v16n2p30

Abstract

Discussions about the extent of integration of adolescent refugees as well as integrating displaced people 'correctly' in the respective education system of the target country have long been held about. Since crisis caused by, for example, war or the Covid-19 pandemic increase the numbers of refugees all over the world, a high number of displaced people suffer from experienced traumas and might therefore be impaired in participating in curricular education. For this study, the observation of three adolescent refugees who attend different sports classes, thus being encompassed by variable social settings, has been at the center of attention for one semester. To ensure data variety, principals, PE teachers, refugee students, 'regular' students have been interviewed, respectively.

The analysis revealed that huge differences in terms of adaptation as well as impairment could be observed among the participating adolescent refugees. While one of the refugee students easily adapted among the observed manifestations (non-)verbal communication, social form, behavioral strategies and potentials of physical education, the other adolescent refugee displayed severe impairment in all of the manifestations mentioned above; hence, experienced traumata experienced before, during or after flight require newly arriving students being psychologically examined and monitored.

Keywords: adolescent refugees, traumatization, impairment, inclusive physical education

1. Introduction

On February 24th, 2022 Russia launched a wide-ranging attack on Ukraine after officially recognizing the two breakaway regions in the East of Ukraine, Donetsk and Luhansk. Without further commenting on the conflicting parties, committed war crimes and fatal attacks on cities, war – no matter where on earth it takes place - always causes humanitarian crises. Merely a small proportion of ailment, disease and suffering among afflicted people is experienced by either neighboring or non-adjacent countries – most commonly in the form of media coverage about people fleeing their home country. Bearing in mind the latest European refugee crisis (in 2015 and the following years) during which a huge proportion of migrants (some of them might even be considered as refugees) started their journey from countries torn by war, for example Syria and Afghanistan (Austrian Ministry of Interior, 2021) together with their parents or relatives. However, a constantly rising number (nine per cent) among newly arrived people, reached Austria individually (without parents or close relatives), thus being referred to as UMF (Note 1) or "unaccompanied minor refugees" (Austrian Ministry of Interior, 2021). In contempt of different reasons for migration or persecution in former years compared to the attack on Ukraine, the saying 'history repeats itself' seems to be true, especially from the perspective of another migration movement within the borders of Europe. Currently, almost 10 million people are displaced either within the Ukraine or outside its borders (International Organization for Migration, 2022).

The majority of people fleeing from Russian invasion of their country are women accompanied by their children since all male Ukrainians aged 18 to 60 are not allowed to leave the country because they have to join armed forces (CNN, 2022). Despite minor differences in terms of origin, major differences among migrants and displaced people will definitely be revealed in terms of their history of origin including flight experiences, literacy embracing first (and possibly second or third) language skills; most importantly, many of the displaced children and adolescents leaving Ukraine are students at an age at which compulsory education is mandatory as it has been proven in the aforementioned migration crisis (Puschautz, Dauer, & Hager, 2022; Blossfeld et al., 2016; Burrman & Mutz, 2016; etc.).

Due to the above mentioned differences among refugees in terms of language skills, experiences with curricular education as well as possibly experienced traumata before or during their flight in combination with the increasing quantity of displaced people having arrived in Austria since 2015, many of whom being obliged to attend school (ÖIF, 2018), the Austrian education infrastructure again meets this challenge obviously unprepared.

Discussions have been held about whether and to what extent displaced people can be integrated 'correctly' into target country's educational institutions. Physical education and sports are frequently regarded as school subjects facilitating the integration of potentially vulnerable human beings (Australian Sports Commission, 2006; Tiemann, 2013; Tiemann, 2015). However, disabled people and the integration of handicapped student groups has been at the center of attention quite often (Black & Stevenson, 2012) which led the author of this article to analyze the contribution of physical education toward the integration of adolescent refugees, therefore, subsequent research questions should be answered:

1) Which manifestations does the adaptation process among both juvenile refugees and 'regular' students during physical education in Austrian sports classes show?
2) In what way do experienced traumata before / during or after flight impair adaptation processes in Austrian (sports) classes?

The design of the study, embracing participants, analysis tools and important background data will be presented first. Afterwards, the results of the analysis among school authorities as well as representatives within the Austrian school system focusing strongly on conducted interview files will be given. This then is followed by a vital discussion of applied strategies in terms of integrating adolescent refugees in Austrian school classes. The paper concludes with future goals, measurements and further challenges.

2. Material Studied

2.1 Area Descriptions

Research on (adolescent) refugees frequently leads to discussions about the notion of de-segregation (Booth, 2008; 2012), integration as well as its "qualitatively advanced concept" (Feyerer, 2012, p. 4) – inclusion. The majority of research being conducted in the context of refugee and migration research focuses on 'bottom-up' approaches (Booth, 2008; 2012; Hinz, 2013) analyzing the corresponding study question merely from one perspective, namely that of refugees and their social surroundings. In the course of this study, analysis through conducted interviews (N = 15) with school authorities, principals and sports teachers has been applied simultaneously.

Bearing in mind the high vulnerability of affected study participants, the ethical review commission of the University of Vienna analyzed the study design, which had been submitted in advance of the study. After the positive evaluation, the researcher applied the "principle of a temporary participation in the area of investigation" (Thiele, 2003, p. 14) which should facilitate the understanding of juvenile refugees' behavior in Austrian physical education classes from 'the inside'; hence, the study design consisted of an observer as a so-called passive participants – a commonly chosen design in social settings (Lamnek, 2005; Thiele, 2003). The observation of three different juvenile refugees who attend different schools and therefore participate in varying sports classes have been observed.

2.2 Participants

It was a prerequisite of this study, that each of the three selected schools and the equivalent sports classes consist of a so called 'focus student'. The selection of focus students has also been at the center of other successfully conducted studies (cf. Breidenstein, 2006, 2008; Huf, 2006; Kamper, 2015). In this study, the focus student should have arrived in Austria only recently (i.e. from 2017-2019) and is likely to remain in the selected class at least for the observation time of this study, allowing the researcher a profound analysis and in-depth description of social interactions with both classmates and teachers experienced in the course of the semester.

As can be seen, Table 1 illustrates that among the observed juvenile refugees, one female and two male students who attend different school types have been selected and thus observed. In comparison, Table 2 shows adolescent refugees' differences in terms of origin, the time of their arrival in Austria and the attendance in the corresponding sports group.

Table 1. Sampling of study participants

Focus student	School type	Academic year
Andreas (male)	Grammar school	11
Benjamin (male)	Secondary school	8
Clara (female)	Secondary school	8

Table 2. Context-based information of the focus students

Focus student (sex)	Country of origin	Duration of residence in Austria/student as part of sport class
Andreas (male)	Syria	Since 2018/ since the school term 2018/19
Benjamin (male)	Afghanistan	unknown/ since the school term 2018/19
Clara (female)	Afghanistan	unknown/ since the school term 2017/18

2.3 Methods

Lofland et al. 2006 claim that the majority of social settings (sports classes can also be classified as social settings) include 'hierarchical aspects or inequalities'; thus a two-tier approach for data collection has been chosen – ethnographic observations and interviews with principals, sports teachers, focus students and their class mates ('regular' students) have been conducted.

Concerning the analysis of the focus students (Note 2), each of them as has been mentioned, being an adolescent refugee (one of them being even unaccompanied, thus referred to as 'UMF') each sports class has been observed once a week over a period of one semester starting in September 2018. In total, 49 observations including observation reports (cf. Lamnek, 2005) have been conducted. However, before any observation at school and the corresponding social setting could commence, each class had been instructed that a stranger will encompass them during their physical instruction classes. This should avoid distractions among students at the start of the study. In addition, remaining questions of students could be answered, despite their parents being already informed via an information letter at the beginning of the new school term.

Data reliability for the conducted observations has been ensured by both a fixed and mobile camera; consequently, all corners of the playing field (or the gym) including scientifically relevant situations could be filmed and, later on, analyzed from various angles. All observed lessons have immediately after the lesson been recorded according to Bodgan and Tylor's (1975, p. 62f.), seemingly archaic but still useful, recommendation: "[R]ecord your notes as soon after the observation session as possible […]."

2.4 Data Analysis-Techniques

Overall, a two-tier system has been applied in order to analyze both the conducted interviews as well as the observation reports. The analysis of the film material from both the mobile and the fixed camera position was carried out simultaneously with the analysis of the comments from the observation reports which allowed additional comments and remarks as video documents conserve both visible and audible incidences guaranteeing insights into undertaken interactions (Dinkelaker & Herrle, 2009). All data, observation reports as well as interview files were transcribed onto a word file.

The researcher used Grounded Theory Method (GTM) (Strauss & Corbin, 1996; Glaser & Strauss 1998) for data analysis derived from the above described word files. Codes were applied to text passages being of high relevance for the overall study questions or the research topic as such. At this stage of data analysis it is of tremendous importance that one follows Saldana's (2016, p. 7f.) advice:

> *Coding requires that you wear your researchers' analytic lens. But how you perceive and interpret what is happening in the data depends on what type of filter covers that lens and from which angle you view that phenomenon.*

Nonetheless, the establishment of suitable categories to the appendant data which then suggest interesting insights into the research topic was the ultimate goal (as it is in all scientific researches using GTM). The generation of themes, concepts and, ultimately even a theory, requires several cycles of coding as Saldana (2016, p. 9) highlights: "Coding is cyclical act. Rarely is the first cycle of coding data perfectly attempted."

Among the three basic steps of coding, the first step is commonly referred to as 'open coding' (Strauss & Corbin 1996). The categorization of phenomena resemble a pattern of rhythm as well as changing and repetitive forms of action-interaction plus the pauses and interruptions that occur when persons act or interact (Corbin & Strauss,

2015, p. 173). The application of names and concepts can either be done through using terms/concepts from literature based on similar study projects, or by in-vivo-coding in which terms/concepts are generated from the data. The latter procedure is frequently applied "in educational ethnographies with youth" (Saldana 2016, p. 106).

The next step, as Lofland et al. (2006, p. 121) mention, is characterized by forming "major units of social organization" since comparisons between text passages including similar characteristics is performed. Similar notions are applied to similar manifestations which in GTM-language is called categorization.

'Focused coding' (Strauss and Corbin, 1996) is the process in which codes or categories from the first two steps are grouped, renamed and frequently reorganized "to determine which [codes] in the research are the dominant ones and which are the less important ones [… and to] reorganize the data set" (Boeije, 2010, p. 109). The final step of focused coding embraces the generation of a major (sometimes even abstract) core category which matches all other so far established categories.

In order to ensure high sensitivity towards adolescent refugees and, simultaneously, dismiss a "one-size fits all reasoning" (Tiemann, 2015, p. 55) in Austrian school settings, the main themes (i.e. major categories) derived from the observation reports and from the interviews will be presented in the following section.

3. Results

The results of this study are presented on the basis of four main themes deduced from a profound analysis of observation reports and interview data: 1) (verbal and non-verbal) communication; 2) social forms; 3) behavioral strategies of teachers and students; 4) potentials of physical education. A selection of the most prominent quotations shall emphasize the results. Crucially, statements of participants should not be regarded as the opinion of individuals, but as a comprehensive frame of common understanding (Dahlin-Ivanof & Holmgren, 2017).

3.1 Verbal/Non-Verbal Communication

This category focuses strongly on patterns of communication between adolescent refugees and 'regular' students as well as between refugee students and their sports teacher. The category also embraces non-verbal communication since non-spoken instances (i.e. body language) equally convey important insights into didactics of refugee education as the following statement suggests:

> *During the arrangements of the teams, she (i.e. focus student) is merely sitting in a corner of the gym (keeping a distance of approximately three meters to the next student) with tucked up legs while fixing the floor with her view. Many of the class mates do not even recognize her leading to a finished process of team arrangements in which three teams have been established, obviously without her being in any of those teams.* (3-16; 16) (Note 3)

Despite participating in the sports group for almost a year, one can easily notice that the observed refugee student applied avoidance strategies displayed especially in non-verbal communication. Luckily, the sports teacher interfered by prompting the other students: "Hey ladies, not everybody has been allocated to a group – Clara participates in the game as well" 3-16; 16. Sadly, one of the students replied: "It does not make a difference whether she plays or not – she does not participate at all. But choose her, so that we can finally start."

As can be seen in the instances above, the focus student Clara, who has already been a member of the observed sports group for almost a year displays non-verbal avoidance strategies. Likewise, she shows hesitancy during instructions when, for example, the teacher has to assign her to a group: "Clara, take a volleyball and join a group!" (3-1; 18).

From the perspective of the teacher a frequently chosen communicative strategy has been encouragement which was directed towards the focus student aiming at her active participation. In contrast to the former mentioned instructions between teacher and focus student, these communication patterns resemble a soft invitation to participate in the lesson:

> *Miss R. (i.e. teacher) moved to Clara and stated: "Come on, Clara, let's try it together. I stand here and we play back and forth." […] Miss R. tried once more to motivate Clara carefully: "Clara, don't you want to try it? You'll see, it is fun!" (3-15; 24).*

Contrasting the above mentioned instances of a highly impaired refugee student, subsequent (non) verbal communication patterns display instances of an adolescent refugee student being at the attention center of the relevant sports group (1-1;14): "What have you been doing at the weekend, Andreas?" Andreas: I have been cycling and studying German. My father says that German is important. Suddenly, another student said to Andreas: "That's true. But you speak German already quite well."

A very common topic among the sports group surrounding Andreas seems to have been football. Interestingly enough, the refugee student is well informed about the topic making himself a welcome conversation partner (1-12; 15):

> *Andreas: They (FC Salzburg) will win the championship; but Rapid Vienna is not that bad either.*
>
> *Moritz: Have you already heard about him (Stöger) being trainer at Dortmund?*
>
> *Andreas: Yes, of course. He is a very good trainer. At the moment, he is the best for Dortmund.*

The instances of communication above shown between adolescent refugees, 'regular' students and teachers are obviously extracts. Nevertheless, even these extracts reveal a stark contrast between the two observed refugee students, Andreas and Clara. In terms of impairment and avoidance strategies, especially non-verbal communication displays challenges of integrating refugee students suffering from high impairment, which can also be seen in the next section.

3.2 Social Forms

Similar to the communicative patterns of refugee student Clara which have been described in section 3.1 also her social contacts in and outside the classroom might be characterized as scarce and hesitant. Especially outside conventional teaching situations (i.e. immediately before or after the lesson) a rather passive behavior could be observed (3-4; 8-13):

> *[…] Many of the girls were talking about varying topics like 'attractive boys', school, clothing or make-up. Clara, who was not involved in any of the conversations, was standing with her back to the group fixing the floor with her view.*

Even when some of the girls actively tried to involve her in one of their conversations ("What do you think? Have you had a boyfriend yet?" 3-3; 4-17) the overall social setting did not alter a lot. As a response to the above mentioned question, Clara only briefly looked up to the girls before moving directly into the gym leaving the other girls astonished behind. The ignorance of the question obviously caused laughter among the other girls while some of them even rolled their eyes as a form of disparagement. When asking the teacher about Clara's hesitant social behavior, she stated that "Clara simply can't or doesn't want to integrate into the sports group" (3-1; 11).

In contrast to Clara, the male refugee student even assisted his classmates which, in return, caused enthusiasm and gratefulness he had accomplished a technically advanced gymnastics exercise (1-12; 32):

> *When Michael tried to accomplish the upward circle forwards, he was assisted by Andreas. Sadly, Michael failed the first attempt so that Andreas assisted him once more by making him aware of the most important aspects of the exercise (You have to tighten your arms while pressing your knees against the bar). This time, Michael managed to accomplish the upward circle forwards; immediately, he jumped off the horizontal bar, running to Andreas with raised arms and saying "Thank you" to Andreas.*

Due to Andreas' extraordinary sports skills, he was very often selected by the sports teacher for demonstration reasons. Whenever Mr. A (i.e. sports teacher) wanted to show the other students how technically advanced exercises (should) look like, he used Andreas as a model (1-12; 39-40):

> *At the second attempt to jump (over the vaulting box) Mr. A invited Andreas to demonstrate the jump once more, so that he could highlight the importance of the extension of the upper body while pushing away his arms (Imagine the surface of the box is a hot stove – push away your arms! Exactly as Andreas does!*

Social forms explained in the latter instances means that parties involved in the relevant sports class approach each other; admittedly, the focus student, due to his extraordinary sports skills, plays a tremendous part in that. Getting into contact with others in the course of sports classes also seems to be linked to sports skills parallel to openness towards social interaction. However, Clara lacks this openness - probably because of being impaired.

3.3 Behavioral Strategies

> *They have fear and many are traumatized and above all there are those, who have lost their parents in war. (T2; 14)*

This citation of an interviewed sports teachers highlights Clara's situation or flight biography. The losses she has experienced in combination with other, not less gruesome experiences during her flight, massively influence her behavior during sports classes. Regretfully, one of her behavioral strategies, as already indicated in the sections above, seems to be avoidance caused by traumatization. Many observation reports imply that the refugee student cannot handle the traumatizing experiences in her life. This became apparent in only one of the observed lessons,

in which the focus was lying on the topic of volleyball. At the beginning of the lesson, when the majority of students was involved in the setup of the net, a critical situation could be observed (3-15; 26):

> *Suddenly, Clara ran out of the gym without speaking to anybody or showing any signs. Since the observer was the only one noticing her absence, he informed the teacher, Miss R. about the situation. The teacher, being shocked and a bit scared about the unfamiliar situation […] also left the gym in order to look for Clara. As the other girls were involved in playing volleyball, they did not notice Miss R, telling the observer about the situation she had experienced in the locker room. Miss R. found Clara having a nervous breakdown. She was lying on the floor of the locker room, crying and whispering the name of her (obviously dead) parents.*

The above described traumatization of the focus student obviously has an impact on the behavior strategies of the teacher. In the beginning, the teacher was shocked about a student instantly leaving the gym. It was only when the teacher realized the seriousness of impairment of her refugee student that she stated: What can a teacher do in a case like that? I have not been trained to deal with problems like these (3-16; 13).

Apart from the shocking situation described above, behavioral strategies can also be characterized as ambitious. For example, when the focus student Andreas was involved in a high jump competition, in which the spectating as well as the opposing students granted him the victory (1-3; 38-39):

> *All eyes were focusing Andreas, who was cheered by all of the spectating students. Even the teacher, Mr. A, said to Andreas: "Come on, you will do it. Concentration!" When Andreas was running away, all the students remained silent. As soon as he accomplished to pass 1.85m, many students jumped exultantly (Note 4). Some of them even ran towards him und hugged him while still lying on the mat, which could clearly be interpreted as cheering. […] When he was leaving the mat, also his contender came to him and said: "Well done! How do you do that?" Even Mr. A congratulated and said to the other students: If you apply the right technique, almost everything is possible. You obviously have to show the right prerequisites and a certain amount of ambition [laughing towards Andreas].*

The behavioral strategies described in the course of this section are diametrically opposed. While Clara seems to be severely impaired by her flight and war experiences, Andreas does not show any signs of negative influences through flight or war; what is more, he fully engages in the set sport activities and outperforms his classmates, while Clara's behavior can be described as (mentally) handicapped.

3.4 Potentials of Physical Education

> *Unfortunately, what I experience while working with adolescent refugees is that they do not associate sports with fun as our kids do or as a leisure time activity, but as a duty. It is only after a certain amount of time that duty can turn into fun. (T3; 82)*

This ambivalence mentioned by a sports teacher (i.e. fun vs. duty) especially applies to the observed focus student Clara for whom the latter aspect seems to prevail. As a matter of fact, this perception was also highlighted in the course of a conversation between her and her teacher after all the other students of her class had already left the gym (3-5; 58-61):

> *Miss R: Clara, why don't you participate in the sports lessons? […] try to place the fun factor in the foreground!*
>
> *Clara was fixing the floor with her view during the whole conversation.*
>
> *Miss R.: Clara, I am really concerned about you. Try not to see sports as a must, but as something joyful, okay?*
>
> *Clara was briefly nodding and immediately left the gym towards the locker room.*

The reduction of physical education to a mere performance of one's duty, as illustrated in the conversation between Miss R. and the focus student, has similarly been observed in another conversation between the refugee student and a classmate while leaving the soccer pitch. At the end of an exciting sports lesson in which a baseball-like game led to a draw between the two sports teams composed of the class, one class mate said to Clara that this had been one of the most exciting sports lessons ever while Clara only replied: "Not for me. I am only here because I have to!" (3-2; 30).

Unlike Clara's perception of institutional education, the second observed focus student appreciates both sports and fun and friendships emerging from physical education. This even led to a link between sports at school and societal participation shown in the subsequent example, in which the focus student was invited to extra-curricular activities in the afternoon:

> *We go mountain biking in the afternoon. Do you want to join us? 1-8; 48*
>
> *Marco, Michael and I, together with some others, meet to play soccer after school. It would be cool, if you joined as us as well. 1-10; 27*

Likewise, the focus student was even urged to join a local soccer club, due to his extraordinary soccer skills shown during many sports lessons:

> *Overall, students tried to utilize Andreas's speed of action. This even led to the team's second goal in which Andreas escaped the defense by making a feint. Being alone in front of the goal keeper, Andreas seized the chance to score. Consequently, one of his team players sprinted towards Andreas and screamed: If you join our local football club, nobody has a chance! (1-1; 17-20)*

Reading the descriptions from the observation reports, one could critically argue that outstanding physical abilities combined with a certain amount of skill in the relevant form of sport ultimately leads to respect and even fame among classmates. According to the author, however, this point of view is somewhat short-sighted, as also the female focus student might be able to outperform some of her class mates in terms of physical abilities and well defined skills. Crucially though, she is incapable of proving her skills due to the experienced traumata. It is only on condition that potentially experienced traumatizing events linked to war, persecution and flight, can be overcome that "sports can cause understanding among nations" as a representative of the Austrian school system stated (M; 76).

4. Discussion

The aim of the present study was to analyze whether and in how far sports students and sports teachers adapt within a period of one school semester (September to January). As other studies focusing on juvenile refugees exercising in the course of physical education classes have indicated that a high number of adolescent refugees suffer from impairment or even traumatization (cf. Kölbel, 2021), this research paper aims at contributing to a more extensive idea of adolescent refugees in both national and international pedagogy.

As far as the first research question is concerned, the establishment of adaptation, which can be defined as a multi-layered, sometimes subconsciously chosen process of humans to their social surroundings, as the core category has been determined. Both the presence as well as the attendance of adolescent refugees causes all native participants (i.e. local students and teachers) to adapt in sports classes. This adaptation, however, is not limited to one characteristic but occurs on a scale of peculiarities: Verbal and non-verbal communication, social forms and physical and psychological behavior strategies of both teachers and students. Interestingly, the attendance of adolescent refugees also alters the potentials of physical education. Most importantly, all manifestations depend strongly on the extent of impairment caused by war, flight and persecution, respectively. Traumatization definitely has to be placed at the most severe end of the 'impairment scale' and must be taken into account in all forms of refugee didactics and pedagogy – independently of subject.

Next to the already established core category 'adaptation' embracing its manifestations (i.e. verbal and non-verbal communication, social forms, behavioral strategies and potentials of physical education) the establishment of another crucial characteristic has to be highlighted - the impairment of juvenile refugees. While the male focus student shows little to no impairment and a high adaptation despite his flight from his home country (Syria), which he successfully managed together with his whole family. Especially his physical skills enable him to raise interest not only among the other students but also among his sports teacher.

In contrast, the female focus student (fleeing from Afghanistan) shows high impairment from the beginning to the end of the observation time. Despite the ambitious goal of fostering her active involvement in class, the severe psychological problems (i.e. witnessing the death of both of her parents) prohibit the active participation in class and even caused a nervous breakdown in one of the physical education classes.

As can be seen in the *Inclusive physical education with adolescent refugees* model (Figure 1) the theoretical frame supports the results gathered through empirical research. Empirical research combined with theory proves that sensitivity towards a heterogeneous sports group is a precondition for social intercourse with juvenile refugees, and, as Tiemann (2015, p. 55) states "has to be taken into consideration in all didactic decisions". Furthermore, being open-minded towards all forms of differences, for example religious beliefs, cultures, languages, opinions and perceptions facilitates adaptation processes in the above mentioned areas of (verbal and non-verbal) communication, social skills, potentials of sports classes and behavioral strategies of participants of sports classes (i.e. local students and teachers).

Most importantly, adaptation among adolescent refugees depends tremendously on potentially experienced negative impacts. Depending on whether refugees have experienced a low or have suffered from a highly

negative impact during their flight to the target country, adaptation proceeds faster or more slowly in the course of physical education or even resembles a boycott of education. The latter has been observed among one of the target students who, while fleeing from Afghanistan to Austria, has witnessed both her parents being killed. Adolescent refugees cannot overcome experienced traumata like the aforementioned; unsurprisingly, a mental breakdown of the target student could be observed.

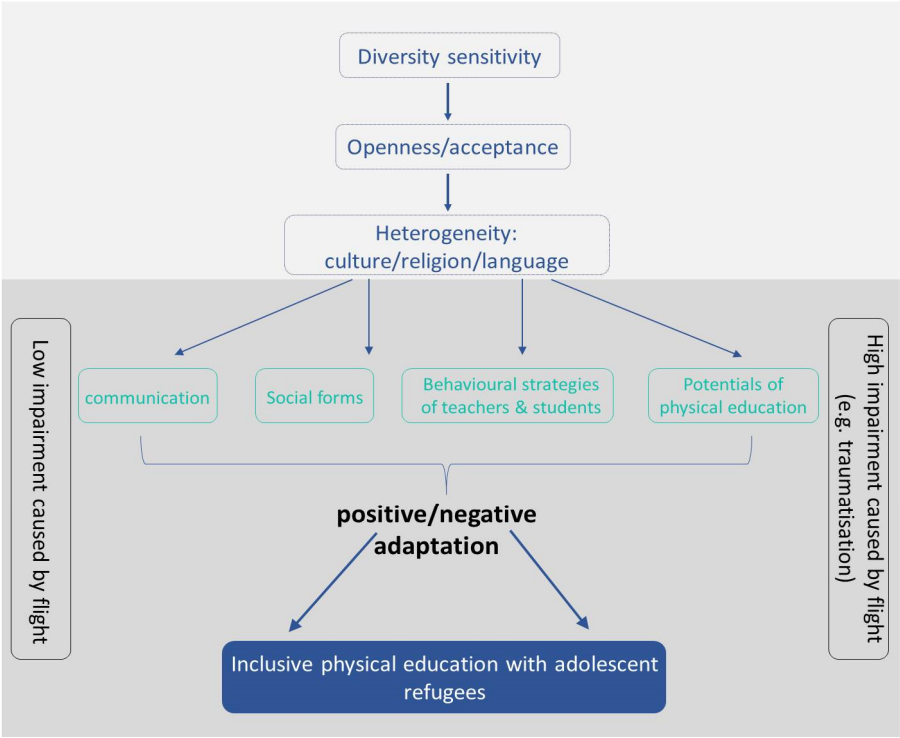

Figure 1. Inclusive physical education with adolescent refugees

5. Conclusion

The main aim of this study was to analyze which scales, and more specifically, which manifestations adolescent student refugees and local students adapt to each other in the course of curricular physical education. As can be seen, the results provide evidence that either group of students (both refugees and locals) and also physical education teachers adapt. Adaptation occurs among a broad range of manifestations embracing verbal and non-verbal communication, social forms, behavioral strategies as well as potentials of physical education.

For the future work with juvenile refugees, independent of school subject, the consideration of the individual flight background of juvenile refugees is of tremendous importance to as this might cause impairment on a psychological level which then also affects physiological participation in sports classes as can be seen in the observation reports (cf. section 2). With regard of inclusion efforts of juvenile refugees in the Austrian school system, some of the above mentioned strategies embracing inclusive educational efforts have (consciously or unconsciously) been utilized by school representatives (i.e. teachers) as well as classmates approaching refugee students with a positive attitude; however, inclusion efforts in sports pedagogy or didactics focusing on juvenile refugees has hitherto neither been evaluated in general nor in relation to physical education. Again, it is crucial to consider when working with refugee students that a high number of them might suffer from traumatic experiences they have faced due to war or on their way fleeing their war-torn home countries. Metzner & Mogk (2016) even assume that a majority of adolescent refugees is affected by post-migratory stress.

Similar to individual approaches towards the inclusion of adolescent refugees, school subjects resembling also for refugee students positive or negative characteristics (depending on individual preferences), might foster heterogeneity (Burrmann, 2017; Burrmann & Mutz, 2016; Krüger & Gebken, 2017). Just as rising numbers of refugees influence and even shape society (Heckmann, 2015) causing a higher number of refugee students in the respective country, more heterogeneous student groups, consequently, do also influence the respective school subjects; hence, teacher training and professional education irrespective of different school types has to focus on and implement heterogeneous classroom conditions in its curricula.

Global displacement is rising and will continue doing so due to natural disasters, violent aggression and war. Likewise, the Covid-19 pandemic, despite continuing travel restrictions and immobility, has led to an even greater imbalance of access to health care causing especially people from South American and African countries to suffer most from the pandemic. Once travel and mobility restrictions are loosened millions of people will move to countries in which access to vital systems and goods is guaranteed. Obviously, this is also the prime reason for people leaving their war-torn home country, like for example Ukraine. Regardless of the reasons behind large scale migration and flight movements, target countries including school and education infrastructure have to be prepared more frequently in the time to come. The establishment of early psychological screening for adolescent refugees should be a primary goal of every affected country as a differentiation between (highly) impaired and non-impaired refugees in terms of flight or war experiences is made possible through screening methods enabling juvenile refugees (and possibly also their parents) a prosperous future in a new country. Overall, the conducted interviews and the extracts presented should contribute to that ambitious goal.

References

Australian Sports Commission. (2006). *Sports Ability Activity Cards*. Belconnen: o.V.

Austrian Ministry of Interior. Bundesministerium Inneres (2021). *Asylstatistik Oktober 2021*. Retrieved from https://www.bmi.gv.at/301/Statistiken/files/2021/Asylstatistik_Oktober_2021.pdf

Black, K., & Stevenson, P. (2012). Information and advice. *The Inclusion Spectrum incorporating STEP*. Retrieved from https://inclusivesportdesign.com/tutorials/the-inclusion-spectrum-planning-sport-activities-for-everyone/

Blossfeld, H. P. et al. (2016). *Integration durch Bildung. Migranten und Flüchtlinge in Deutschland. Gutachten.* Herausgegeben vom vbw. Münster: Waxmann. Retrieved from https://www.aktionsratbildung.de/fileadmin/Dokumente/ARB_Gutachten_Integration_gesamt_mit_Cover.pdf

Bodgan, R., & Tylor, S. (1975). *Introduction to qualitative research methods. A phenomenological approach to the social sciences*. NY: Wiley.

Boeije, H. (2010). *Analysis in qualitative research*. London: Sage.

Booth, T. (2008). Ein internationaler Blick auf inklusive Bildung: Werte für alle? In A. Hinz, I. Körner & U. Niehoff (Eds.), *Von der Integration zur Inklusion. Grundlagen – Perspektiven – Praxis* (pp. 53-73). Marburg: Lebenshilfe.

Booth, T. (2012). Der aktuelle "Index for Inclusion" in dritter Auflage. In Reich, Kersten (Ed.), *Inklusion und Bildungsgerechtigkeit. Standards und Regeln zur Umsetzung einer inklusiven Schule* (pp. 180-204). Weinheim/Basel: Beltz.

Breidenstein, G. (2006). *Teilnahme am Unterricht. Ethnographische Studien zum Schülerjob.* Wiesbaden: VS Verlag für Sozialwissenschaften.

Burrmann, U., & Mutz, M. (2016). Selbstberichtete Angst im Sportunterricht: Eine Analyse unter besonderer Berücksichtigung des Geschlechts und der ethnischen Herkunft. *Leipziger sportwissenschaftliche Beiträge, 57*(1), 95-119.

Burrmann, U. (2017). Integration von geflüchteten Heranwachsenden im und durch (Schul-)Sport? In Deutsche Sportlehrerverband e.V. (DSLV) (Eds.), *Sportunterricht Jg. 66 (2017)6* (pp. 163-168). Hofmann Verlag: Schorndorf.

CNN, Tamara Qiblawi, T., & Alvard, C. (2022). *Ukrainian males aged 18-60 are banned from leaving the country, Zelensky says in new declaration.* Retrieved from https://edition.cnn.com/europe/live-news/ukraine-russia-news-02-24-22-intl/h_4309a4916d57670f85519210a07fb2c9

Corbin, J., & Strauss, A. (2015). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.* Fourth Edition. California: Sage.

Dahlin Ivanoff, S., & Holmgren, K. (2017). *Focus groups*. Lund: Studentlitteratur.

Dinkelaker, J., & Herrle, M. (2009). *Erziehungswissenschaftliche Videographie. Eine Einführung*. Wiesbaden: VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-91676-7

Feyerer, E. (2012). Der Umgang mit besonderen Bedürfnissen im Bildungswesen. *Zeitschrift für Inklusion-online*. Retrieved from https://www.inklusion-online.net/index.php/inklusion-online/article/view/33/33

Glaser, B., & Strauss, A. (1998). Grounded *Theory: Strategien qualitativer Forschung*. Bern: Huber.

Heckmann, F. (2015). *Integration von Migranten. Einwanderung und neue Nationenbildung*. Wiesbaden: Springer. https://doi.org/10.1007/978-3-658-06980-3

Hinz, A. (2013). Inklusive Inklusion – von der Unkenntnis zur Unkenntlichkeit!? - Kritische Anmerkungen zu einem Jahrzehnt Diskurs über schulische Inklusion in Deutschland. *Zeitschrift für Inklusion – online.net*. Retrieved from https://www.inklusion-online.net/index.php/inklusion-online/article/view/26

Huf, C. (2006). *Didaktische Arrangements aus der Perspektive von Schulanfängerinnen. Eine ethnographische Feldstudie über Alltagspraktiken, Deutungsmuster und Handlungsperspektiven von Schülerinnen der Eingangsstufe der Bielefelder Laborschule*. Bad Heilbrunn: Klinkhardt.

International Organization for Migration. (2022). *Almost 6.5 Million People Internally Displaced in Ukraine*. Retrieved from https://www.iom.int/news/almost-65-million-people-internally-displaced-ukraine-iom

Kamper, S. (2015). Schüler im Sportunterricht. Eine empirische Untersuchung zur Aufdeckung und Beschreibung von Schülerpraktiken. *Forum Sportwissenschaft*, Band 30. Hamburg: Feldhaus Verlag.

Kölbel, M. (2021). Adolescent refugees and their adaptation in Austrian physical education classes – a call for restructuring existing policy. *International Journal of Education and Research, 9*(10), 129-140.

Krüger, M., & Gebken, U. (2017). Sportunterricht für Seiteneinsteiger. In Deutsche Sportlehrerverband e.V. (DSLV) (Eds.), *Sportunterricht Jg. 66* (2017)6 (pp. 175-181). Schorndorf: Hofmann.

Lamnek, S. (2005). *Qualitative Sozialforschung. Lehrbuch* (4. Überarbeitete Aufl.). Weinheim, Basel: Beltz.

Lofland, J., Snow, D., Anderson, L., & Lofland, L. H. (2006). *Analyzing social settings: A guide to qualitative observation and analysis* (4th ed.). Belmont, CA: Thomson Wadsworth.

Metzner, F., & Mogk, C. (2016). Auswirkungen traumatischer Erlebnisse von Flüchtlingskindern auf die Teilhabemöglichkeiten im Alltagsleben und in der Schule – Erfahrungen aus der Flüchtlingsambulanz für Kinder und Jugendliche am Universitätsklinikum Hamburg –Eppendorf. In G. Markmann & C. Osburg (Eds.), *Kinder und Jugendliche mit Fluchterfahrung in der Schule. Impulse für die inklusive Praxis* (pp. 48-63). Baltmannsweiler: Schneiderverlag Hohengehren.

ÖIF. Österreichischer Integrationsfond. (2018). *Fact sheet 30. Migration und Schule*. Retrieved from https://www.integrationsfonds.at

Puschautz, A., Dauer, D., & Hager, J. (2022). Wie ukrainische Kinder jetzt in Österreichs Schulen lernen sollen. *Kurier.* Mediaprint Zeitungs- und Zeitschriftenverlag. Retrieved from https://kurier.at/politik/inland/wie-ukrainische-kinder-jetzt-in-oesterreichs-schulen-lernen-sollen/401934760

Saldana, J. (2016). *The Coding manual for qualitative researchers*. California: Sage Publications Inc.

Strauss, A. L., & Corbin, J. (1990/1996). *Grounded Theory. Grundlagen qualitativer Sozialforschung.* Weinheim: Psychologie Verlags Union.

Thiele, J. (2003). Ethnographische Perspektiven der Sportwissenschaft in Deutschland – Status Quo und Entwicklungschancen (37 Absätze). *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research (Online Journal), 4*(1). Retrieved from https://www.qualitative-research.net

Tiemann, H. (2013). Inklusiver Sportunterricht: Ansätze und Modelle. *Sportpädagogik, 37*(6), 47-50.

Tiemann, H. (2015). Inklusiven Sportunterricht gestalten - didaktisch-methodische Überlegungen. In M. Giese & L. Weigelt (Eds.), *Inklusiver Sportunterricht in Theorie und Prax*is (pp. 53-66). Aachen: Meyer und Meyer. https://doi.org/10.5771/9783840311192-53

Notes

Note 1. This abbreviation stands for “Unbegleiteter Minderjähriger Flüchtling” and means unaccompanied minor refugee.

Note 2. However, data derived from the focus student Benjamin have not been further analyzed in the course of this manuscript.

Note 3. Anonymity among study participants has been ensured by a three-tier system for indicating quote references has been applied: while the first number indicates the specific focus student (i.e. 1, 2 or 3), the second number suggests the number lesson observation of this corresponding focus student, the third number points out

the line number of the transcript, this citation can be encountered. In some cases also the function of the interviewee in the school system (M = Ministry, P = Principal, T= Teacher, S= Local student; RS=Refugee student) is indicated.

Note 4. 1m resembles 1,28ft.

Modern Applied Science; Vol. 16, No. 2; 2022
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

Development of A Smart Rescue Communication System for Drowning Personnel

Ifeoma B. Asianuba[1] & Kpegara N. Saana[1]

[1] University of Port Harcourt, Department of Electrical/Electronic Engineering, Choba Rivers State, Nigeria

Correspondence: Ifeoma B. Asianuba, Faculty of Engineering, Department of Electrical/ Electronic Engineering, University of Port- Harcourt, East/West Road, PMB 5323 Choba, Rivers State, Nigeria.

Received: March 11, 2022 Accepted: May 2, 2022 Online Published: May 5, 2022

doi:10.5539/mas.v16n2p41 URL: https://doi.org/10.5539/mas.v16n2p41

Abstract

Recently, there is an alarming increase in the number of deaths resulting from late rescue of drowning personnel falling overboard. Most mechanisms deployed are faced with the inability to detect the exact location of the drowning person especially when completely submerged in water. This paper therefore describes the development of a smart rescue communication system for drowning personnel. The developed system considered two major activities involved in drowning: the first scenario considers when the individual is completely submerged in water and the second; when the victim is struggling to survive. Thus, water and vibration sensors are useful input devices in actualizing the work. Arduino microcontroller was also used for the control system mechanism. For drowning and drowned situations which is detected and specified by the readings from the relevant sensors, an SMS (short message system) alert is communicated to the rescue personnel's phone indicating that there is an emergency. The exact location of the man overboard is also indicated in the SMS with the aid of the global positioning system (GPS) module. The SMS is sent at specified intervals to increase awareness of the current situation to aid fast rescue operation. The prototype is designed to be a wearable device.

Keywords: water and vibration sensors, GPS, Arduino micro controller, drowning personnel

1. Introduction

The need for smart emergency alert systems cannot be over emphasized in terms of personnel safety and security. One of the major safety concerns for offshore workers and sea travelers is preventing personnel from drowning in case of capsizing of the ship/boat. According to Case et al. (2018), it was recorded that between 2000 – 2016 unintentional falls overboard resulted in 204 fatalities, representing 27% work-related deaths in the industry. Ukoji & Ukoji (2015) recorded that within the period of 2006 to 2015, 180 boats capsized amounting to 1607 deaths. Identified human related and natural causes of such fatal boat accidents include overloading, carelessness, political instability, piracy, militancy, negligence and turbulent weather condition. From the aforementioned causes, late notification, inaccurate information about the incident and poor rescue time are factors that increase the high fatality rate.

Drowning has been one of the most devastating forms of death till date. International Lifesaving Federation (2007) showed that Drowning is associated with difficulty in breathing as a result of excess entry of liquid into mouth or nostrils. Nevertheless, there have been several efforts to cut down the number of deaths resulting from drowning. In most of these systems, a camera is deployed for monitoring the water body while in others a wearable device is worn to detect a drown situation and trigger an alarm to alert a lifeguard of the emergency situation. But in all of these the exact location of the victim is not usually communicated to the lifeguard through the alert system. This limitation introduces much delay in the rescue time, putting the victim in a more life-threatening situation. Thus, the need for a smart and more reliable drowning personnel alert system that can detect the location of the drowning person using GPS module in conjunction with other sensors and micro controller to notify a rescue team is presented.

The World Health Organization, WHO states that drowning is a public health challenge which claims more than 372,000 people a year worldwide. This scenario amounts to 90% death rate which is prevalent in low and middle income countries (World Health Organization, 2014).

Fatal drowning usually occurs when the individual is alone or the people in the same area with the drowning person are unaware of what is happening to the individual and are therefore unable to help out (Wikipedia, 2021). Rescued victims are most times faced with the challenges of associated health risks like respiratory distress, confusion, vomiting, aspiration and even unconsciousness. Drowning is associated with numerous risk factors such as epilepsy, inexperience and use of drugs (Handley, 2014). Drowning usually occurs in man-made and artificial water surfaces (Meck Manuals, 2017; Mott & Latimer, 2016).

Spending substantial time with respiratory parts of the human body in water results in reduced amount of oxygen and large amount of carbon dioxide in the blood. The latter triggers increased breath issues which gives rise to physical anomalies (North, 2002).

1.1 Review of Related Work

Video based drowning monitoring systems was proposed in How-Lung et al. (2008) but the technology is very prone to visual and sensor disturbances especially when the pool or water-body is crowded. In B. Dhande et al. (2018), a comprehensive survey on different drowning and rescue system was considered ranging from the concept of image processing, pressure and motion sensing, heartbeat sensing etc. The issue of drowning can also be handled with internet of things application (Mohammed et al., 2018), by sending signals received from a pulse sensor to rescue hub. Samuel et al proposed a wrist wearable device which measures the heartbeat and blood pressure of victims and alerts a rescue team. Stauffer and Grimson 2000 adopted learning patterns of activity for real time tracking systems. John et al. (2019) also proposed a rescue alert system to prevent drowning in victims. Sentag (2021) proposed a safety solution for swimming pools to monitor the depth of individual in water, motion of the individual and time spent. The wearable device is given to the individual prior to using the pool.

1.2 Statement of the Problem

Most deaths recorded from drowning of personnel overboard and boat accident is as a result of the inability to timely locate the victim due to poor communication process. With the knowledge that drowning is a situation that takes life very quickly, it is expected that a swift response from the rescue team is required to save lives. In this work, a smart system is developed to monitor near drowning situation that occurs before drowning actually take place. The hardware developed will help reduce deaths by developing a system which can communicate the exact location of the drowning personnel within a short time interval. The smart system is also designed to reduce false alarm since some of the existing rescue systems are faced with the challenges of false alarm. This is because unnecessary panic resulting from false alarm in some emergency alert systems have also posed much danger than the actual drowning process.

2. Methodology

The methodology adopted in the design is made up of the software and hard ware aspects. The hardware component is made up of water and vibration sensing module, Arduino microcontroller, GPS module, DC battery.

2.1 Hardware Design

The Water sensing module's Digital Output pins (DO) is connected to the Microcontroller's Digital pin 7 (D7). The VCC and GND pins of the microcontroller are connected to the 5V and GND pins respectively. The module's Digital Output pin for the vibration sensor is connected to the Microcontroller's Digital pin 9 (D9). The power supply of the microcontroller board was attached to the power and ground pins of the GPS module which is further interfaced with the Transmitter (Tx) and Receiver (Rx) terminals of the GPS to the microcontroller digital pins 4 and 5 respectively. The SIM800 also takes this interfacing pattern with GSM Transmitter to Arduino digital pin 2 and GSM Receiver to Arduino digital pin 3.

A 5v DC battery connected to the power input of the Arduino Mini will adequately run the designed system effectively. The circuit Diagram for the entire hardware is shown in the Figure 1 below.

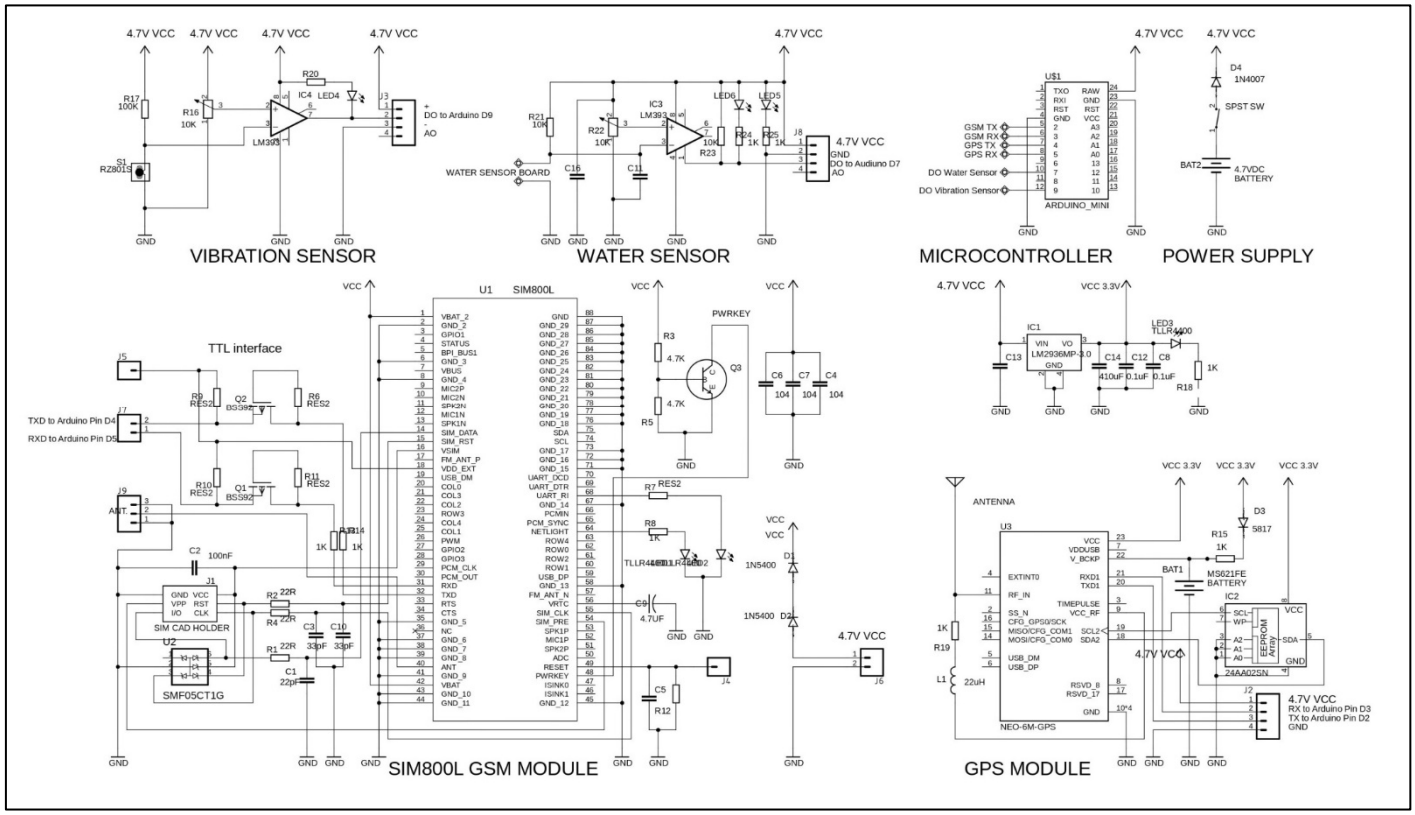

Figure1. Circuit Diagram of the Smart Rescue communication System for Drowning Personnel

2.2 System Software

The Arduino Board is interfaced with the ATMEGA328P microcontroller. The latter can therefore be programmed with a computer using the Arduino IDE compiler.

2.2.1 Arduino IDE

The Arduino Software (IDE) consist of, but not limited an information field for messages, text console, text editor for code writing, a toolbar for basic functions, and a set of menus. It interfaces with the Arduino Microcontroller hardware and uploads programs to it.

Sketches are the names given to programs created with the Arduino Software (IDE) stored as files with the extension '. ino'. Cutting/pasting, as well as searching/replacing text, are all possible in the editor. The message region shows errors and provides input when saving and exporting. The Arduino Program (IDE) outputs text to console which contains full error messages and other information. The designed board and serial port are shown in the window's bottom right corner. Verify and import programs, make, view, and save drawings, as well as opening the serial monitor are all possible with the toolbar buttons.

When a sketch is submitted, the Arduino boot loader is used, which is a simple program loaded on the board's microcontroller. It enables the upload of code without the need for any extra hardware. On resetting the board, the boot loader within a few seconds is made active before starting whatever action that must have been sent to the microcontroller. When the boot loader finishes, i.e., after the board had reset, the LED of pin 13 will blink. The IDE's interface is seen in Figure 2.

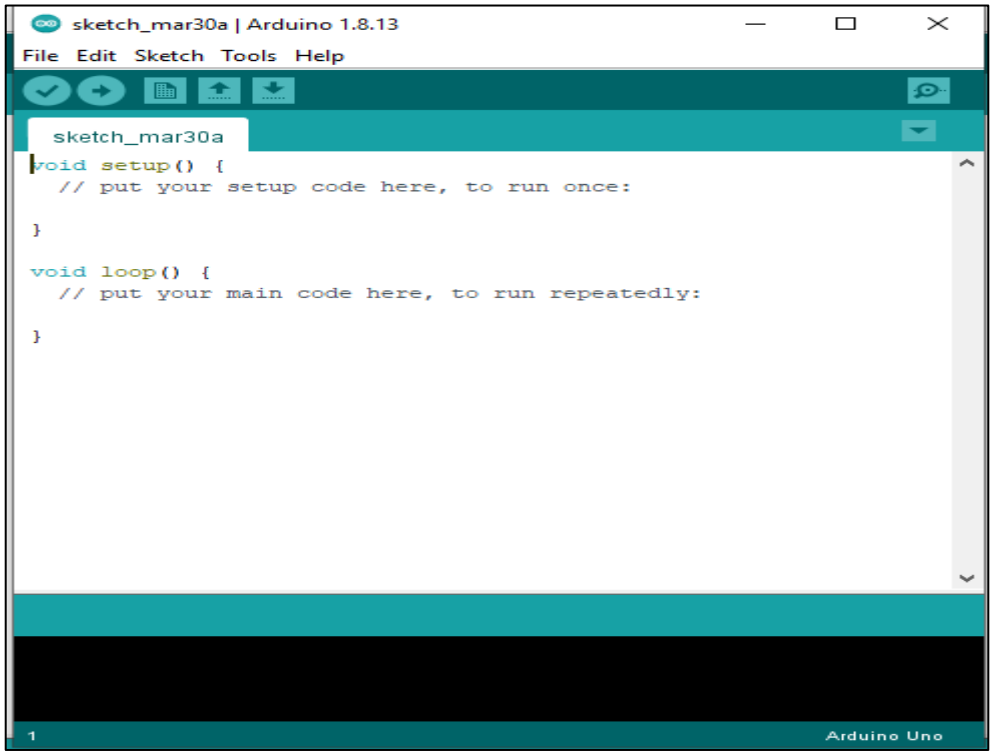

Figure 2. Arduino IDE environment

The Arduino IDE is a platform where the codes that serve as the intelligence of the system are written, compiled and sent to the Arduino board. The overall algorithmic progression of the intelligence is however discussed as follows:

2.2.2 Algorithm of the System

The following steps are used to describe the algorithmic process of the system design.

1) Start
2) Initialize system and set all microcontroller pins to the right pin Mode.
3) Check SIM800 Connection and set to Text Mode.
4) Receive User number and set it for communication.
5) Set pins to receive Water and Vibration Sensor readings.
6) Check Water Sensor modules for data set transfer.
7) If data set from Water module signifies high presence of water, then go to 8; else, return to 5.
8) Check Vibration sensor module for data set transfer.
9) If data from Vibration Sensor signifies high amount of movement, then got to 10; else return to 5.
10) Initiate GPS module for localization operation
11) Extract location of user from GPS module
12) Initiate SIM800 to send an emergency SMS alert and GPS location to designated rescue contacts
13) Initiate system rest/standby for a designated period of time.
14) Check Water Sensor modules and Vibration Modules again for data set transfer.
15) If data set from Water module signifies NO presence of water, then go to 16; else, return to 13.
16) If data from Vibration Sensor signifies NO movement, then go to 17; else return to 13.
17) Initiate SIM800 to send a clear alarm SMS alert.

The Flowchart for the above Algorithm is shown in the Figure 3 below.

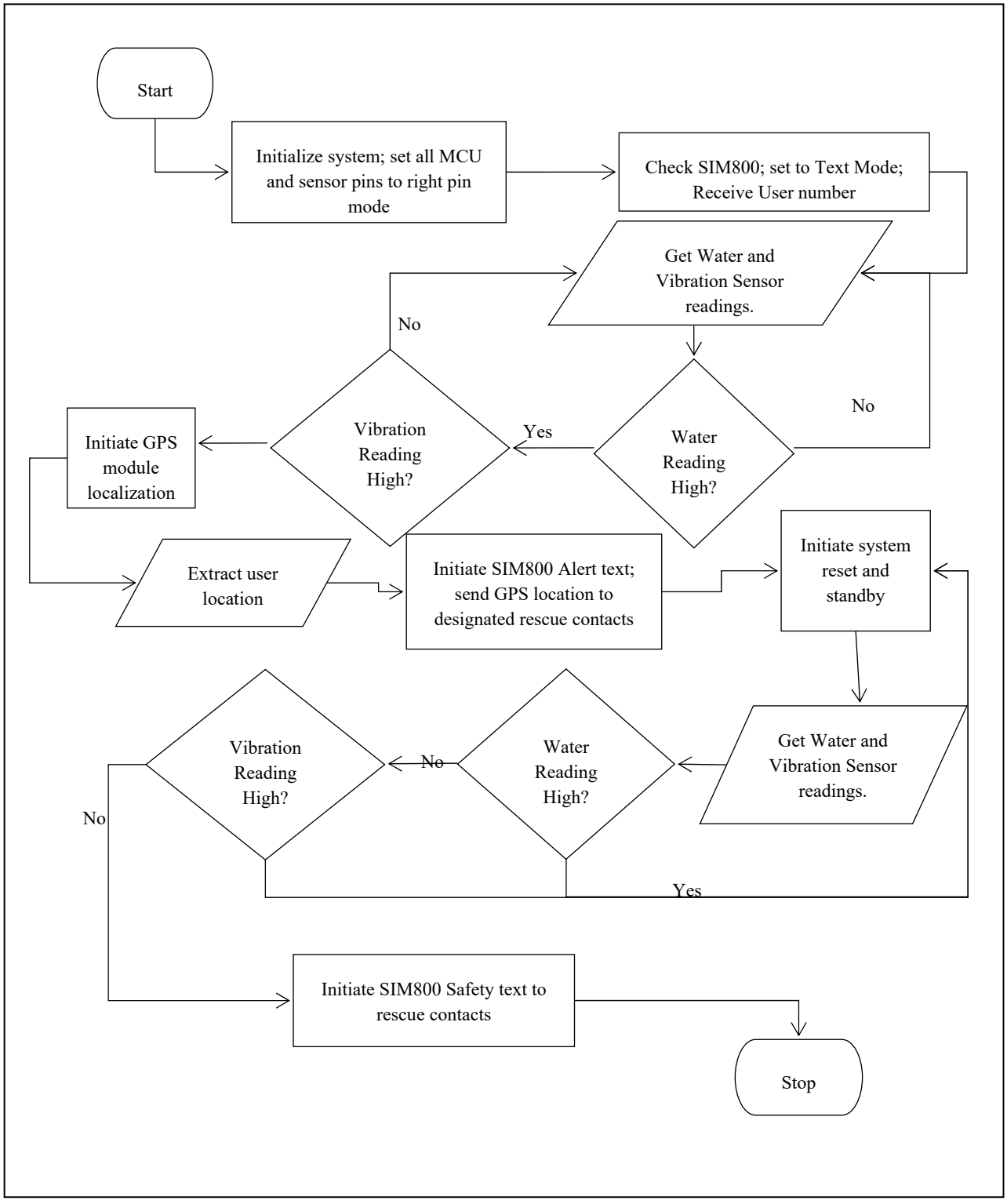

Figure 3. Flowchart of Designed System

3. Result

Series of tests were carried out to determine the efficiency of the designed system. Modifications were made according to discovered errors and limitations that were experienced during the test. These modifications are however very small and do not affect the proposed system design. These changes are usually concerned with the manner of execution of certain functions which could be changed without causing major design drifts. The tests carried are as follows:

Table 1. Table showing Test results of Water sensor

Water Level	Conductivity Range	Resistance Level (ohms)	Microcontroller Output
Dry (no water)	0 – 300	1000 – 10000	LOW
Humid (partially immersed in water)	300 – 700	100 – 1000	LOW
Wet (fully immersed in water)	700 – 950	1 – 100	HIGH

Table 1. Table Showing Vibration Sensor Test results

Scenario	Threshold	Triggered Result
Measured movement	< 50mV/g	LOW
Continuous and energetic movement	>50mV/g	HIGH

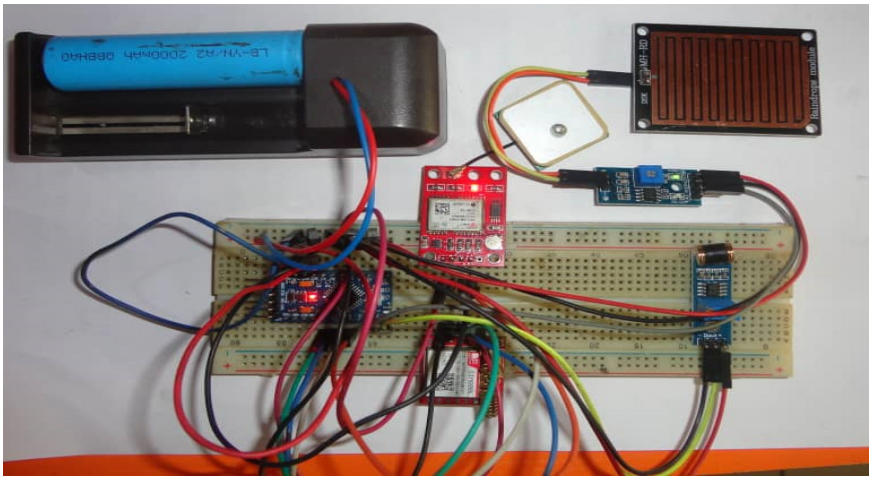

Figure 4. Setup for testing the GPS and SMS Module

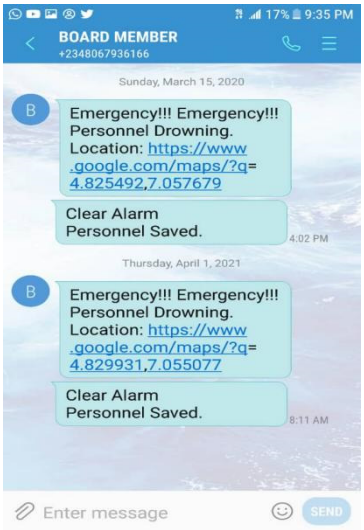

Figure 5. Result of successful GPS and SMS Module test

The Proposed system was designed to combine two of the most prevalent components in a drowning situation: One is total immersion in water and the other is continuous energetic movement of the victim. The Arduino mini microcontroller is chosen for its acceptable processing speed and negligible size and weight. When both sensors give corresponding data readings to the microcontroller which signify a drowning situation, the microcontroller

is required to respond to the situation. The appropriate response is to initiate the SMS alert system which is driven by the SIM800 module. The SIM800 is programmed to send an SMS alert to designated rescue contacts warning them about the system user's imminent demise. This work also takes a further step to ensure the rescue of the system's user by incorporating a GPS module which will aid the rescue team in finding the user. This is possible through the capability of the GPS module to triangulate the location of the user based on a Global Position evaluation within permissible error levels. The proposed system was successfully designed and implementation proved successful with results to validate claim.

Most research works on emergency alert systems for a drowning person focuses on creating awareness of the emergency situation with little or no attention to the exact location of the person. In this research work, a smart rescue system has been developed with effective communication through low powered electronic circuit to indicate exact map location in the rescue alert system.

4. Conclusion

The design and development of a smart rescue communication system for detection of drowning personnel was achieved in this paper. The work is aimed at developing a means to ensure the safety of users within the proximity of large water bodies since the safety of personnel off the shores is vital and of critical concern. The Drowning Detection System is based on the combined information provided by the water sensor, vibration sensor and other relevant components that were deployed to achieve this device. It is recommended that other communication module operating in dedicated channel can be implemented for further use.

References

Bhavesh, D., Yash, K., Abhishek, K., & Anjali, A. (2018). Comprehensive survey of Drowning detection and rescue techniques. *International Research Journal of Engineering and technology, 5*(3).

Case, S. L., Lincoln, J. M., & Lucas, D. L. (2018). Fatal Falls Overboard in Commercial Fishing — United States, 2000-2016. *Morbidity and Mortality Weekly Report, 67*(16), 465-469. https://doi.org/10.15585/mmwr.mm6716a2

Handley, A. J. (2014). Drowning. *BMJ (Clinical Research Ed.)*, 348. https://doi.org/10.1136/bmj.g1734

How-Lung, E., Toh, K., Yau, W., & Wang, J. (2008). DE WS: A Live Visual Surveillance System for Early Drowning Detection at Pool. *IEEE Transactions on Circuits and Systems for Video Technology, 18*(2), 196-210. https://doi.org/10.1109/TCSVT.2007.913960

International Life Saving Federation. (2007). International Life Saving Federation World Drowning Report 2007. *International Journal of Aquatic Research and Education, 1*(4). https://doi.org/10.25035/ijare.01.04.08

John, S. N., Godswill, J. U., Osemwegie, O., Onyiagha, G., Etinosa, N. O., & Okpujie, K. (2019). Design of a drowning rescue alert system. *International Journal of Mechanical Engineering and Technology (IJMET), 10*(1), 1987-1995. Retrieved from https://www.iaeme.com/ijmet/issues.asp?JType=IJMET&VType=10&IType=01

Merck. (2018). *Drowning-Injuries; Poisoning, Merck Manuals Professional Edition.*

Mott, T. F., & Latimer, K. M. (2016). Prevention and Treatment of Drowning. *American Family Physician, 93*(7), 576-582.

Muhammed, M. R., Mohammed A., Eberechukwu, P., Kamaludo, M. Y., Ghazli, N. E., & Samura, A. (2018). An early drowning detection system for internet of things (IoT) applications. *TELKONIKA (Telecommunication Computing Electronics and Control), 16*(4), 1870-1876. https://doi.org/10.12928/telkomnika.v16i4.9046

North, R. (2002). The pathophysiology of drowning. *South Pacific Underwater Medicine Society Journal*.

Samuel, N. J., UkpabioImelda, G., Omoruyi, O., Godfrey, O., Etinosa, N., & Kennedy, O. (2019). *International Journal of Mechanical Engineering and Technology, 10*(1), 1987-1995.

SenTag. (2018). Drowning Detection System. *Sentag Pool Safety Drowning Detection*. Retrieved from https://www.sentag.com

Stauffer, C., & Grimson, W. E. (2000). Learning patterns of activity using real time tracking. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 22*(8), 747-757. https://doi.org/10.1109/34.868677

Ukoji, V. N., & Ukoji, V. U. (2015). Boat Accidents in Nigeria: General Trends and Risk Factors (June 2006-May 2015). *ADR Journals 2015*. Retrieved from https://www.nigeriawatch.org/media/html/Ukoji2015.pdf

Wikipedia. (2021). *Man Overboard*. Retrieved from https://en.wikipedia.org/wiki/Man_overboard

World Health Organization. (2014). *Global report on drowning: preventing a leading killer Australian Policy*. Retrieved from https://apo.org.au/node/423502014

Modern Applied Science; Vol. 16, No. 2; 2022
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

Reviewer Acknowledgements

Modern Applied Science wishes to acknowledge the following individuals for their assistance with peer review of manuscripts for this issue. Their help and contributions in maintaining the quality of the journal are greatly appreciated.

Modern Applied Science is recruiting reviewers for the journal. If you are interested in becoming a reviewer, we welcome you to join us. Please contact us for the application form at: mas@ccsenet.org

Reviewers for Volume 16, Number 2

Abdullah Murrar, Indiana University of Pennsylvania, United States

Adli Odeh, Palestine Technical University Kadoorie, Palestine

Ahmed Hashem Mohamed, Veterinary Beni Seuf Universty, Egypt

Alejandra L. San Martin-Azocar, Monterrey Institute of Technology and Higher Education, Mexico

Dinesh Sathyamoorthy, Ministry of Defence, Malaysia

Husam Al Qasem, Palestine Technical University, Palestine

Hussein Abdel Jaber, Arab Open University, Kingdom of Saudi Arabia

Imad Z. Ramadan, Applied Science Private University, Jordan

Jacek Leszczynski, AGH University of Science and Technology, Poland

Jafar Wasfi Abu Saa, Palestine Technical University Kadoorie, Palestine

Jill Smith, University of York, United Kingdom

Jose Manuel Castellano, Universidad Nacional de Educación de Ecuador, España

Kareem Q. Hussein, Mustansiriyah University, Iraq

Lina Fuad Murwih Hussien, Jarash University, Jordan

Marek Brabec, Academy of Sciences of the Czech Republic, Czech Republic

Mohammed Abu Saleem, Yarmok University, Jordan

Mohmmad Shaibat, Al -Quds University, Palestine

O. G Uduoka, Akwa Ibom State University, Nigeria

Omar M. F. Zraqat, The World Islamic Science & Education University, Jordan

Oscar Díaz Olariaga, Universidad Santo Tomás, Colombia

Prem Narayan Aryal, Tribhuvan University, Nepal

Ricardo Ondarza Rovira, Instituto Nacional de Investigaciones Nucleares, Mexico

Rodica Luca, Gh. Asachi Technical University, Romania

Samir Moujaes, University of Nevada, Las Vegas (UNLV), United States

Call for Manuscripts

Modern Applied Science (MAS) is an international, double-blind peer-reviewed, open-access journal, published by the Canadian Center of Science and Education. It publishes original research, applied, and educational articles in all areas of applied science. It provides an academic platform for professionals and researchers to contribute innovative work in the field. The scopes of the journal include, but are not limited to, the following fields: agricultural and biological engineering, applied mathematics and statistics, applied physics and engineering, chemistry and materials sciences, civil engineering and architecture, computer and information sciences, electrical engineering, energy, environmental science and engineering, mechanics. The journal is published in both print and online versions. The online version is free access and download.

We are seeking submissions for forthcoming issues. All manuscripts should be written in English. Manuscripts from 3000–8000 words in length are preferred. All manuscripts should be prepared in MS-Word format, and submitted online, or sent to: mas@ccsenet.org

Paper Selection and Publishing Process

a) Upon receipt of a submission, the editor sends an e-mail of confirmation to the submission's author within one to three working days. If you fail to receive this confirmation, your submission e-mail may have been missed.

b) Peer review. We use a double-blind system for peer review; both reviewers' and authors' identities remain anonymous. The paper will be reviewed by at least two experts: one editorial staff member and at least one external reviewer. The review process may take four to ten weeks.

c) Notification of the result of review by e-mail.

d) If the submission is accepted, the authors revise paper and pay the Article Processing Charge.

e) A PDF version of the journal is available for download on the journal's website, free of charge.

Requirements and Copyrights

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the authorities responsible where the work was carried out, and that, if accepted, the article will not be published elsewhere in the same form, in English or in any other language, without the written consent of the publisher. The editors reserve the right to edit or otherwise alter all contributions, but authors will receive proofs for approval before publication.

Copyrights for articles are retained by the authors, with first publication rights granted to the journal. The journal/publisher is not responsible for subsequent uses of the work. It is the author's responsibility to bring an infringement action if so desired by the author.

More Information

E-mail: mas@ccsenet.org

Website: http://mas.ccsenet.org

The journal is peer-reviewed
The journal is open-access to the full text
The journal is included in:

CABI
Chemical Abstracts database
ERA
LOCKSS
MIAR
Open J-Gate
Polish Scholarly Bibliography (PBN)
SHERPA/RoMEO
Standard Periodical Directory
Ulrich's
Universe Digital Library

Modern Applied Science
Quarterly

Publisher Canadian Center of Science and Education
Address 1595 Sixteenth Ave, Suite 301, Richmond Hill, Ontario, L4B 3N9, Canada
Telephone 1-416-642-2606
E-mail mas@ccsenet.org
Website mas.ccsenet.org

ISSN 1913-1844