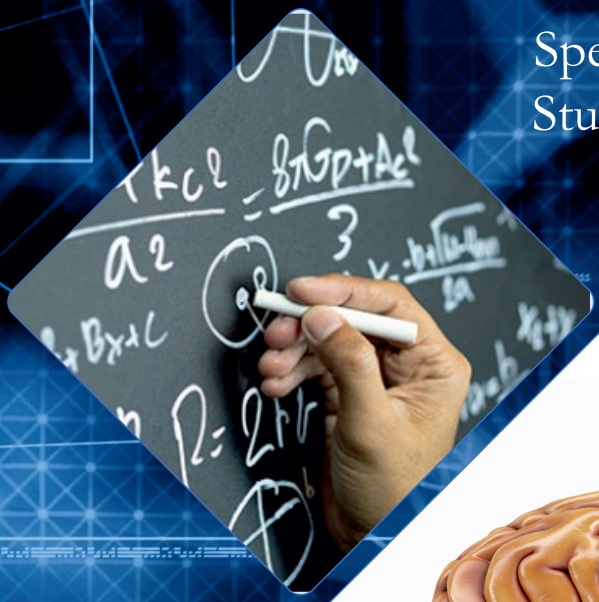
Journal for the
Education of Gifted Young Scientists

ISSN: 2149-360X

Special Issue on STEM Studies, Giftedness and Sustainability of Education

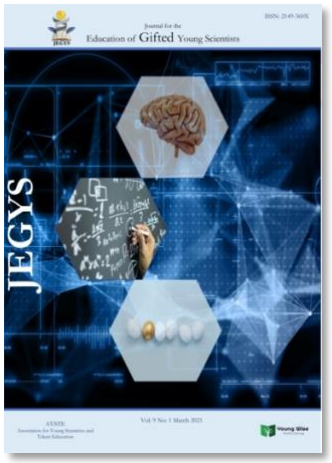


JEGYS

AYSTE
Association for Young Scientists and Talent Education
www.ayste.org

Volume: 9 Issue: 5 Special Issue 2021

Young Wise Publishing



Journal for the Education of Gifted Young Scientists
e-ISSN: 2149- 360X

Vol: 9 Issue: 5 Special Issue 2021 (Winter)
Issue Full File

Special Issue on STEM Studies, Giftedness and Sustainability of Education

Young Wise Publishing

Editor in Chief
Assoc. Prof. Hasan Said Tortop
Young Wise Publishing Ltd., London, UK

Advisory Board Members
Prof. Dr. **Ann Robinson**, University of Arkansas, Department of Educational Psychology, Little Rock, UNITED STATE**.** E-mail: aerobinson@ualr.edu
Prof. Dr. **Hanna David**, Tel Aviv University (Emirata), Department of Gifted Education, Tel Aviv, ISRAEL. E-mail: hannadav@post.tau.ac.il
Prof.Dr. **Albert Ziegler**, University of Erlangen, Department of Gifted Education, Erlangen, GERMANY. E-mail: Albert.Ziegler@fau.de

Section Editors
- **Agricultural-Rural-Biotechnology Education**

Dr. Pakkapong Poungsuk, King Mongkut's Institute of Technology Ladkrabang, THAILAND – E-mail: pakkapong.po@kmitl.ac.th
- **Philosophy of Science**

Prof. Dr. Lütfullah Türkmen, Usak University, TURKEY – E-mail: lutfullah.turkmen@usak.edu.tr
- **Guidance and Counseling**

Dr. Abu Yazid Abu Bakar, Universiti Kebangsaan Malaysia, MALAYSIA – E-mail: yazid3338@ukm.edu.my
- **STEM Education**

Prof. Dr. Gillian H. Roehrig, University of Minnesota, UNITED STATE – E-mail: roehr013@umn.edu
- **Special Education (Twice Exceptionality)**

Dr. Suhail Mahmoud Al-Zoubi, Sultan Qaboos University, OMAN – E-mail: suhailalzoubi@yahoo.com
- **Math Education**

Dr. Adeeb Mohamed Jarrah, United Arab Emirates University, UNITED ARAB EMIRATES – E-mail: jarrah@uaeu.ac.ae
- **Educational Psychology**

Dr. János Szabó, Eszterhazy Karoly University, HUNGARY – Eszterházy Károly University- E-mail: raulrivaul@gmail.com
- **Gifted Education**

Assoc. Prof. Hasan Said Tortop, AYSTE, TURKEY – E-mail: hasansaidfen@gmail.com

Asistant Editors
Dr. Mehmet Fatih Çoşkun, Istanbul Medeniyet University, Physics Engineering, TURKEY – E-mail: fatihmehmetcoskun@gmail.com
Dr. Abdullah Eker, Kilis 7 Aralık University, TURKEY.

Language Review Editors
Fatma Ağaoğlu, Science and Art Center, TURKEY.

Secretary
Dr. Abdullah Eker, Kilis 7 Aralık University, Gifted Education, Turkey, E-mail: aeker38@gmail.com

Editorial Board Members
Prof. Dr. **Albert Ziegler**; University of Erlangen, Department of Gifted Education, Erlangen, GERMANY. E-mail: Albert.Ziegler@fau.de
Prof. Dr. **Carmen Ferrándiz-García**, University of Murcia, Department of Gifted Education, Murcia, SPAIN. E-mail: carmenfg@um.es

Dr. **Abu Yazid Abu Bakar**, University of Kebangsaan, Department of Special Education, Bangi, MALAYSIA. Email: yazid3338@ukm.edu.my

Prof. Dr. **Ann Robinson**, University of Arkansas, Deparment of Educational Psychology, Little Rock, UNITED STATE. e-mail: aerobinson@ualr.edu
Prof. Dr. **Tracy Ford Inman**, Western Kentucky University, The Center for Gifted Studies, Bowling Green, UNITED STATE. E-mail: racy.inman@wku.edu
Prof.Dr. **Margaret J., Sutherland**, University of Glasgow, Department of Special Education, Glasgow, UNITED KINGDOM. E-mail: Margaret.Sutherland@glasgow.ac.uk

Assoc.Prof. **Suhail Mahmoud Al-Zoubi**, Sultan Qaboos University, Department of Psychology, OMAN. E-mail: suhailalzoubi@yahoo.com
Dr. **János Szabó,** Eszterházy Károly University-HUNGARY. E-mail: raulrivaul@gmail.com

Dr. **Milan Kubiatko**, Department of Pedagogical Studies at Faculty of Humanities, Univerzita Jana Evangelisty Purkyne v Ústí nad Labem, CZECH REPUBLIC. E-mail: mkubiatko@gmail.com
Prof.Dr. **Aikaterini Gari,** National and Kapodistrian University of Athens, Department of Psychology, School of Philosophy, Athens, Greece. E-mail: agari@psych.uoa.gr

Assoc.Prof. **A. Abdurrahman**, Universitas Lampung, Physics Education Deparment, INDONESIA. E-mail: abdurrahman.1968@fkip.unila.ac.id
Prof.Dr. **Gillian H. Roehrig**, Institute on Environment Fellow, STEM Education, UNİTED STATE. E-mail: roehr013@umn.edu
Assoc. Prof. **Ilker Işsever**, State Conservatory, Istanbul University, TURKEY. E-mail: ilker.issever@istanbul.edu.tr

Dr. **Elena Leonidovna Grigorenko**: University of Houston, Department of Psychology, Houston, **USA.** Email: elena.grigorenko@times.uh.edu

Contents

Young Wise Publishing House
Adress 1: 63 – 66 Hatton Garden, Fifth Floor, Suite 23, EC1N 8LE, London, UK
Web site: https://youngwisepub.com/
E-mail: info@youngwisepub.com
Adress 2: Besyol Avenue Karadeniz St. No:5-7/3 Kucukcekmece -Istanbul, Turkey
Web site: http://gencbilgeyayincilik.com/
E-mail: gencbilgeyayincilik@gmail.com

Journal for the Education of Gifted Young Scientists, 9(5), 0-0, Dec 2021
e-ISSN: 2149- 360X
jegys.org

youngwisepub.com
© 2021

From the Editor: Special Issue on STEM education studies, Giftedness and Sustainability of Education

Abstract
This special issue aims to combine research on STEM education studies, giftedness, and research on sustainability of education under one umbrella. This is the first special issue of JEGYS and we hope to publish new special issues on important topics in the coming years.
Keywords:
STEM education studies, giftedness, sustainability of education

Dear Authors, Readers, Reviewers, Editors

STEM education has been seen as the transformation of gifted education to normal students in developed countries. However, one thing that I come across very often is this; When I put forward a hypothesis that "STEM education is not suitable for normal students", I immediately say "STEM education is right for normal students", "Why do we distinguish between normal or gifted?" I've come across answers like: I guess this discussion will end soon. The reason is this;

For example, "Nature of science" research began in the 1990s, accelerated until 2010, and has now come to an end. Why?

Trying to apply a very difficult subject such as philosophy to students with normal intelligence level means to start wrong in the first place. Likewise, not everyone can be an engineer. Especially not a very talented engineer. From this point of view, it will be understood that trying to apply a teaching approach that was put forward to train talented engineers to normal students after a certain time is a waste of effort. As a matter of fact, this is the reason why making vehicles from garbage materials is applied so much in many developing countries as STEM education.

Giftedness is not limited to certain talent areas or students. For example, if even a university building is designed for more students to spend time than other university buildings, this design can have giftedness in every aspect. I hope this brings a different perspective for giftedness research.

I think that developing countries should give importance to sustainability in education as much as they give importance to gifted education. It is no longer necessary to spend a lot of money to build a continuous, constantly improving, self-improving education system. Because education has started to evolve itself in a way that it no longer needs material buildings. The virtual world and online education opportunities have now begun to equate most of the students in terms of opportunity. Therefore, the subject of sustainability in education will always take place in the future vision of JEGYS. Thanks to all the authors who supported this special issue.

Best regards
Dr. Hasan Said Tortop
Editor-in-Chief of the JEGYS

Journal for the Education of Gifted Young Scientists, 9(5) Special Issue, 1-9, Dec 2021
e-ISSN: 2149- 360X
jegys.org

Young Wise Publishing
youngwisepub.com
© 2020

Review Article

A critical overview at Israel's PISA 2018 results[1]

Hanna David[2]

Tel Aviv University (Emerita), Israel

Article Info

Received: 01 January 2021
Revised: 10 September 2021
Accepted: 28 October 2021
Available online: 30 Dec 2021

Keywords:
Arab students
Haredi students
Israel
Mathematics
PISA

2149-360X/ © 2021 the JEGYS. Published by Young Wise Pub. Ltd. This is an open access article under the CC BY-NC-ND license

Abstract

This article will present the results of the 2018 PISA International Tests of Israeli students. These tests have been administrated every three years since 2000 in mathematics, science and verbal literacy. The results of Israeli students have been compared to those of the OECD members as well as to those of all 79 participants of the PISA 2018. The first part of the article deals with the consensual harsh critique published in Israel as soon as the law achievements of Israeli students were revealed. It will show that the educational gaps among students from various socio-economic backgrounds, religions, and level of religiosity, as reflected by the school system they belong to. This has happened in spite of the substantial increase of resources Israel has adopted in the last decade, the very generous amount of money allocated to closing the educational gaps between the under-achieving sub-populations and non-minority, Jewish students, and the repeating declarations of all ministers of education and other official authorities about their personal commitment to strive for both closing the educational gaps and increasing its level. The second part of this article will deal with the fact that students who were expected to achieve poorly, have not been included in the PISA sample. These students were mainly Arab, as well as practically all Ultra-Orthodox boys. The Ultra-Orthodox girls included have not been a representative sample but rather a minority of girls belonging to this sector who do tale the matriculation examinations. As a result, the very disappointing results of Israeli student in the PISA 2018 tests have actually been much more inferior than published.

To cite this article:
David, H. (2021). A critical overview at Israel's PISA 2018 results *Journal for the Education of Gifted Young Scientists*, *9*(Special Issue), 1-9. DOI: http://dx.doi.org/10.17478/jegys.760533

Introduction

The Israeli "love-hate affair" with mathematics and science international tests have long passed its fiftieth anniversary. The results of the first TIMSS [*Trends in International Mathematics and Science Study] were published in* 1964; Israel scored the highest among the 12 participants: 8 European countries, the US, Australia and Japan (David, 2015).

In the last 50 years many more countries participated in both the TIMSS and the PISA tests. The TIMSS results of Israeli students varied from excellent to mediocre; those of the PISA – from mediocre to bad. Without getting into a comparison between these two tests (see, for example, Grønmo, 2010; Hole, Grønmo, & Onstad, 2018), it should just be noted, that while TIMSS tests only math and science achievements, and the PIRLS [The Progress in International Reading Literacy Study] are administrated only in some of the countries that participate in the TIMSS, PISA has always examined also verbal literacy and since 2018 – global competence.

Thus, the main difference between these two tests is that while TIMSS examines the learnt and assimilated knowledge, PISA is both about knowledge and the ability to use it as citizens of the global world.

What Happened in Israel When the Results of PISA 2018 were Released?

The results of the PISA 2018 tests were released on December 3, 2019. On the same day a wave of accusations, excuses, explanations, apologizes, and declarations flooded the Israeli media: news webs, declarations and statements of politicians and educators, official and non-official radio and television channels. Most of them referred to the low

[1] This paper was partially presented at 1st International Congress on Gifted Young Scientists Education (ICGYSE), 20-22 November 2020, Istanbul, Turkey.

[2] Dr., Tel Aviv University (Emerita), Israel. E-mail: hannadav@tauex.tau.ac.il Orcid No: 0000-0002-7917-3152D

achievements, blaming the government, or the lack of government – in December 2019 Israel had just gone through its second elections cycle without any visible prospects to reach a majority in the Israeli Parliament. The office considered "most responsible" for the "failure" was the Israeli Ministry of Education, but the Ministry of Finance and the Ministry of Social Equality were also considered guilty. The teachers were described as suffering from lack of competence, lack of education or lack of motivation; the class size was to blame, being defined as "too large"; Israeli culture was titled as "anti-educational". However, the most frequently-heard explanation for the poor achievements that had been cited time and again were the inclusion of Arabs and Ultra-Orthodox students in the sample.

Blaming these two minorities – Arabs living in Israel and having an Israeli citizenship, consisting of about 20% of the Israeli population (The Jewish Agency for Israel, 2020) and Ultra-Orthodox Jews, consisting of about 25% of Israeli Jews – for the low achievements of Israeli students, seemed like the statement: "WE are ok, it is just them, who made US look so badly". But this statement is but a lie, worse than a fig leaf that does not cover the blank true unflattering facts.

Indeed, in countries where the percentage of school-age children consists of a substantial group of immigrants, the OECD has been taking into consideration the educational gaps among various populations. But this is not the case in Israel. In fact, neither Arabs nor Ultra-Orthodox Jews suit the OECD definition for "immigrants". On the contrary: Israeli Arabs have been the descendants of families who lived in Mandatory Palestine a long time before 1948, when the State of Israel was founded. Furthermore: in 1948 only 35.4% of Israeli Jews were natives of Palestine, and this rate had not substantially changed in 1962, when due to the massive waves of immigration to the new-born country only a similar rate – 37.8% – were Israeli-born (The Jewish Agency of Israel, 2020). The vast majority of Arabs in Israel, on the other hand, were born here, as well as their parents, grandparents and grand-grandparents. The second "guilty" sub-population, Ultra-Orthodox Jews, is divided to mainly two non-equal groups: the children and grandchildren of Jews living in Mandatory Palestine as well as Ashkenazim who immigrated to Israel after the holocaust, and Haredi Sephardim. A smaller part consists of American or European immigrants whose children had, in general, more human capital than the children of the other groups.

More than a dozen articles were published in all Israeli daily papers and webs discussing the PISA 2018 in the three days following the publication of the PISA results. Here is a concise summary of the issues they discussed:

1. The deterioration of achievements in comparison to those of the previous PISA results ([Dabul] Dvir, 2019; Dattel, 3/12/2019a, 6/12/2019; Tversky, 3/12/2019; Yanko, 2019; Yarkazi, 3/12/2019; Kogahinof, 3/12/2019; Livnat, 3/12/2019;
2. The substantial decrease in the achievements of Arab students (Tversky, 3/12/2019; Yanko, 2019; Yarkazi, 3/12/2019; Kogahinof, 3/12/2019; Livnat, 3/12/2019;
3. The low Israeli achievements in comparison to the other OECD countries and even non-OECD PISA 2018 participants (Ilan, 3/12.2019; Dabul] Dvir, 2019; Dattel, 3/12/2019a; Yanko, 2019; Yarkazi, 3/12/2019; Kogahinof, 3/12/2019; Livnat, 3/12/2019);
4. The enormous gaps among Jewish sub-populations (Ilan, 2018; Dabul] Dvir, 2019; Dattel, 3/12/2019a, Yarkazi, 3/12/2019; Kogahinof, 3/12/2019; Kashti, 4/12/2019;
5. The gaps between Bedouin and non-Bedouin populations (Yanko, 2019);
6. The increasing gaps between the achievements of Jewish and Arab students (Dabul] Dvir, 2019; Dattel, 3/12/2019a, 6/12/2019; Tversky, 3/12/2019; Yanko, 2019; Yarkazi, 3/12/2019; Kogahinof, 3/12/2019; Livnat, 3/12/2019; Kashti, 4/12/2019;
7. The fact that Jewish Ultra-Orthodox student were no tested, which increased the achievements (Dattel, 3/12/2019a, 9/12/209; Yanko, 2019);
8. Israel made a record by the lowest score ever achieved in any international science test;
9. had the lowest score in science (Dattel, 3/12/2019a, 6/12/2019);
10. The very low rate of students excelling in the PISA 2018 test (Dattel, 6/12/2019; Ilan, 3/12/2019);
11. The very high rate of struggling and failing Israeli students in all three testes areas (Ilan, 3.12.2019; Dvir, 2019; Dattel, 3/12/2019a; Yanko, 2019; Yarkazi, 3/12/2019).

What's New? Or: How are the PISA 2018 Results Different from Those of PISA 2015 or 2018?

The low achievements of Israeli students in the PISA 2018 should not have been a surprise, had we not been exposed, time and again, to the declarations of the official authorities about the improvement of mathematics learning in Israel (Harari, 2016; A record of all times in students taking the 5-point [highest level] math matriculation examinations, 2017); in teachers' salaries (e.g.: A new agreement for [salaries of] high school teachers, 2018; Chai, 2017) and in a very

substantial increase of the budget of the [Israeli] Ministry of Education (by 63%, Tzipori, 2017). This increase did not result in any increase of the students' achievement (Dattel, 2016). As Tzipori (2017) summarizes, Israel's score was not even "reasonable" taking into consideration its financial investment in education. A comparison of the cost/improvement index shows that Singapore cored "very good"; Slovenia and England scored "good"; Cyprus, Greece, Malta, Bahrain, Bulgaria, Malaysia, Romania, Turkey, and Chile scored much better than Israel.

After the PISA 2012 results were released a comparison was made between the PISA achievements of Israel and Turkey (David, 2015). Israel started participating in the Pisa tests in 1963/4; Turkey, on the other hand, started only in 2000. While in Israel a steady deterioration has been observed, in Turkey there has been a constant improvement both in math and science during the last two decades. Thus, it was not such a surprise that the Israeli PISA 2018 results were so poor.

Israel did quite poorly both in the PISA 2012 and the PISA 2015 tests; nothing has substantially changed in the PISA 2018 one. In all these tests the Israeli samples were unreliable; large sub-populations, those whose achievements were lower than the average was either partially or completely excluded. Thus actual achievements had been poorer than those published. Here are the main faults of the PISA 2018 test.

Firstly: The 2018 sample did not cover the whole population

- The 2018 "sample" did not include sufficient Ultra-Orthodox male students; Ultra-Orthodox female students that were included were highly selective (PISA 2018, 2019).
- Arab students living in East Jerusalem were not included at all. Not only the children of Arabs living permanently in Jerusalem were excluded, but also those of the 90,000 Israeli citizens.

According to the Israeli Social security Office, while the 2015 poverty rate in Israel had been 27.1% among adults and 30% among children, it reached 76% among adults and 83.4% among children in East Jerusalem (Poverty rates and social gaps in Israel, 2016).[3]

After excluding from the PISA 2018 test such a substantial number of under-privileged children living in Israel, its coverage reached 90%, the 78th place out the 79 countries participating in PISA 2018. The last place belonged to Sweden – the country where the immigrant rate is one of the highest in the world. It should be noted, that while Arabs in Israel had a low participation rate in the PISA 2018 test, the participation rate in all Arab countries surrounding Israel was high: in Jordan it was 99.5%; in the United Arab Emirates [UAE], Morocco, and Lebanon – about 98% and in Qatar – over 96% (OECD, 2019). It should be noted that excluding the two traditionally-underachieving populations, Ultra-Orthodox and Arab children from samples of international tests, has been done in Israel on a regular basis. Arlozorov (2012), Chai (2012), Meniv (2012) and Kashti (2012) have written about it after the PISA 2011 results had been released; the lack of the Ultra-Orthodox boys had been mentioned in the PISA 2015 report (PISA 2015, 2016) as well as by many others (e.g. Kregenbild, 2018).

Secondly: The weak Israeli students are the worst in the western world

The average grade in PISA 2018 of percentile-5 Israeli students, the 5% receiving the lowest grades, was 295, the worst average in the western world. The average grade of percentile 5 OECD students was 336: 41 points higher (Dattel, 6/12/2019). The picture in each of the three areas tests is similar: 0.7% of the Israeli students did not reach the first among the 8-level reading PISA 2018 classification, in comparison to the OECD mean 0.1% (PISA 2018, Annex B1, Table I.B1.1); 17.7% did not reach the first among the 6-level mathematics PISA 2018 classification, in comparison to the OECD mean 9.1% (PISA 2018, Annex B1, Table I.B1.2), and 3.2% did not reach the first among the 6-level science PISA 2018 classification, in comparison to the OECD mean 0.7% (PISA 2018, Annex B1, Table I.B1.3).

Thirdly: Israel had the world record in gaps between the best and he worst students

According to Kashti (4/12/2019), in PISA 2018 Israel had the highest gaps between Jews and Arabs and among the various Jewish sub-populations.

I. As can be observed from the results, the standard deviation [sd] for reading was 124 points in Israel (OECD, 2019, Table I.B1.4) while in the three following countries – neither of whom has been an OECD member, Lebanon, Malta and the UAE – it was 113. Israel had also the world record in math gaps: its sd had been

[3] One of the reasons that explain this situation – but by no means the main one – is the fact that most of the East Jerusalem families who had lost their Jordanian citizenship face difficulties in acquiring an Israeli one, and thus have no citizenship. As a result, they suffer from major difficulties when trying to improve their educational or financial situation (Ramon, 2018).

108, the OECD mean was only 91 and the next countries with the highest record were, again, non-OECD members, Lebanon and the UAE (106 points) and Malta - 106 points (ibid, Table I.B1.5). The picture is quite similar in science: Israel's sd was 111 points, before Malta – 107 points, and Germany, Qatar and the UAE – 103 points (ibid, Table I.B1.6).

II. Another criterion of measuring inequality is offered by using the indicator of gender and socio-economic inequalities in minimum proficiency (OECD 2019, Table I.10.2). This "parity index":

> compares the share of 15-year-old students who reached at least Level 2 performance across two groups of students that differ in some background characteristics. The parity index varies between 0 and 2. It is equal to 1 if the share of 15-year-old students scoring above minimum levels is the same for both groups (no disparity). (ibid, p. 155).

Israel has been at the "top" of the OECD countries, measuring 0.57 in reading; only Slovakia, Mexico and Colombia, measuring 0.56, 0.47 and 0.44 subsequently, had smaller inequity indices (OECD, 2019, Table I.10.2). In mathematics Israel measured 0.53 in inequity, right above Mexico (0.44), Colombia (0.39) and Chile (0.34) (ibid).

As these indices have a high positive correlation with socio-economic status, it means that Israel has failed in closing educational gaps between the wealthy and the poor. Thus, unlike in many European countries, social and financial mobility in Israel can be defined as very limited.

There is Under-presentation of Arab Ultra-Orthodox Jews Students and Thus the "sample" is Faulty

According to the Hebrew expanded summary of the PISA 2018 results (PISA 2018, 2019, pp. 50-51), only 3.89% of Israeli students were not sampled. 1.8% of them were special education students, hospitalized children, and students in schools tutoring neither in Hebrew nor in Arabic. Another 2.12% were not examined because of physical limitations, cognitive problems, and lingual issues typical to immigrants who have not yet acquired proficiency in Hebrew or Arabic.

However, the real rate of students who did not participate in the PISA 2018 test was much higher than 3.92%:[4] two sub-populations were substantially under-represented – Arabs and Ultra-Orthodox Jews. As the public Arabic education system fails to close the gaps with the Jewish one and Ultra-Orthodox boys do not lean the core studies, math, science and English (see Dattel, 13/5/2019; Krakowski, 2019), had these populations been fully represented the Israeli achievements had been much lower than the actual published ones.

Partial Participation of Arabs

According to the Central Bureau of Statistics (Statistical Abstracts of Israel – No. 70, 2019), 919,438 Arabs lived in Jerusalem in 2018; 38% or them – 349,386 were Arabs. The number of all Arabs in the state of Israel was about 1,878,00 at that time (Press release, 31/12/2018). As the children of East Jerusalem did not participate in the PISA test (OECD, 2019), the meaning is that about 19% of the Arab children were excluded. In fact, the rate of children that did not participate was even higher, due to the higher birth-rate in East Jerusalem than among Arabs who live in other parts of Israel (Korach & Choshen, 2019).

In 2017 about 14% of East Jerusalem children are not registered in any school; 32% did not graduate from high school and the dropout rate among them was substantially higher in comparison to that of the general Arab population in Israel (Report of The Association for Civil Rights in Israel, 2017). Had they been included in the PISA 2018 test, they would probably have much lower achievements than the poor ones of Arabs in Israel living elsewhere.

Partial Participation of Ultra-Orthodox Children

There is an agreed-upon lie, according to which the PISA 2018 consisted of "all 15-year-olds, including Yeshiva- and [other] Ultra-Orthodox students" (PISA 2018 [2019), p. 50). However, the same document (ibid) states that the number of Ultra-Orthodox boys that took the PISA 2018 test was only a fifth of the number that should have taken it. Furthermore: the boys that actually took the test were chosen from just 6 schools. According to Malach, Choshen & Cahaner (2016), in 2012 only about 2% of Ultra-Orthodox boys were entitled to the matriculation certificate. That means that the actual number of 15-year-old Ultra-Orthodox boys was similar to the number of those taking the matriculation examinations, but they were by no means any "sample", as required by the PISA regulations.

In addition, according to table 4.14 in the Statistical Abstracts of Israel – No. 70 (2019), there were 90,374 Ultra-Orthodox students in grade 10 in the year 2018. The yearly dropout rate among Ultra-Orthodox boys was about 3%

[4] There is a slight mathematical inaccuracy in the given calculation: the sum of 1.8%+12% is 3.92% rather than 3.89%.

(Malach et al. 2016); thus is can be assumed that in 2018 there were about 33,000 students in the Ultra-Orthodox education system. If we add the sampling frame *given* numbers of the boys and the girls – 10,486 and 10,948 – they add up to 21,434 – less than two-thirds of the expected number. The "disappearance" of more than a third of the sampling frame questions the whole sampling process and thus the results.

Not only the boys' schools could have been defined as a "sample": the 15 girls' Ultra-Orthodox schools participating in the PISA 2018 test (PISA 2018, table 7) were the *only* schools for Ultra-Orthodox girls in Israel whose students were entitled to the matriculation certification.[5] All these institutes were very small in comparison to the girls' seminars where the vast majority of Ultra-Orthodox girls studies. For example: some of the seminars[6] consisted of thousands of students; the others – many hundreds; "Darchei Sarah", for example, which was included in the PISA 2018 sample, consisted in 2012 but 60 students; only 14 took the matriculation exams on that year (Aharon, 2012).

Participation of Ultra-Orthodox boys had been even poorer. As already stated, only three boys' institutes participated in the so-called Haredi sample. According to Ettinger (2011), until the second decade of the 21st century there were in Israel but 4 Ultra-Orthodox Yeshiva high schools.[7] Even when counting the "Me'orot" school in Beit Shemesh (a total of 92 students), the total number of all students in these institutes was less than the number of students in one average-size "regular" Yeshiva, that did not participate in the PISA 2018 test as its students did not learn any mathematics, English or science.

In summa: The given achievements of Ultra-Orthodox Yeshiva-high-school students are not reliable as

- The students examined studied in just 3 or 4 schools;
- The students studied in highly selective institutes (Spiegel, 2011), and the results were biased upwards.
- Ultra-Orthodox students had a different version of the test, a version that did not include the "global competencies acquisition" part (PISA 2018, 2019).

Are There Any Bright Spots in the PISA 2018 Test?

There have been two main justifications when desperately trying to find bright spots in the poor PISA 2018 results of Israeli students. The first argued that "not taking into consideration the educational achievements of Arabs – the Israeli results were not really; they are quite reasonable"; the second claimed that the interpretation of the result had been biased; had the analysis been done in a different way the results would have been different. Let use refute these claims.

The Arabs are "to blame" (Dabul [Dvir], 2019; Kogahinof, 2019); Their Very Low Achievements Decreased the Average Grade of Israel

This is but an unsuccessful attempt to explain the right for good, equal education to all Israeli citizens and those living permanently in Israel. Without getting into politics and racial discrimination issues, here are the actual facts:

- Arab children in Israel's neighboring countries – e.g. Jordan and Lebanon – where the economic situation is much worse than in Israel, have done much better in the PISA 2018 than Arab students living in Israel (Dattel, 3/12/209b). This is a solid proof that being an Arab is not a reason for school failure; the Israeli education system is.
- In no country among the 79 participants in the PISA 2018 were students' achievements were divided by religion, race, or nationality. In some countries students could have been examined in their mother-tongue rather than in the national language or the language spoken by the majority of the students, as has been the situation in Israel, where Arab students were examined in Arabic. Students who took the Arabic version of the PISA 2018 used the same questionnaires as in all other Arab countries.
- Arab students – whether Christian or Muslim – learning in Christian institutes in Israel have had the highest grades in the matriculation examination for decades, much higher than Israeli Jews (e.g. David, 2008, 2009, 2014a, b, 2017; Sha'alan, 2015; Shadma, 2014).

The Achievements are not Actually so Bad; They Could Have Been Interpreted Differently

[5] Here is the list of these high schools: 1. Moreshet, Tel Aviv; 2. Darchei Sarah, Jerusalem; 3. The Ultra-Orthodox school, Holon; 4. Beit Rivkah (Chabd), Netanya; 5. Beit Ya'akov, Haifa; 6. Beit Ya'akov, Or Yehudah; 7. The girls' Haredi high school, Petach Tikvah; 8. The Experimental-observant school – Pelech, Jerusalem; 9. The Lustig Ultra-Orthodox girls' school, Ramat Gan; 10. The girls' Ultra-Orthodox school – Kanfei Yonah, Zefat; 11. Beit Hannah (Chabad), Zefat; 12. The girls' Ultra-Orthodox school – Akko, 13. The girls' Ultra-Orthodox school – Horev, Ra'anana; 14. Beit Ya'akov, Rechasim; 15. Ultra-Orthodox girls' school "Bnot Leah", Yavneh.

[6] A Beit Ya'akov traditional seminar is an Ultra-Orthodox girls' high school where no matriculation exams are taken, and thus none of them was included in the PISA 2018 sample.

[7] 1. Ha'Yishuv He'Chadah, Tel Aviv; 2. Ma'aravah, Chashmonaim; 3. Nehorah, Mevo Horon; 4. Neharde'ah, Ganei Tikvah.

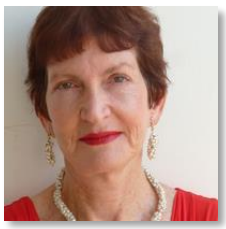
- The rate of the excellent students in all 3 examined areas was 2%, as was the OECD average (Dabul [Dvir], 3.12.2019). What does this fact have to do with the poor Israeli average? What about Israel's pride as the "high-tech country"? is it enough if 3% of Israeli students are outstanding – the same rate as among developed countries whose total average is so much higher than the Israeli? Does it compensate for the high rate of the weak students?
- According to Yanko (3/12/2019), there has been an improvement since 2006. Indeed, this is true, but this justification suffers from two substantial faults: first, comparisons are always done since the last test, the last decade, or the last revolution, plan or re-organization. If any comparison will do, why not to compare the PISA 2018 achievements to those of TIMSS 1963/4, when Israel had the world best achievements in the first international test? And second, taking into consideration the huge amount of money invested in the Israeli education system, at least some improvement could have been expected.
- According to the chief executive officer of the Ministry of Education, there was a positive tendency in the "Growth and Effectiveness Measures for Schools" test [MEIZAV] results of Arab students" (Yarkechy, 3.12.2019). What does this expected – or hoped for – improvement have to do with the PISA 2018 results?
- According to Tzadkani (9/12/2019), "one should not judge because of isolated results". The results of a statistics-based study are not "isolated" – they are valid and reliable even if they do not satisfy the observer.
- Tzadkani (ibid) explains, that the grade-deterioration was "just of a few points", and insignificant in comparison to the previous PISA test. Should we be glad that our deterioration was not more substantial? Or blame the other countries for not deteriorating and thus "making us look bad"?
- According to Ma'or and Dattel (2019), citing Prof. Salberg, "We" [Israelis] should not earn from the countries where the achievements are the highest in the world, namely, from East-Asian
- countries, as the "the children there are miserable". Is it really so? Does a bad score in the most important international test contribute to the students' happiness?

Short Summary

This is the first of a 2-part analysis of the Israeli results in the PISA-2018 test. The article presents the main findings, focuses on the gaps among sub-populations, and refutes the suggestions that "it is not as bad as presented". The second part of the analysis is to discuss the future implications of the gaps among the various sub-populations, including a part about gender differences in achievements.

Had all the detailed facts about the coverage of the PISA 2018 been taken into consideration, Israel's coverage would have been fallen well under the minimal 80% – the minimal coverage allowed by the PISA test rules. Thus, the conclusion is that the bad Israeli results of the PISA 2018 test are much worse than published.

Biodata of Authors



Hanna David received her PhD, "magna cum laude", from Ludwig Maximilians Universität, München and was a college lecturer in Psychology and literature. Dr. David's undergraduate studies started at the Hebrew university of Jerusalem where she majored in Physics and mathematics, and also graduated in Hebrew Literature. She received her Master's degree from the Jewish Theological Seminary in New York at age 22. She is currently a counselor for gifted students and their families; a well-known lecturer in national and international conferences of psychology, education, and giftedness, and an expert evaluator of research proposals for the European Commission. David has published widely in English, Hebrew, French and German, she has authored 18 books and 200+ papers. Dr. David is a licensed Pilates instructor and practices yoga. **Research interests:** Mathematical education, giftedness, educational psychology, creativity, counseling, feminism **Affilation**: Tel Aviv University, Emerita **E-mail:** hannadav@tauex.tau.ac.il **Phone:** 972-39674748 **Orcid No:** 0000-0002-7917-3152 AcademicEdu ResearchGate GoogleScholar

Books:

David, H. (2020). Dynamic assessment of gifted children. New York: Nova Science Publishers.

David, H**.** (2020). On-line dynamic assessment of gifted children during corona-time. New York: Nova Science Publishers.

David, H. (2019). *Emotionally, Socially and Learning Disabled Gifted Children: Theory and Treatment*. New York: Nova Science Publishers.

David, H. (2016). Gifted children with learning disabilities or emotional/social problems (Hebrew). Retrieved from Hebrew Psychology: http://www.hebpsy.net/articles.asp?id=3476

David, H. (2015). *The gifted girl: Case studies*. Retrieved from http://www.hebpsy.net/articles.asp?id=3351

David, H. (2014). Demographic characteristics of students accepted to The Young Person's Institute for the Promotion of Creativity and Excellence: Findings in three decade-cohorts. Retrieved from http://www.hebpsy.net/articles.asp?id = 3216

David, H. (2014). *The gifted child in school* (Hebrew). Retrieved from http://www.hebpsy.net/articles.asp?id=3105

David, H. (2014). *The gifted Arab child in Israel*. Saarbruecken, Germany: Lambert Academic Publishing.

David, H. (2013). *Parenting the gifted child* (Hebrew). Retrieved from http://www.hebpsy.net/articles.asp?t=0&id=3021

David, H. (2011). *The gifted child in the periphery: Studies in nurturing and teaching* (Hebrew). Retrieved from http://www.hebpsy.net/articles.asp?t=0&id=2616

David, H., & Wu, E. (2009). *Understanding Giftedness: A Chinese-Israeli Casebook*. Hong Kong: Pearson Education South Asia.

David, H. (2009). Mathematics learning in the Israeli junior high school. The influence of gender, religion, grade, class-type, and religiosity on mathematics learning in the Israeli junior high school. Saarbrücken, Germany: VDM Verlag.

Ziegler, A., David, H. & Stöger, H. (2004). Male stereotype: An Empirical Study on the Effects of the Concept of a Successful Academic Person. *Ulmer Forsciungsberichte aus den Pädagogischen Psychologie, 8*. Universit of Ulm: Germany.

Zorman, R. & David, H. (2000). *There is another way: Girls and women – Achievements and challenges*. Jerusalem: The Henrietta Szold Institute and The Ministry of Education (Hebrew).

David, H. (1998). Index to Keshet [Rainbow]: A Literary Periodical + Introduction. Tel Aviv University.

David, H. (1995). *The divorcing woman: Prejudices, truths and half-truths.* Tel Aviv: Yaron Golan Publishing House.

David, H. (2017). Gifted Education in the Middle East. In: S. Pfeiffer, E. Shaunessy-Dedrick & M. Foley Nicpon (Eds.), *APA Handbook of Giftedness and Talent* (pp. 113-129). Washington, DC: APA Books.

Selected Journal Articles:

David, H. (2019). Shared parenting in the modern family from a feminist point of view. *Journal of Interdisciplinary Sciences, 3*(2), 36-54.

David, H. (2019). Teaching Mathematically Gifted Students in Israel: The State of the Art. *Journal* for the *Education* of *Gifted Young Scientists*, 7(1), 57-69.

David, H. (2018). Problems and challenges of the gifted adolescent: School-related problems of the gifted adolescent. *Journal of Interdisciplinary Sciences, 2*(2), 113-131.

David, H. (2018). To be a gifted adolescent. *Journal of Interdisciplinary Sciences, 1*(2), 8-23.

David, H. (2018). 4.5-5.5-year-old gifted students: Findings from the 2004 cohort of the Erika Landau Institute. *Scholarly Journal of Psychology and Behavioral Sciences, 1*(4), 75-81.

David, H. (21.1.2018). Ten questions frequently asked by parents of children participating in enrichment programs for the gifted (Hebrew). Retrieved from https://www.hebpsy.net/articles.asp?t=0&id=3634

te Nijenhuis, J., van den Hoek, M., Metzen, D., & David, H. (2017). Spearman's hypothesis not supported? Three meta-analyses of Black and White prisoners, Northeast Asians, and Arabs and Jews. *Personal and Individual Differences, 117*(1), 52-59.

David, H. (2017). Giftedness – How does it work with Sensitivities, learning disabilities, and disorders. *Journal of Interdisciplinary Sciences, 1*(1), 61-75.

David, H. (2017). Seeking help for young gifted children with emotional or educational problems: Who looks for counseling? Part I: Between the telephone call and the meeting. *Journal for the Education Gifted Young Scientists, 5*(1), 57-70.

References

Aharon, I. (2012). The new Haredim founded a new seminar "like Beit Ya'akov". Retrieved from https://www.kikar.co.il/

Alyan, N., Sela, R., & Ramati, T. (August 2012). Failed-Grade: The failing education system in East Jerusalem. Retrieved from https://law.acri.org.il/he/wp-content/uploads/2012/12/Failed-Grade-en.pdf

Arlozorov, M. (13/12/2012). The success in the international tests – Reality of legend? Retrieved from http://www.themarker.com/news/1.1885101

Chai, Sh (12/12/2012). Without Ultra-Orthodox and Arab [students]. The jump-off in the [achievements] in the international tests. Retrieved from http://www.ynet.co.il/articles/0,7340,L-4318599,00.html

Chai, S. (12/12/2017). A new agreement with the teachers: Initial [monthly] salary of 8,000 Shekel. Retrieved from https://www.ynet.co.il/articles/0,7340,L-5055524,00.html

Dabul (Dvir), N. (3.12.2019). Left-behind in mathematics and struggling in reading: [Israeli] worrying results in the PISA [2018] results. Retrieved from https://www.israelhayom.co.il/article/712417

Dattel, L. (6/12/2016). A catastrophe in education: The worst student in the west. Retrieved from The Marker web https://www.themarker.com/news/education/1.3144079

Dattel, L. (3/12/2019a). The big failure of the Ministry of Education: Israeli students deteriorated in all international tests. Retrieved from https://www.themarker.com/news/education/1.8217664

Dattel, L. (3/12/2019b). Crisis in Arab society: the education system went 15 years back. Retrieved from https://www.themarker.com/news/education/1.8218330

Dattel, L (13/5/2019). One third of Israel's religious students are exempt from studying math, science and English. Retrieved from https://www.haaretz.com/israel-news/business/haredi-exemptions-from-core-curriculum-soaring-1.7225781

David, H. (2008). Educational gaps between Jews and Arabs in Israel. *Al-Nibras*, *Articles in Education, Science & Society, 4*, 35-53.

David, H. (2009). The Arab gifted child in Israel: Book summary. *Gifted Education Press Quarterly*, *23*(4), 9-15.

David, H. (2014a). Are Christian Arabs the New Israeli Jews? Reflections on the Educational Level of Arab Christians in Israel. *International Letters of Social and Humanistic Studies, 21*(3) 175-187.

David, H. (2014b). *The gifted Arab child in Israel*. Saarbruecken, Germany: Lambert Academic Publishing.

David, H. (2015). The PISA Results in mathematics and science: A comparison between Israel and Turkey. *Journal for the Education of the Young Scientist and Giftedness, 3*(1), 22-28.

David, H. (2017). Gifted Education in the Middle East. In: S. Pfeiffer, E. Shaunessy-Dedrick & M. Foley Nicpon (Eds.), *APA Handbook of Giftedness and Talent* (pp. 113-129). Washington, DC: APA Books.

Ettinger, Y. (2011). Only 4 Yeshiva-high-schools enable Torah studies and learning for the matriculation certification. Retrieved from https://www.haaretz.co.il/misc/1.1070607

Grønmo, L. S. (2010). Low achievement in mathematics in compulsory school as evidenced by TIMSS and PISA. In B. Sriraman, C. Bergsten, S. Goodchild, G. Pálsdóttir, B. Dahl, & L. Haapasalo (Eds.), *The first sourcebook on Nordic research in mathematics education* (pp. 49-69). Charlotte, NC: Information Age.

Harari, O. (15/11/2016). The [Israeli] Minister of Education launched the "we shall meet at 5" [=5-point matriculation examination, the highest Israeli high school level math exam]. Retrieved from https://www.inn.co.il/News/News.aspx/333691

Hole, A., Grønmo, L.S. & Onstad, T. (2018). The dependence on mathematical theory in TIMSS, PISA and TIMSS Advanced test items and its relation to student achievement. *Large-scale Assessments in Education, 6*(3). doi: 10.1186/s40536-018-0055-0

Ilan, Sh (23/10/2018). A new report: The gaps between the rich and the poor in Israel are among the highest in the OECD. Retrieved from https://www.calcalist.co.il/local/articles/0,7340,L-3748225,00.html

Ilan, Sh. (3/12/2019). The PISA 2019 test: The Israeli students' grades are lower than the OECD average. Retrieved from https://www.calcalist.co.il/local/articles/0,7340,L-3775025,00.html

The Jewish Agency for Israel (2020). Introduction: The Diversity of Israeli Society. Retrieved from http://archive.jewishagency.org/society-and-politics/content/36171

Kashti, O. (11.12.2012). What is not said about the international tests. Retrieved from http://www.haaretz.co.il/news/education/1.1884223

Kashti, O. (4/12/2019). The PISA [2018] results are the first symptoms: The Israeli education system is ill. Retrieved from https://www.haaretz.co.il/news/education/.premium-MAGAZINE-1.8221015

Kogahinof, L. (3/12/2019). The PISA 2018 test: Israel took the first place in [educational] gaps; the lowest ever record in the achievements of the Arab students. Retrieved from https://www.kan.org.il/item/?itemid=62767

Korach, M. & Choshen, M. (2019). Jerusalem: Facts and Trends. The State of the City and Changing Trends. Jerusalem institute for Policy Research, Publication No. 505. Retrieved from https://jerusaleminstitute.org.il/en/publications/facts-and-trends-2019/

Krakowski, M. (19/9/2019). The truth about secular studies in Haredi schools. Retrieved from https://forward.com/opinion/431757/the-truth-about-secular-studies-in-haredi-schools/

Kregenbild, T. (22/12/2028). The Israeli Education system: The PISA test. Retrieved from https://easyconomy.com

Livnat, O. (3/12/2019). The Israeli average grades is lower than the OECD average. Retrieved from https://www.maariv.co.il/news/israel/Article-733006

Malach, G., Choshen, M., & Chaner, L. (2016). The annual of the Ultra-Orthodox society in Israel. Retrieved from https://www.idi.org.il/media/7882/haredi_shnaton.pdf

Ma'or, D., & Dattel, L. (17/12/2019). A world education expert: "Israel should not learn from the best countries in the world – the children are miserable there". Retrieved from https://www.themarker.com/news/education/.premium-1.8279177

Meniv, O. (12/12/2012). About a quarter of Israeli students did not participate in the international tests. Retrieved from http://www.nrg.co.il/online/1/ART2/421/734.html?hp=1&cat=404&loc=1

Ministry of Finance (2018). A new agreement for [salaries of] high school teachers (14/3/2018). Retrieved from the The Ministry of Finance web https://mof.gov.il/Releases/Pages/morim_heskem.aspx

OECD (2019). *PISA 2018 Results (Volume I): What Students Know and Can Do*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/5f07c754-en

PISA 2015 (December 2016). *PISA – Programme for International Student Assessment.* An Israeli view (2016) (in Hebrew). Retrieved from http://meyda.education.gov.il/files/Rama/PISA_2015_Full_Report_8_Chapters.pdf

PISA 2018: Programme for International Student Assessment. An Israeli view (2019). Literacy of 15-year-old Israeli students in reading, mathematics and science (in Hebrew). The State of Israel, The Ministry of education: The National Institute for Educational Measurement and Evaluation. Retrieved from http://meyda.education.gov.il/files/Rama/PISA_2018_Report.pdf

PISA 2018 Global Competence (2018). Retrieved from https://www.oecd.org/pisa/pisa-2018-global-competence.htm

Poverty rates and social gaps in Israel (2016). The 2015 annual report of the Social Security Institute (in Hebrew). Retrieved from https://www.btl.gov.il/Publications/oni_report/Documents/oni2015.pdf

Press release (31/12/2018). 9.0 million citizens lived in Israel on the turn of the year 2019. Retrieved from https://www.cbs.gov.il

Ramon, A. (2018). The Arabs of East Jerusalem, what next? The residency and citizenship issues – state of the art and policy recommendations (in Hebrew). Retrieved from https://jerusaleminstitute.org.il/wp-content/uploads/2019/09/Pub

A record of all times in students taking the 5-point [highest level] math matriculation examinations (2017). Retrieved from the [Israeli Ministry of Education web https://edu.gov.il/owlHeb/Pages/math-record.aspx

Report of The Association for Civil Rights in Israel (2017). East Jerusalem: Facts and data (in Hebrew). Retrieved from https://www.acri.org.il

Sha'Alan, H. (18/9/2015). The excellent [schools] are striking: A glimpse into the ecclesiastical schools. Retrieved from https://www.ynet.co.il/articles/0,7340,L-4701593,00.html

Shadma, A. (2014). 'Leading' Arab schools in Israel: Review of the phenomenon, and the future social-economic integration of their graduates. Retrieved from https://employment.molsa.gov.il/Research/Documents/X12892.pdf

Spiegel, A. (2011). "But the study of Torah is equal to them all".[8] Ultra-Orthodox education for boys in Jerusalem. Jerusalem Institute for Policy Research, Publication No. 405. Retrieved from https://jerusaleminstitute.org.il/en/publications/facts-and-trends-2019/

[8] Mishnah Peah 1:1: These are the things that have no measure: *Peah* [corner of the field which, while harvesting, must be left for the poor], *Bikurim* [First-fruits that must be brought to the Temple and given to the priest], the appearance-sacrifice [brought to the Temple on Pilgrimage Festivals], acts of kindness, and

Statistical Abstracts of Israel – No. 70 (2019). Jerusalem: The Central bureau of Statistics. Retrieved from https://www.cbs.gov.il/en/publications/Pages/2019/Statistical-Abstract-of-Israel-2019-No-70.aspx

Tversky, D. (3/12/2019). The under average level of the [Israeli] education system. The PISA test: Deterioration of the achievements of Israeli students and the increase of the gaps between the rich and the poor. Retrieved from https://www.davar1.co.il/202048

Tzadkani, R. (9/12/2019). Did the Israeli education system really fail? Retrieved from https://www.kipa.co.il

Tzipori, E. (10/4/2017). The bog failure of the Education budget. Retrieved from https://www.globes.co.il/news/article.aspx?did=1001184658

Yanko, A. (3/12/2019). Decrease in the scores and gigantic gaps between Jewish and Arab students: The Pisa test results. Retrieved from https://www.ynet.co.il/articles/0,7340,L-5636364,00.html

Yarkechy, D. (3.12.2019). Weak in reading, mathematics and science: The exposure of the grades of Israeli students. Retrieved from https://news.walla.co.il/item/3327160

the study of the Torah. These are things the fruits of which a man enjoys in this world, while the principal remains for him in the World to Come: Honoring one's father and mother, acts of kindness, and bringing peace between a man and his fellow. But the study of Torah is equal to them all.

Journal for the Education of Gifted Young Scientists, 9(5) Special Issue, 11-17, Dec 2021
e-ISSN: 2149- 360X
jegys.org

Young Wise Publishing
youngwisepub.com
© 2021

Research Article

Literature review: a STEM approach to improving the quality of science learning in Indonesia

Atip Nurwahyunani[1],

Biology Education Program, Malang State University, Indonesia

Article Info

Received: 04 January 2021
Revised: 29 June 2021
Accepted: 29 October 2021
Available online: 30 Dec 2021

Keywords:
Learning quality
STEM approach
Science learning

2149-360X/ © 2021 the JEGYS. Published by Young Wise Pub. Ltd. This is an open access article under the CC BY-NC-ND license

Abstract

The application of STEM learning as a preventive approach is expected to help students interpret learning, especially science, so that it influences to improving learning quality. This is expected to be able to answer the challenge of creating a high-quality generation that focuses on the integration of science, technology, engineering and mathematics. STEM integration is related to contextual issues that support each other in science learning that is related to life. In this study, a review was carried out on research articles of STEM learning application which included four disciplines, namely science, technology, engineering, and mathematics, involving pupils in the investigation process that resulted in understanding and explanation supported by relevant evidence. The investigation process involved 20 articles related to the STEM approach, then analyzed. The results of the literature review show that the approach bar be able repair of learning grade. However, in its implementation there are various views regarding the role of various disciplines in STEM integration. The results of the literature review are expected to contribute to recommendations for implementing the STEM approach in improving the quality of learning.

To cite this article:

Nurwahyunani, A. (2021). Literature review: a STEM approach to improving the quality of science learning in Indonesia. *Journal for the Education of Gifted Young Scientists*, *9(5)* Special Issue, 11-17. DOI: http://dx.doi.org/10.17478/jegys.853203

Introduction

The Organization for Economic Cooperation and Development (OECD) noted that the ranking of the Indonesia Program for International Student Assessment (PISA) based on the 2018 survey was at the bottom of the list. For reading competency scores, Indonesia level is 72 out from 77 countries. For Mather number is ranked 72. While the Science grade is 70. This value tends to be stagnant in the last 10 - 15 years. As a step to increase the value of Indonesia's PISA, Minister of Education and Culture (Mendikbud) Nadiem Anwar Makarim prepared a strategy to implement holistic learning to develop superior Indonesian human resources (Kasih, 2020)

The STEM integration program in learning is a learning program that combines two or more fields of science contained therein (Science, Technology, Engineering, and Mathematics) (Laboy-Rush, 2010). The use of the STEM approach in learning is a new approach in the development of the world of education that runs in more than one scientific discipline. The combination of several disciplines such as Science, Technology, Engineering, and Mathematics (STEM) in learning is expected to be able to improve the quality of education in Indonesia, therefore be contend with neighboring state. STEM does not yet have the right framework and even requires greater efforts to produce competitive students in the fields of STEM (Zeidler, 2016). Each of the STEM disciplines principle is other epistemological opinions. Science try to expand an concept of nature by testing generalizations of hypotheses, and developing in students a predetermined set of beliefs about their native environment (Williams, 2011).

STEM education is starting to develop in various countries around the world. Several countries that have implemented STEM education for ± 3 decades and are increasingly significant in recent years include the United

[1] Program Studi Pendidikan Biologi FPMIPATI Universitas PGRI Semarang, Jl. Sidodadi Timur No 24, Dr. Cipto - Semarang, Indonesia. Anggrek: 0000-0003-4972-4360

States, Taiwan, Finland, Australia, Vietnam, China, and the Philippines. STEM literacy, namely awareness of several disciplines such as science, technology, engineering, and mathematics and getting to know some of the basic concepts of each discipline should be an educational priority for all students (Bybee, 2010; National Engineering Academy and National Research Council, 2014). an integrated approach to STEM education argues that student interest, success and motivation will be enhanced with focus daily problems and eventually amount of students chase careers in STEM will increase (Sayang, Pearson & Schweingruber, 2014). In accordance with the cognitive themes that develop from the learning sciences, integrative STEM activities are examples of constructivist practices in education. They present a context and structure to arrange noetict understanding of science and mathematics and push learner to vibrant build contextual awareness of science and mathematics, there by supporting remembering and assignment of learning (Sander, 2009).

Therefore, in this study the authors intend to discuss the integration of STEM education in learning and its impact on improving the quality of education. This study formulas is "How can the influence of the STEM approach in learning improve the Indonesia education quality?

Method

The research method apply literature study with adopt analyzing some articles. Review the documents by discussing and evaluating previous similar research on STEM approaches to learning.

The phase of the literature review method contain; 1) Manuscript filtering. The articles analyzed were achieve by searching for relevant literature online using several well-known online research databases related to education, STEM and science (ERIC and google scholar). Articles used from 2008 to 2020. The articles studied are journal articles in English and Indonesian. Articles should focus on the integration of at least three STEM disciplines. Articles that study a combination of only two disciplines, for example interdisciplinary mathematics and the integration of science or technology in mathematics, are excluded. 50 Articles provide clear descriptions of the STEM approach. By reviewing the title and abstract, the selected articles are examined by the researcher to determine whether the articles are suitable for the research objectives. A total of 10 articles met the criteria for inclusion in the final review. 2) Analysis. the analyzed using qualitative content with correlation between content and context. Articles were analyzed based on subcategories according to their respective research questions. Categories are useful for grouping studies according to the variables studied. During the systematic review process, some subcategories emerge and others are refined to reflect emerging information (Paramita, Dasna, & Yahmin, 2019).

Results and Discussion

This research is based on an article that examines research activities on the STEM approach in science learning published in the period 2008 - 2020. According to experts, the STEM approach has several meanings, so in this article the authors synthesize the definition of the STEM approach based on these opinions. Expert opinion regarding the application of the STEM approach describe in table 1.

Table 1.

Details of the Selected Articles

STEM Approach in Indonesian Education		
Author	**Title**	**Journal**
Widarti, Rokhim, & Syafruddin (2020)	Development of electrolysis ….	Jurnal Pendidikan IPA Indonesia
Arlinwibowo, Retnawati, & Kartowagiran (2020)	Type of Implementation of STEM Education in Indonesia	Jurnal Universitas Arsitektur & Teknologi Xi'an
Abdurrahman, Suyatna, & Nuangchalerm, (2019)	TEM-integrated newtonian dynamics effects…	Jurnal Ilmiah Pendidikan FisikaAl-BiRuNi
Abdurrahman, Nurulsari, Maulina, & Ariyani, (2019)	Design and Validation of Inquiry-based STEM Learning Strategies as Effective ….	Journal for Education of Gifted Young Scientists
Paramita, Dasna, & Yahmin, (2019)	Literature Review: STEM Integration….	Jurnal Pembelajaran Kimia
Milaturrahmah, Mardiyana, & Pramudya, (2017)	Mathematics Learning Process with Science, Technology, Engineering …	Jurnal Fisika: Conf. Seri 895 (2017) 012030

Theme 1. A Fun, Interesting, Fun and Exciting Approach

Teacher will be support in the classroom if they understood their material deep, thus they can flatten concepts and procedures from a lot of perspectives. What is more important is the need to be able to turn questions into learning moments that will help spark student interest in STEM (Ejiwale, 2012). Twenty-eight participants felt that science learning through designing and making science-based toys offered a learning environment that was fun, interesting, active, enjoyable and fun (Siew, Amir, & Chong, 2015). Participants expressed the view that the level of self-confidence of teachers and students in learning chemistry at school on voltaic cell material was carried out based on STEM-PjBL education assisted by instructional videos 78.6 and 89.2. Therefore, it is necessary to develop teaching materials with appropriate approaches and methods that can support chemistry learning on the topic of electrolysis cells in the form of STEM-PjBl-based textbooks assisted by learning videos featuring triple representatives (Widarti, 2020). Inquiry-based STEM learning strategies (Generating motivation and interest in science, increasing curiosity, in-depth discussion, analyzing, compiling, and constructing ideas) (Abdurrahman et al. 2020).

Theme 2. Increased Student Motivation

After one day attending the STEM-PjBL workshop, participants believed that STEM-PjBL was able to go up student encouragement to learn science and also motivate teachers to strengthen and repair the teaching and learning process, students gain motivation and when they are stimulated by their peers who develop self-esteem (Siew, Amir, & Chong, 2015)

Theme 3. Offer Opportunities to be Creative

Participants noted that learning with science-based toys was more than just playing with toys for fun. They believe that designing and making science toys themselves is a promising approach that offers students the opportunity to create something new and develop creative thinking skills (Siew, Amir, & Chong, 2015). STEM has been and will continue to provide for everyone - to provide the new knowledge and technology needed to overcome challenges (Supranto, 2016). Integrated STEM offers students the opportunity to carry out learning in real-world situations. Integrated STEM offers students the occasion to carry out learning in daily life situations as opposed to studying STEM fragments separately (Tsupros, Kohler, & Hallinen, 2009). Real and direct experiences that have the potential to increase student interest in STEM and STEM careers include mentoring programs, internships, afterschool that focuses on STEM subjects or health, and participation in math and science competitions (Miller, Chang, & Hoyt, 2010). STEM through Project Based Learning which makes students more aware of the need for clean water in the future (Stohlmann, Moore, & Roehrig, 2012).

Theme 4. Develop HOTs Abilities and Problem Solving Skills

Details of the articles studied regarding the STEM approach to HOTs ability and problem solving skills are shown in Table 2.

Table 2.

STEM Approach to HOTs Ability and Problem Solving Skills

STEM approach to HOTs ability and problem solving skills		
Author (Year)	Title Journal identity	Journal identity
Yusuf & Widyaningsih, (2019)	HOTS profile of physics education students ….	International Conference on Mathematics and Science Education (ICMScE 2018)
Siew, Amir, & Chong, (2015)	The perceptions of pre-service and in-service teachers regarding …	SpringerPlus
Lestari, Astuti, & Darsono, (2018)	Implementation of worksheets with a STEM …	Jurnal Pendidikan Fisika dan Teknologi
Supranto (2016)	Students' Attitudes towards STEM Education…	Journal of Turkish Science Education.

Based on Table 2, it is explained that physics-based STEM learning using PhET media is used to develop students' HOTS abilities. Students' perceptions of learning carried out generally show that students agree with the learning. STEM-based physics learning using PhET media will continue to be developed in various subjects in the Department of Physics Education, University of Papua to improve students' HOTS abilities (Yusuf & Widyaningsih, 2019). Three participants said the view that the workshop encouraged them to find their own solutions for designing and creating projects. They realized that STEM-PjBL gave students the opportunity to work alone with the guidance of an instructor (Siew, Amir, & Chong, 2015). Research on the results of the

implementation of the LKS with the STEM approach in class VIII A students regarding critical thinking skills obtained an increase in n-gain at the pretestposttest score of 0.5 on moderate criteria. This means that student worksheets developed with the STEM approach can improve students' critical thinking skills (Lestari, Astuti, & Darsono, 2018). STEM has been and will keep on to provide for everyone - to provide new knowledge and technology needed to overcome challenges, and to support new goods and services (Suprapto, 2016). Research on the results of the implementation of the LKS with the STEM approach in class VIII A students regarding critical thinking skills obtained an increase in n-gain at the pretestposttest score of 0.5 on moderate criteria. This means that student worksheets developed with the STEM approach can improve students' critical thinking skills (Lestari, Astuti, & Darsono, 2018).

Theme 5. The Effect of the STEM Approach on Literacy Skills

Details of the articles studied regarding of the STEM approach on literacy skills effect are shown in Table 3.

Table 3.

The STEM Approach Can Improve Literacy Skills

The STEM approach can improve literacy skills		
Author (Year)	Title Journal identity	Journal identity
Kelana et al. (2020)	The effect of STEM approach on the mathematics literacy ability….	Journal of Physics: Conference Series 1657 (2020) 012006
Morrison (2006)	TIES STEM Education Monograph Series	http://www.wytheexcellence.org /media/STEM_Articles.pdf
Stohlmann, Moore, & Roehrig, (2012)	Considerations for Teaching Integrated STEM Education	Journal of Pre-College Engineering Education Research *(J-PEER)*
Becker & Park (2011)	Integrative Approaches among Science, Technology…	Journal of STEM Education

Based on table 3, the effect of the STEM approach on the mathematical literacy skills of elementary school teacher candidates is seen in the increase in the average pretest and posttest results of students which shows that the research sample has increased by 10.39 with an average pretest of 30.19 and posttest of 40.58 . Data were processed using SPSS 20. The results showed the sig value. (2-tailed) 0,000 (Kelana et al. 2020). Morrison (2006) describes some of the characteristics of STEM education for students, schools, and classrooms. STEM educated students are problem solvers, logical thinkers, technology literate, and able to connect their own culture to learning. STEM schools prioritize STEM literacy and are culturally relevant to all students, have curriculum materials that support STEM teaching, foster a culture of questioning and creativity, and encourage formative and performance-based assessment practices. STEM education through project-based learning that makes students more aware of the need for clean water in the future (Stohlmann, Moore, & Roehrig, 2012). The findings obtained in this initial meta-analysis suggest that an integrative approach among STEM subjects makes STEM instruction more effective. Specially, the integrative approach shows upper effects at the elementary school grade (Becker & Park, 2011).

However, implementing the STEM approach in learning also requires commitment from stakeholders in the implementation process in schools (Arlinwibowo, Retnawati,& Kartowagiran, 2020; Maltese, & Tai, 2011). The application of STEM education can develop the interests, attitudes and skills needed in the 21st century, including communication which refers to argumentation skills. In its application, the teacher can choose a strategy that suits the needs and characteristics of the material. Regarding which strategy is the most effective, further empirical testing is needed (Paramita, Dasna, & Yahmin, 2019). STEM education often requires much materials and resources for pupil to investigate solutions to real-world problems through designing, disclosing, testing, and revising their ideas (Stohlmann, Moore, & Roehrig, 2012). Research by (Milaturrahmah, 2017) on the process of learning mathematics with the STEM approach in Indonesia is an aspect of preparation including preparation of media and learning resources, preparation of activity sheets, preparation of practical tools and materials, aspects of implementing learning. Introduction includes preparing students psychologically and physically before the learning process, asking questions about previous knowledge regarding the material to be studied, using the STEM approach in learning, content includes using an inquiry-based learning approach, linking material with everyday life, practice, involving students in practice, students are actively involved in classroom practice, guide students in practice, utilize technology (computers, internet), use active learning strategies, communicate actively with students during learning, assign assignments in groups, use problem solving learning methods, combine STEM in one subject (at least 2 STEM disciplines), students are motivated to like mathematics, develop teaching materials, teach according to their

fields, there is no gap between students. The class for us as teacher is to realize that school subjects need to be connected and not taught in isolation from one another. Students must be able to transfer all learning across curricular areas and make connections that can increase levels of academic achievement. The urgency is clear and many school systems have invested in the need for curriculum reform (Barcelona, 2014).

The National Research Council (2010) notes that in STEM learning, the ability to command the teaching strategies needed to illuminate STEM for students is just as important as teachers who know the various ways in which learners develop STEM knowledge and skills. Other support for teachers comes through federally funded mathematics and science teacher professional development training to help teachers implement STEM integration (Harris & Felix, 2010; Susanti, Prasetyo, & Retnawati, 2020; Mahmudi, Susantini, & Yakub, 2020). This will assist in preparing learners with the tools obligatory to tackle the STEM program. In another study, faculty from the University of Nebraska developed a two-week summer professional development program to help middle and high school science and math teachers carry out engineering lessons. In studying the effect of their lessons found students' interest in mathematics, science, and engineering was recommend (Nugent et al. 2010; Kennedy, & Odell, 2014). A large cadre of leading educational leaders and professional associations strongly advocate improvements in STEM education at the undergraduate level. Many influential groups and organizations recognize the need to reform STEM education and work to improve undergraduate teaching and learning in the STEM field. A number of articles, reports and books have appeared in recent years criticizing current practice and advocating improvements in STEM undergraduate education strategies. Many professional organizations and disciplinary communities have joined the reform chorus, pleading with their members and stakeholders to adopt more flexible, active, collaborative, and friendly pedagogical practices that will reach more effectively to a diverse range of students (Baldwin, 2009; Mutakinati, Anwari, & Yoshisuke, 2018). The aim of our professional development summer institute is to build on the existing literature on increasing the capacity and effectiveness of teachers to teach STEM with attention to content knowledge and their affective perceptions in the context of STEM teaching and learning. Our results show significant gains in the perceptions of efficacy, comfort, satisfaction, and knowledge of participating teachers with regard to STEM education. These results support the effectiveness of our intervention in increasing the capacity of teachers to teach STEM and provide a model for others who wish to respond to calls to increase the quantity and quality of STEM education (Nadelson & Callahan, 2011). These teacher candidates developed a more positive attitude about teaching STEM content and expressed a desire to include place-based pedagogy in their future STEM teaching (Adams et al. 2019; Bancong & Song, 2018).

Conclusion and Recommendations

The STEM approach in learning is used to improve the quality of learning, such as students' HOTS abilities, interests, student motivation, problem-solving abilities, and creating active learning. The results showed that be united approach between STEM subjects had a great effect of science learning quality. However, applying the STEM approach to learning also requires commitment from stakeholders in the implementation process in schools. These teacher candidates developed a more positive attitude about teaching STEM content and expressed a desire to include place-based pedagogy in their future STEM teaching.

Based on the research results it is recommended that the implementation of the STEM approach in education will improve the quality of education in Indonesia.

Limitations of Study

Review the literature by discussing and evaluating previous similar research on STEM approaches to learning.

Acknowledgment

I would like to thank all science teachers in Amman/Marka district; without their generous support, this study would not have been possible. Furthermore, grateful for my family and my lecture of motivating me to conduct this research.

Biodata of Authors

Atip Nurwahyunani, was born in Blora Indonesia. The author received a bachelor of science degree from the Department of Biology in 2006, a bachelor's degree in Biology education in 2008, and a master's degree in science education with a concentration of Biology in 2010 at Universitas Negeri Semarang. Currently the author is active as a lecturer in the field of Biology Education, and Microbiology at the Biology Education Study Program, FPMIPATI, Universitas PGRI Semarang. Currently the author is completing a Doctoral study in Science Education at the Postgraduate Program at Universitas Negeri Semarang. The author is actively conducting various researches in the field of Applied Biology and Biology Education published in National and International journals

References

Abdurrahman, A., Nurulsari, N., Maulina, H. & Ariyani, F. (2019). Design and Validation of Inquiry-based STEM Learning Strategy as a Powerful Alternative Solution to Facilitate Gift Students Facing 21st Century Challenging . Journal for the Education of Gifted Young Scientists, 7(1), 33-56 . DOI: 10.17478/jegys.513308

Adams, A.E., Miller, B.G., Saul, M., & Pegg, J. (2019). Supporting Elementary Pre-Service Teachers to Teach STEM Through Place-Based Teaching and Learning Experiences. *Electronic Journal of Science Education, 18*(5), 1-22.

Adams, W.K., Armstrong, Z., & Galovich, C. (2015). Can students learn from PhET sims at home, alone? Proc. Int. Conf. on Physics Education Research Conference (College Park: American Association of Physics Teachers) p 23

Arlinwibowo, J., Retnawati, H., & Kartowagiran, B. (2020). The Types of STEM Education Implementation in Indonesia. Journal of Xi'an University of Architecture & Technology, 12(8), 606-613.

Baldwin, R.G. (2009). *The Climate for Undergraduate Teaching and Learning in STEM.* Wiley InterScience

Bancong H., & Song, J. (2018). Do physics textbooks present the ideas of thought experiments?: a case in Indonesia. *Jurnal Pendidikan IPA Indonesia, 7*(1), 25-33.

Barcelona, K. (2014). 21st Century Curriculum Change Initiative: A Focus on STEM Education as an Integrated Approach to Teaching and Learning. *American Journal of Educational Research, 2*(10), 862-875

Becker, K.H., & Park, K. (2011). Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A preliminary meta-analysis. *Journal of STEM Education, 12*(5-6), 23-37.

Bybee, R. W. (2010). Advancing STEM education: A 2020 vision. *Technology and Engineering Teacher, 70*(1), 30-35.

Çevik, M. (2017). Content Analysis of Stem-Focused Education Research in Turkey. *Journal of Turkish Science Education, 14*(2), 12-26.

Ejiwale, J. A. (2012). Facilitating Teaching and Learning Across STEM Fields. Journal of STEM Education, 13(3), 87-94.

Harris, J., & Felix, A. (2010). A project-based, STEM-integrated team challenge for elementary and middle school teachers in alternative energy.

Honey, M., Pearson, G. & Schweingruber, H. (Eds). National academy of engineering and national research council (2014). stem integration in k-12 education: status, prospects, and an agenda for research. Washington D.C.: The National Academies Press

Kasih, A.P. (2020). Nilai PISA Siswa Indonesia Rendah, Nadiem Siapkan 5 Strategi Ini Kompas.com - 05/04/2020. https://edukasi.kompas.com/read/2020/04/05/154418571/nilai-pisa-siswa-indonesia-rendah-nadiem-siapkan-5-strategi-ini?page=all

Kelana, J.B., Wardani, D.S., Firdaus, A.R., Altaftazani, D.H., & Rahayu, G.D.S. (2020). The effect of STEM approach on the mathematics literacy ability of elementary school teacher education students. Journal of Physics: Conference Series 1657 (2020) 012006

Kennedy, T.J., & Odell, M.R.L. (2014). Engaging Students In STEM Education. *Science Education International, 25*(3), 246-258. https://files.eric.ed.gov/fulltext/EJ1044508.pdf

Laboy-Rush, D. (2010). Integrated STEM Education through Project-Based Learning. New York: Learning.com

Lestari, D.A.B, Astuti, B., & Darsono, T. (2018). Implementasi LKS Dengan Pendekatan STEM (Science, Technology, Engineering, And Mathematics) Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Pendidikan Fisika dan Teknologi, 4*(2), 203-207.

Mahmudi, I., Susantini, E., & Yakub. P. (2020). The development of student worksheet integrated by stem approach in plant gowth and development material to train bio-entrepreneurship skills. *Bioedu Berkala Ilmiah Pendidikan Biologi, 10*(1), 150-157. https://ejournal.unesa.ac.id/index.php/bioedu

Maltese, A.V., & Tai, R.H. (2011). Pipeline persistence: Examining theassociation of educational experiences with earned degrees in STEM among U.S. students. *Science Education, 95*(5), 877–907.doi:10.1002/sce.20441

Milaturrahmah, N., Mardiyana, M., & Pramudya, I. (2017). Mathematics Learning Process with Science, Technology, Engineering, Mathematics (STEM) Approach in Indonesia. Journal of Physics: Conf. Series 895 (2017) 012030

Miller, L., Chang, C.-I., & Hoyt, D. (2010). CSI web adventures: A forensics virtual apprenticeship for teaching science and inspiring STEM careers. *Science Scope, 33*(5), 42-44

Morrison, J. (2006). *Attributes of STEM education: The student, the school, the classroom* [Monograph]. Baltimore, MD: Teaching Institute for Excellence in STEM. Retrieved from http://www.tiesteach.org/

Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM Education Project-Based Learning . *Jurnal Pendidikan IPA Indonesia (Indonesian Journal of Science Education), 7*(1), 54-65

Nadelson, L.S., & Callahan, J. (2011). A comparison of two engineering outreach programs for adolescents. *Journal of STEM Education, 12*(1-2), 42-54.

National Research Council (2010). *Preparing teachers: Building evidence for sound policy.* Washington, DC: National Academic Press

Nikolakopoulou, K, Koustourakis, G, Komis, V., & Ravanis, K. (2016). The discourse for the integration of ICT in STEM education: attitudes expressed in texts on education in Greece (1984-2006). *Journal of Subject Didactics*, 1, 67-81

Nugent, G., Kunz, G., Rilett, L., & Jones, E. (2010). Extending engineering education to K-12. *The Technology Teacher, 69*(7), 14 -19

Nugroho, O.F., Permanasari, A., & Firman, A. (2019). The movement of stem education in indonesia: science teachers' perspectives. *JPII, 8*(3), 417-425

Paramita, A.S., Dasna, I.W., & Yahmin (2019). Kajian Pustaka: Integrasi STEM Untuk Keterampilan Argumentasi Dalam Pembelajaran Sains. *Jurnal Pembelajaran Kimia, 4*(2), 92-99.

Sanders, M. (2009). STEM, STEM Education, STEMmania. http://hdl.handle.net/10919/51616

Siew, N.M., Amir, N., & Chong, C.L. (2015). The perceptions of pre-service and in-service teachers regarding a project-based STEM approach to teaching science. SpringerPlus, 4 (8). http://www.springerplus.com/content/4/1/8

Stohlmann, M., Moore, T.J., & Roehrig, G.H. (2012). Considerations for Teaching Integrated STEM Education. *Journal of Pre-College Engineering Education Research (J-PEER), 2*(1), Article 4.

Supranto, N. (2016). Students' Attitudes towards STEM Education: Voices from Indonesian Junior High Schools. *Journal of Turkish Science Education, 13*(Special Issue), 75-87.

Susanti, D., Prasetyo, Z.K., & Retnawati, H. (2020). Analysis of elementary school teachers' perspectives on STEM implementation. 2020. *Jurnal Prima Edukasia, 8*(1), 40-50

Tanujaya, B. (2016). Development of an instrument to measure higher order thinking skills in senior high school mathematics. *Instruction Journal of Education and Practice*, 7, 144-148

Tsupros, N., Kohler, R., & Hallinen, J. (2009). *STEM education: A project to identify the missing components*. Intermediate Unit, 11-17.

Widarti, H.R., Rokhim, D.A., and Syafruddin, A.B. (2020). The Development Of Electrolysis Cell Teaching Material Based On STEM-PJBL Approach Assisted By Learning Video: A Need Analysis. JPII 9(3), 309-318. https://journal.unnes.ac.id/nju/index.php/jpii/article/view/25199/10778

Williams, J. (2011). STEM Education: Proceed with caution. Design and Technology Education: An International Journal 16.1 2011. https://ojs.lboro.ac.uk/DATE/article/view/1590/1514

Yusuf, I., & Widyaningsih, S.W. (2019). HOTS profile of physics education students in STEM-based classes using PhET media. International Conference on Mathematics and Science Education (ICMScE 2018) IOP Conf. Series: Journal of Physics: Conf. Series 1157 (2019) 032021

Yusuf, I., Widyaningsih, S.W., & Purwati, D. (2015). Pengembangan perangkat pembelajaran fisika modern berbasis media laboratorium virtual berdasarkan paradigma pembelajaran abad 21 dan kurikulum 2013. *Pancaran Pendidikan, 4,* 189-200

Zeidler, D. L. (2016). STEM education: A deficit framework for the twenty first century? A sociocultural socioscientific response. *Cultural Studies of Science Education, 11*(1), 11–26. https://doi.org/10.1007/s11422-014-9578-z

Journal for the Education of Gifted Young Scientists, 9(5), Special Issue, 19-25, Dec 2021 e-ISSN: 2149- 360X
jegys.org

youngwisepub.com
© 2021

Research Article

Leadership roles of teachers as school counsellors in schools to enhance giftedness in children

Vimbi Petrus Mahlangu[1]

Department of Educational Leadership and Leadership, University of South Africa, South Africa

Article Info

Received: 01 October 2021
Revised: 28 October 2021
Accepted: 04 November 2021
Available online: 30 Dec 2021

Keywords:
Counselling Program
Leadership
School Counselling
Professional Training
Professional Development
Place
Skills
Spaces

2149-360X/ © 2021 JEGYS
Published by Young Wise Pub. Ltd.
This is an open access article under the CC BY-NC-ND license

Abstract

The purpose of the paper is to explore leadership roles of teachers as school counsellors in schools to enhance giftedness in children. This review is important because it adds value to what is already happening in schools. The issue is that school counsellors must conduct counseling and listen to students' grievances, which they cannot do without the cooperation of school leadership. In order to investigate the role of leadership in school counseling, the paper employs an interpretive paradigm and a qualitative approach. Teachers working as school counsellors are expected to promote, advocate for, and work toward social justice and culturally responsive programs that are accessible and accountable to all school stakeholders. Principals, as leaders, must guarantee that counseling services are offered to all students in schools; a lack of suitable training, professional counselling knowledge, and abilities may have an impact on the school counsellor's role as a leader. As leaders, school counsellors must promote student achievement by providing services that influence the career development, social, and emotional development of all students enrolled in the school. All stakeholders in schools must be able to control their emotions, relationships, and actions, and leaders must be able to do so.

To cite this article:
Mahlangu, V.P. (2021). Leadership roles of teachers as school counsellors in schools to enhance giftedness in children. *Journal for the Education of Gifted Young Scientists*, *9*(5), Special Issue, 19-25. DOI: http://dx.doi.org/10.17478/jegys.1003299

Introduction

Giftedness is a fluid term that comes from the interaction of a child's and his or her family's qualities. Parents' understanding of their children's developmental features and how they treat them is an important aspect in their social and emotional development. A positive parental attitude contributes significantly to a child's growth, ensuring that the child is satisfied with his or her life and is raised as a healthy and happy individual (Yıldız & Altay, 2021). That is why the role of leadership in school counselling spaces and places is very important for the giftedness of children in schools.

The purpose of the paper is to advance the knowledge about the role of leadership in school counselling. In this paper the school counsellor must be understood in the context of being a leader. The school's counsellor is expected to advance the mental, social, academic, and professional development of all students and staff in the school. Bolden and Gosling (2006) believe that leadership cannot be dissociated from the temporal and situational contexts. Hence it must occur in situation and must be based on openness and honesty. Consequently, the school counsellor must provide counselling services and to listen to students' complaints.

Heled and Davidovitch (2020) believe that the school's counsellor needs to do this from a viewpoint of the entire schooling system. When she school counsellor meets with the rest of the school space must be s/he must be able to

[1] Prof.Dr., Department of Educational Leadership and Leadership, University of South Africa, South Africa. E–mail: mahlavp@unisa.ac.za ORCID: 0000-0002-8251-750X

have the knowledge and bae able to deal with the challenges of the well-being of the student as an individual within the schooling system. In addition, Heled & Davidovitch, (2020) advise that the school counsellor must strive to lead developments directed at reducing the level of violence in the school and transforming it into a safe and protected environment. They also think that the work of the school counsellor ought to follow systemic principles, i.e. it is expected that the school counsellor should promote the students' mental well-being within the schooling system. School counsellors are expected to fulfill many roles in their areas of function. Their work must include all stakeholders, e.g. the principals, teaching staff, and the students as well as other relevant stakeholders outside the school. Amongst others, these are the psychologists, social workers, and other community workers. These school counsellors are responsible for supporting and integrating students with special needs, operating intervention programs, implementing placements and constructing classes, completing forms, as well as individual counselling for struggling students (Heled & Davidovitch, 2020).

Theoretical Framework

The paper draws from the Capability Approach of Amartya Sen of 1979**.** It focuses on what people are able to do and be, and their readiness and skills to do what they deem important in all aspects of their lives. This approach postulates that one's potential is critical to one's well-being, and it prioritises people's beings, and doings and their opportunities to realise their competences. The capability approach is a theoretical framework which involves people's capabilities and functionings, and to be understood in terms of people's abilities and their functionings. Capabilities are the things and people that a person can do if they wish to, for example, obtain an education (Ingrid & Byskov, 2020).

Problem of Research

The overarching question this paper is trying to understand is: What do we mean when we say that teachers have a leadership role in school counselling to help students develop their giftedness? Leadership roles of teachers pre-democratic era South Africa's schooling education systems were characterized by an environment of direct and structural discrimination. Generally, South African schools had to collaborate with communities to support the youth from disadvantaged backgrounds who demonstrated higher levels of academic performance to secure spaces in places for enrollment (Mampane & Brown, 2021).

Method

Research Model

This is a conceptual paper, and sources from 1992 through 2021 were used to compile it. The paper explores the role of leadership in school counselling places and spaces. Qualitative approach and interpretive paradigm was used in understanding the role of leadership in schools. Literature review was used investigating the topic.

Figure 1.

Research Design

Data Collection Tools-Documents

By evaluating materials such as articles and books that pertain to teachers' leadership roles as school counsellors in schools to increase giftedness in children, literature reviews were employed as data gathering techniques. A thorough literature study considers a wide range of sources, including academic articles and scholarly books. The following were the criteria for selecting literature: One source from 1992, one from 2006, one from 2010, one from 2016, one from 2017, one from 2018, six from 2020, and ten from 2021. The author prefers the 2020 and 2021 sources because he wants the most up-to-date perspectives from other authors.

Procedure

The paper was started on 7 December 2020 until March 2021. The paper was compiled at the University of South Africa.

Results

The Role of School Counsellor in Schools

School counselors must show leadership through leading, collaborating, caring, patience, helpful, non-judgmental and consulting with others who are important to students' health and well-being, such as teachers, administrators, family members, and members of the community (Wingfield, 2010).

As a result, what school counselors perform in the classroom may hinder them from engaging in other activities that would better meet the needs of the students they are supposed to help.

Counselling programs in school spaces must be integrated into mainstream and extra-curricular activities of the schools to help students gain the knowledge needed about different occupations and awareness of their abilities, in addition to skills for their future career and social lives. At times, the lack of professional support by school counsellors, and counselling programs in schools may hamper students' career planning and students' mental health and personal/emotional development. Another challenge that may influence the work of the school's counsellor could be the lack of appropriate training, professional counselling knowledge or skills (Pham & Akos, 2020). The counsellors' own spiritual beliefs must be considered a vital element for counsellors, especially in forging relationships with the students. Counsellors as leaders must be cognizant of all aspects of humanity when working with students, e.g. the spirituality and the religion of the students. Leaders must be aware that their need to develop an understanding of their own spiritual beliefs have an influence on the students (Lindsay, 2021). The time schools' counsellors utilise in school can be critical for students' career development. Most school-based career development activities help students achieve a variety of goals, such as increasing knowledge of educational and occupational options, increasing self-awareness (e.g., attitudes, values, beliefs, etc.) about aspirations and abilities, and developing the ability to use information to support goal-setting and career decisions (Falco & Shaheed, 2021).

The Role of Leadership In School Counselling

One of the places where interpersonal connection is particularly strong is in school. As a result, schools are institutions with strong leadership positions and behaviors. Schools have an environment that includes classrooms with varying constructions and features, as well as a climate that emerges from the unity of all classrooms. Some individuals are thought to be more dominant and prominent than others in such an atmosphere. Managers' attitudes and behaviors as school leaders provide some insight into which leadership qualities they employ (Ignatescu, Uredi & Kosece, 2021). Donal (2018) believes that the role of leadership in school counselling must ensure that all students individually achieve optimal development through self-disclosure-recognition, environmental recognition, decision making, self-direction and self-realization. The leaders must ensure that counselling services are available to every student through the media by means of guidance boards, problem boxes, leaflets, and development of guidance and counselling media. In leadership, the school's counsellor must know that the administrative activities are important, such as the implementation and follow-up of needs assessments, the preparation and reporting of work programs, the evaluation of guidance and counselling, the administration and management of guidance and counselling, as well as home visit to those students who are vulnerable in the school (Ibid, 2018).

School leaders as counsellors must be able to identify problems and set goals for improvement, use accountability practices that are carried out and get feedback, develop visions and targets that are identical to school vision, identify measurable changes, develop research plans, implement plans, collect and analyze data, and report results. (Suherman, et al. 2020) think that the leader must have the support of the school principal to be able to carry out effective school counselling services. Skills such as creativity and innovation are needed in the implementation of counselling services in the school space. Again, Suherman et al. (2020) advise that leadership for the school counsellor because they must rely on leadership to accomplish essential tasks and goals of the school. So, the role of leadership of the school counsellors is the influencing of others, emphasizing use of leadership skills in creating and running a school counselling service. In addition, leadership skills of the leader must form an integral part to other areas of school counselling work, such as political awareness skills and intentional relationship building skills. Therefore, the relationship between the school, the family and the community must be a partnership that has interventions strategies that can help to minimize bullying in schools. Leadership also plays a role in school counsellors' use of information to manage school counselling services. Some school counsellors may have little success in their counselling leadership practice without the support of the school's principal (LeBlanc & Borders, 2021).

School-based career development activities must be practiced in schools' space. Many of these activities are include classroom guidance, career fairs, education planning, individual or group counselling to support career development outcomes. Leaders with counselling skills can provide students with the tools they need to determine their professional objectives and comprehend the education and skills they'll need to achieve them (Falco & Shaheed, 2021). Leaders must strive to provide students with lived experiences such as lived body (sexual identity of students of various sexual orientations), lived space (the school environment in which students of various sexual orientations study and live), lived time (the first year of study and living for students of various sexual orientations), and lived human relations (interpersonal relationships that students of various sexual orientations have). Ensure that school counselling programs are comprehensive in scope and given to all children in a methodical manner; Establish school counselling

as an important part of the educational system's academic mission and promote equitable access to school counselling services for all students (Falco & Camelia Shaheed, 2021).

Counselling and advice in schools must be thorough, meaningful, and progressive, according to the leader. Its curriculum, like that of other educational programs, must be based on a philosophy or mission statement that is shared by other schools in the district. Again, the leader must ensure that the counselling and guidance curriculum includes particular student abilities and objectives in order to help students achieve these goals (Falco et al. 2021).

School counsellors as leaders must support student achievement through services that have an influence on career development, social and emotional development of all students enrolled in schools. They must also be able to create school counselling programs that meet the needs of all students, in terms of equity and access (Johnson & Brookover, 2021). These leaders are expected to work with all students to address their career needs. Usually, school counsellors tend to be focused on the intrapsychic strengths and challenges that influence student growth such as structural barriers and inequity. Twenty-first century leaders are expected to recognize oppression and injustice and advocate for change on schooling systems. For example, students from rural areas may encounter systemic barriers, which can create additional challenges for these students to achieve. This type of students living in the rural context experience higher rates of poverty than urban students do (Granta, Springera, Tuttle, & Reno, 2021).

Leaders must ensure that counselling programs help individual students understand their potential and career planning. In this period of Covid-19 pandemic disruption, career direction and aspirations for individual students have undergone increasingly rapid changes. The emergence of new types of careers is a challenge for counsellors in guiding and providing direction to students according to their potential and talents. For example, the use of technology is prominent and schools in rural areas are left behind because of the technology (Utami, 2020). In assessing their competencies school counsellors as leaders must be trained to be ethical and effective practitioners. To be ethical, means that the leaders must have counselling competencies, especially their behaviors, dispositions, and skills needed to be effective and ethical reality (Lambie & Haugen, 2021). Leadership must have a strong emphasis within school counsellors' professional identities. School counsellor teacher need to consider how preservice school counsellors develop the foundation within their training programs, including how to secure a strong working partnership with school principals. Hence, leadership skills must be an integral part to other areas of school counselling work, especially the political skills and intentional relationship building skills. Generally, school counsellors as leaders are likely to fail without the support of the school's principal (LeBlanc & Borders, 2021).

Therefore, counselling to students in creating their comprehensive career plan must always be emphasized and to become a priority of counsellors in schools. It must be noted that counselling, is a complex process that encompasses several strategies with special expertise. The success of counselling can be achieved through the following strategies, namely: (a)The active and full involvement of responsibility between counsellor and student, (b) the experiences of counsellors born of their professional identity, and, (c) the emotional experiences, meaning of life, and the distress attached to their economic status (Dahlan, 2021).

Decolonial curriculum should teach analytical abilities for arguing, critical analysis, and criticizing and deconstructing the colonial curriculum, implying that the curriculum must be meaningful and relevant to the user (Mbhele, 2020).

The limited resources that schools must scramble for are one of the challenges they face. For example, Kobayashi and Tsuboya (2021) found that students in single-parent homes seem to suffer money-wise.

Therefore, to adequately support the career, and personal development of all students, school counsellors ought to collaborate with all stakeholders. School counsellor-principal collaboration is very important in promoting a positive school culture where students' emotional-being, and opportunities can be supported. Furthermore, the collaboration between the counsellor and the school principals can be beneficial for students and teachers (Geesa et al. 2020). Fewer students are likely to drop out of school the standard of scholarship can be increased. Better morale in the student body and a better all-round school life can be achieved by all students.

Evans, Wright, et al., (2016) believe that the role of leaders must be the development of teams to work toward achieving the counselling school's aim. The type of leadership such as situational leadership must be seen as the assessment of the teacher counsellor's person's learning needs so that the leader can modify their style of instruction to meet learners' needs. In counselling leadership, a supervisor must be able assesses the supervisee's abilities in terms of task behaviors, relationship behaviors, and readiness. Similarly, relying on situational leadership learners' needs and strengths can be made to fit their development needs (Ibid, 2016). Through the creation of a loving environment and positive working connection with all stakeholders, servant leadership management style may motivate, guide, and

bring hope. In therapy, this would imply forming a positive working relationship with all stakeholders and aligning with basic counselling ideas such as relationships, individual empowerment, self-growth, and value identification.

Leaders in counselling must empower; provide direction; humility; and interpersonal acceptance to stakeholders (Evans et al. 2016). Oftentimes, leaders must focus on counselling skills and relationship dynamics, and to conduct management and administrative responsibilities to provide appropriate intervention strategies and to make resources available. Counselling centers and counsellor education programs must be integrated to achieve client safety and optimal training opportunities for counsellors and learners (Evans et al. 2016). Leaders must be able to manage their emotions and relationships, as well as actions that are thought to give them a high level of emotional intelligence and interpersonal flexibility (Fassinger & Shullman, 2017).

Shullman (2017) believes that for individual effectiveness, leaders must be able to emphasize assets and strengths of human endeavor, awareness of human behavior, and a focus on education and career development as lifelong learning processes. They must, once again, utilize shorter interventions to unlock human potential, seeing people as individuals with both strengths and development difficulties to address. These leaders need to appreciate the strengths of all stakeholders involved in the school. Their leadership must focus on facilitating learning, development, empowerment, and school reform. Counselling services in schools should be culturally sensitive and socially just. Counselling leaders in schools are expected to promote, advocate for, and work for social justice and culturally responsive programs that are accessible and accountable to all school stakeholders. To ensure that social, cultural, political, historical, and economic systems account for equality and are held responsible, leaders must create a culture that supports and engages in social justice advocacy and reform.

The paper has some significant implications Schools should have counselling policies in place that will prescribe to school counsellors how to assess managerial behaviour and individual strengths and differences. Also, the policies should focus on outcomes.

Discussion

In this paper, the core claim of the Capability Approach is that the quality of life of gifted children, should not primarily focus on resources, but on the effective opportunities that these children have to lead the lives they have reason to value (Robeyns, 2006). Teachers as school counselors are expected lead children by caring, patience, being helpful, and not to judge the children in their care (Wingfield, 2010). They should develop children to have an understanding of their own spiritual beliefs (Lindsay, 2021). The lack of appropriate training and skills to help children by teachers ought to be challenged by principals (Pham & Akos, 2020). Gifted children should be developed in their capabilities to have positive attitudes, values, beliefs, aspirations and abilities, to make good career choices (Falco & Shaheed, 2021). Teachers' attitudes and behaviors must always be positive (Ignatescu, Uredi & Kosece, 2021). Donal (2018) believes that teachers need to ensure that children are developed through self-disclosure-recognition. These teachers are expected to make counselling services available to all children in schools. (Suherman et al. 2020) think that teachers must be supported by the principal in supporting gifted children in schools. Creativity and innovation are the skills needed in leading counselling services in schools (LeBlanc & Borders, 2021). Decolonial curriculum ought to teach analytical abilities for arguing, critical analysis, and criticizing and deconstructing the colonial curriculum, implying that the curriculum must be meaningful and relevant to gifted children (Mbhele, 2020). Many schools are unable to unleash the gifted children's potentials because of limited resources (Kobayashi and Tsuboya, 2021).

Conclusion

In concluding the paper, it should be noted that leadership in school counselling must be about enabling learning, development, empowerment, and transformation of schools for giftedness to flourish in schools. Leaders must have the ability to manage emotions, relationships, and behaviors of all stakeholders involved in school spaces and places.

Further research is needed to look at the strategies that can be used to transform schools to accommodate both the disabled and the gifted learners in schools.

The lack of professional support by school counsellors, and counselling programs in schools may hamper students' career planning and students' mental health and personal/emotional development. School leaders as counsellors must be able to identify problems that are experienced by students in schools and to use accountability practices to improve their practices. The relationship between the school, the family and the community must be a partnership that has interventions strategies that can help to minimize bullying in schools. School counsellors as leaders must support student achievement through services that have an influence on career development, social and emotional development of all students enrolled in schools. School counsellors as leaders must be trained to be ethical (counselling competencies). Leaders must focus on counselling skills and relationship dynamics and be able to conduct

management and administrative responsibilities to provide appropriate intervention strategies to enhance giftedness in children. Principals in schools should promote, advocate for, and work for social justice and culturally responsive programs that will be accessible and accountable to all those involved in schools. School counsellor-principal collaboration is a key in promoting a positive school culture where students' emotional-being, and opportunities can be enhanced. Capable leaders need to appreciate the strengths of all stakeholders involved in the school.

Recommendations

Recommendation for Applicants

Teachers, as leaders, should encourage student achievement by offering services that influence all students' career development, social, and emotional development. In order to function as leaders, school counselors must be ethical and have counseling abilities. Leaders should prioritize counseling skills and relationship dynamics. During Covid-19, school counselors should serve as leaders in assisting learners with issues of social, emotional, academic, conflict, wellness, mental health, informational, and interfacing with parents' difficulties.

Recommendation for Further Research

It is suggested that the topic be researched at universities and colleges of higher learning. Issues like how teachers can prepare learners to deal with a pandemic and the changes brought on by the fourth industrial revolution in schools should be investigated.

Limitations of Study

This paper used qualitative approach and has made use of literature review. Because this is a conceptual paper, no interviews were conducted.

Acknowledgments

This paper was presented at Comparative School Counselling International Conference organised by the Bulgarian Comparative Education Society from 21-25 March 2021. This is my original work and there is no conflict of interest.

Biodata of the Author

Prof. Dr. Vimbi Petrus Mahlangu, BA. Ed; B.Ed.; M. Ed; PhD] is a Full Professor at the University of South Africa, Department of Educational Leadership and Leadership. He had extensive writing, supervision, and publication experience in education. He had published books, book chapters, articles and supervised M and D students to completion. He presented papers at national and international conferences. Affiliation: University of South Africa E-mail: mahlavp@unisa.ac.za Orcid number: 0000-0002-8251-750X Phone: (+27)124298550

References

Bolden, R., & Gosling, J. (2006). Leadership Competencies: Time to Change the Tune? *Leadership,* 2(2), 147–163. DOI: 10.1177/1742715006062932

Borders, I.D., & Drury, S.M. (1992). Comprehensive School Counselling Programs: A Review for Policymakers and Practitioners. *Journal of Counselling & Development* March/April 1992. Vol. 70.

Dahlan, S. (2021). Self-Assessment Based Counselling: A Further Study Planning Service in High School. *International Journal of Instruction*, 14(1), 411– 426.

Donal, R. (2018). Implementation of Guidance and Counselling at Schools. Proceedings of the University of Riau. International Conference on Educational Sciences, 13 October 2018, Grand Suka Hotel, Pekanbaru-Indonesia, pp. 77–87.

Evans, A.M., Wright, S., Murphy, P., & Maki, J. (2016). Incorporating Leadership Models Into Counselling Supervision: Recommendations to Strengthen Services. VISTAS project sponsored by the American Counselling Association. http://www.counselling.org/knowledge-center/vistas

Falco, L.D., & Shaheed, C. (2021). Putting Theory Into Practice: A Conceptual Framework for Career Group Counselling in School Settings, *The Journal for Specialists in Group Work*, 46(1), pp. 6–19. DOI: 10.1080/01933922.2020.1867678

Fassinger, R.E., &. Shullman, S.L. (2017). Leadership and Counselling Psychology: What Should We Know? Where Could We Go? *The Counselling Psychologist*, *45*(7), 927–964.

Geesa, R. L., Mayes, R.D., Lowery, K.P., Quick, M.M., Boyland, L.G., Kim, J., Elam, N.P., & McDonald, K.M. (2020). Increasing partnerships in educational leadership and school counselling: a framework for collaborative school principal and school counsellor preparation and support, *International Journal of Leadership in Education*, 1-24. DOI: 10.1080/13603124.2020.1787525

Grant, K. L., Springer, S.I., Tuttle, M., & Reno, M. (2021). Small-Group Counselling Intervention to Support Career Exploration of Rural Middle School Students, *The Journal for Specialists in Group Work,* 46(1), 108-127, DOI: 10.1080/01933922.2020.1856254

Heled, E., & Davidovitch, N. (2020). An Occupation in Search of Identity-What Is School Counselling? *Journal of Education and Learning*; *9*(5), 215–232.

https://za.pinterest.com/cynthiaab/counseling-clip-art/

Ignatescu, C., Uredi, L., & Kosece, P. (2021). Ethical Leadership Role and Behaviors of Teachers in the Context of Eff ective Classroom Management, Revista de cercetare şi intervenţie socială, 73, 34-56.

Ingrid, B., & Byskov, M.F. (2020). "The Capability Approach", *The Stanford Encyclopedia of Philosophy* (Winter 2020 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2020/entries/capability-approach/>

Johnson, K.F., & Brookover, D.L. (2021). School Counsellors' Knowledge, Actions, and Recommendations for Addressing Social Determinants of Health With Students, Families, and in Communities. *Professional School Counselling*, *25*(1), 1–12.

Lambie, G.W. & Haugen, J. S. (2021). The Assessment of School Counselling Competencies as a Tool to Support School Counselling Students, Supervisors, and Training Programs. *Professional School Counselling, 25*(1), 1-10.

Kobayashi, H., & Tsuboya, M. (2021). Social Resources and Challenges Related to the Schooling and Education of Immigrant Children at High Schools in Japan. Journal of International Migration and Integration, 22, 369–384.

LeBlanc, J., & Borders, L.D. (2021). Educating future leaders: integrating leadership into an introductory school counselling course, *Journal of Counsellor Leadership and Advocacy*, *8*(1), 1-14. DOI: 10.1080/2326716X.2020.1861489

Lindsay, C. (2021). The Impact of Spirituality on Counselling Students' Self-Perceived Professional Competencies. *Journal of Graduate Education Research*, 2, Article 11.

Mampane, J.N., & Brown, A. (2021). Transitioning Experiences of First Year Gender Non-Conforming Students from School to University in South Africa. *Interchange*, 1-15. https://doi.org/10.1007/s10780-021-09419–3

Mbhele, S.S. (2020). *Prospects, opportunities and challenges of a decolonial curriculum in South Africa* . Master Thesis. School of Built Environment and Development Studies Faculty of Humanities, University of KwaZulu-Natal Howard College Campus Durban, South Africa.

Pham, A.K., & Akos, P. (2020): Professional School Counselling in Vietnam Public Schools. *Journal of Asia Pacific Counselling*, *10*(2), 37- 49.

Robeyns, I. (2006). The Capability Approach in Practice. *The Journal of Political Philosophy, 14*(3), 351–376.

Shullman, S.L. (2017). Leadership and Counselling Psychology: Dilemmas, Ambiguities, and Possibilities. *The Counselling Psychologist, 45*(7), 910-926.

Suherman, M.U., Nurhudaya, A., & Adiputra, S. (2020). Effect of knowledge and skills of counsellors on the level of selfefficacy in evaluating guidance and counselling programs. *International Journal of Scientific & Technology Research*, 9(3), 3958–3961.

Utami, F.P. (2020). *Evaluation of Career Guidance and Counselling Program through Accountability Model Bridge.* The 3nd International Conference on Technology, Education, and Social Science 2020 (The 3nd ICTESS 2020) Proceeding ICTESS

Wingfield, R.J. (2010). Counselors as Leaders in Schools. *Florida Journal of Educational Administration & Policy, 4*(1), 114-130.

Yıldız, S., & Altay, N. (2021). The parenting attitudes and effects on their gifted children: a literature review. *Journal for the Education of Gifted Young Scientists, 9*(2), 123-132. DOI: http://dx.doi.org/10.17478/jegys.864037

Journal for the Education of Gifted Young Scientists, 9(5) Special Issue, 27-37, Dec 2021
e-ISSN: 2149- 360X
jegys.org

Young Wise Publishing
youngwisepub.com
© 2021

Research Article

Entrepreneurial leadership in early childhood education for sustainable development in South Africa

Matshediso Rebecca Modise[1]

Department of Early Childhood, College of Education, University of South Africa, Pretoria, South Africa

Article Info

Received: 16 September 2021
Revised: 26 October 2021
Accepted: 11 December 2021
Available online: 15 Dec 2021

Keywords:
Classroom practice
Teachers
Teaching challenges
Natural sciences
Senior phase

2149-360X/ © 2021 the JEGYS
Published by Young Wise Pub. Ltd.
This is an open access article under the CC BY-NC-ND license

Abstract

This paper examined empirical data from research conducted in South Africa about problems induced by the global outbreak of COVID-19 pandemic from 2019 to 2021 to Entrepreneurial Leadership in Early Childhood Education (ECE) for sustainable development of the sector. A desktop analysis method was employed in this paper to review the report by 'Ilifa Labantwana', and Entrepreneurial Leadership in Early Childhood Education for sustainable development in South Africa during COVID-19 lockdown restrictions. The researchers discovered that the lengthy COVID-19 lockdown restrictions exposed gaps in government, ECE school leaders, parents and the other stakeholders' preparedness for survival, focus, continuity, and resilience in times of unexpected pandemics. The paper relied on data from the desk research, which may not have been collected from the desired setting or time. The researcher had no control over the data and may therefore only provide partial analysis in terms of precision due to lack of triangulation. The paper's findings described the importance of change in Early Childhood Development (ECD) centres and Entrepreneurial leaders to take risks associated with the change which requires support. The paper has theoretical implications in empowering the leaders' survival strategies in ECD centres. It further recommends new leadership directions for other leaders. The paper is an attempt to develop survival strategies during turbulent times in ECD centres and improves the level of readiness against natural disasters in developed and developing countries.

To cite this article:
Modise, M.R. (2021). Entrepreneurial leadership in early childhood education for sustainable development in South Africa. *Journal for the Education of Gifted Young Scientists*, *9(5)* Special Issue, 27-37. DOI: http://dx.doi.org/10.17478/jegys.1010680

Introduction

The concept entrepreneurial leadership suggests the proficiencies possessed by the leader to direct and convince followers to accomplish organizational goals that embrace guidance and recognition of entrepreneurial opportunities (Renko, El Tarabishy, Carsrud and Brännback, 2015). In general, organisational leaders need to possess operational competencies which according to Damayanti, Hartono, and Wijaya (2021) is related to the ability to realise innovative ideas and concepts that are creative from the team into the organisation's operational system including its sustainability. If global society is serious about reaching sustainable development goals before 2030, then Entrepreneurial Leaders are among those who are going to bring about the desired change, particularly, in the face of the COVID-19 pandemic. The outbreak of COVID –19 global pandemic has drastically affected organisational operations and impacted negatively on the economic sustainability of different organisations. Among the organisations affected, the Early Childhood sector is vulnerable.

Globally, the Early Childhood Education (ECE) sector has been hit hard during the outbreak of COVID-19 pandemic. The first officially recognised COVID-19 case in South Africa was recorded on the 5th of March 2020,

[1] Senior Lecturer in the Department of Early Childhood Education, College of Education Associate Professor in Department of curriculum and instruction, University of South Africa, Pretoria, South Africa. E–mail: modismr@unisa.ac.za ORCID: 0000- 0002-0404-2035

(Soudien, Reddy, and Harvey, 2021). This eventually led to the closure of schools. After the middle of April 2021, the levels of lockdown restrictions were gradually eased to level 1.

In South Africa, some early childhood centres were not able to open when COVID-19 lockdown restrictions were relaxed due to the negative impact brought by the pandemic on their financial status. A report on 'the plight of ECE Workforce: An urgent call for relief in the wake of COVID-19 pandemic', in April 2020 by 'Ilifa Labantwana' a social development wing, presented the findings to understand the impact of the closure of the ECE sector and its future sustainability. Ilifa Labantwana is a South African early childhood development programme founded in 2009. Its goal is to enable an additional 1 million children, aged zero to five, to access quality Early Childhood Development (ECD) through the Early Learning Subsidy. According to the report (Ilifa la bantwana) the majority of ECE teachers and support staff lost their monthly income as the sector was instructed to close by the Department of Social Development (DSD), which is responsible for social issues of children from birth to four years in the ECE sector. in light of the high job losses and unemployment rate triggered by the Covid-19 pandemic, the office of the presidency provided ECD centres with, the Early Childhood Development Employment Stimulus Relief Fund (ECDESRF) as part of sustaining employment prospects in the sector. To have access to the funds ECD centers had to apply for the funds. Not all the ECD centres managed to access the funds hence the concern by the Centre for Early Childhood Development (CECD). The CECD facilitates several Integrated ECD Programmes throughout South Africa by providing ECD centers with a range of support services including teacher training, equipment provision, building upgrades, governance training, and outreach programs to parents and the community" (educationinnovations.org, 2021). The CECD workforce in South Africa organised campaigns to help the ECD centres to get clarity on the presidency's ECD Stimulus Relief Fund package that was supposed to have been paid to the ECD centres by the DSD. The placard below is an extract from the CECD website – COVID19 Resources publication mobilising the ECD centres to join forces for the campaign.

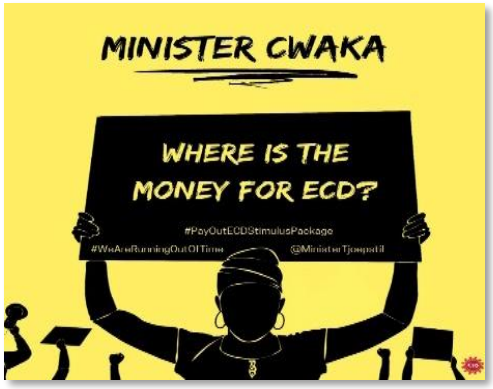


Figure 1.
Campaign placard for ECD Stimulus Relief Fund (cecd.org.za, 2021)

During the March 2020 Level 5 lockdown there were two possible ways that learning could continue taking place: self- learning or online with siblings or parental support (Soudien, Reddy and Harvey, 2021). Most parents succumbed to the pandemic which meant some children failed to pay expected fees and therefore dropped out of the ECE programme.

Some ECE leaders tried to provide online support to parents for children to continue with learning at home to maintain their (parents') monthly payment to the centre. Facilitating stimulating activities at home put enormous stress on some parents who felt they were not teachers and were not able to facilitate such activities. According to the report, most of the ECE centres experienced payments withdrawals from parents as they felt that they could not pay for services they did not receive. Owing to these lockdown restrictions, most ECE centre operators in South Africa were unable to collect monthly payments from parents whom they mostly rely on to pay salaries and other fixed costs. It is very clear from the report that adaptive leadership behaviour was needed in response to the changing circumstances of the sector, and for ECE leaders to look at what strategies would enable them to continue operating during and beyond the COVID-19 pandemic.

The outbreak of the COVID-19 pandemic revealed that the way some of the centres were run was not sustainable and needed a leadership shift. Little was mentioned about entrepreneurial leadership as one way of bringing change in the ECE sector, yet it is a strategy that could help sustain the sector. Renko, El Tarabishy, Carsrud and Brännback (2015) state that the entrepreneurial behaviours were increasingly important in a variety of contexts. In organizations,

these behaviours foster innovation and adaptation to changing environments. ECE centres are important organizations in any educational system and therefore need visionary leaders with innovative and creative minds.

To prolong their existence, organizations according to Mishra and Misra (2017), need to adopt innovation in their work practices to make their processes efficient and effective in future. Similarly, the leadership in the ECE sector needs to adopt ground-breaking practices for their effectiveness and future sustainability. Entrepreneurial leadership is one of the options that could be well-thought-out for future sustainability of the ECE sector. Kasim and Zakaria (2019), regard entrepreneurial leadership as a unique type of leadership required for dealing with challenges and crises of the current organizational setting such as weakening of the economy.

South Africa's economy has been weakened by the outbreak of the global COVID-19 pandemic and the decision by Moody's investors' service to downgrade South Africa's long term foreign and local currency debt ratings to one notch below investment grade in 2020, Stoddard (2020) has brought some unintended consequences. Half of the population in South Africa seems to be living in excessively high level of poverty due to unemployment. The rate of unemployment has been going up almost annually. The 2018 South African Statistics revealed that 50% of the country's population lived in excessively high levels of poverty (Teffo & Tabit, 2020). The unemployment rate has been increasing almost every year (Stoddard, 2020). Many South Africans, particularly the youth, are disconnected from the formal economy through their inability to find employment. Some have sought employment in the ECE centres which offers them hope for growth and development. It is suggested that the best way to overcome slow economic growth is to create interventions that promote entrepreneurship and job creation. ECE leaderships need to strengthen their leadership skills to match that of entrepreneurship to sustain the sector. This would also help in addressing the SA National Development Plan (NDP) Vision 2030 introduced in 2012. The SA (NDP) vision aim at reducing inequality, eliminating poverty, creating jobs, and growing an inclusive economy by 2030, National Planning Commission (2011). Therefore, the major contribution of this research was to examine the role of entrepreneurial leadership for sustainable development in early childhood sector.

Theoretical Framework

This research was underpinned by Kurt Lewin's Change Theory (1947). Kurt Lewin's Theory is time tested and widely considered the essence of change models suitable for organizational, group and personal change (Kaminski, 2011). The process of change, according to Lewis, entails creating the perception that there is a need for change, then moving towards the new, desired level of behaviour and, finally, solidifying that new behaviour as the norm. According to Kaminski (2011), this change theory is a 'planned change' guide consisting of three stages, namely: *unfreezing*, *change process,* and *refreezing*.

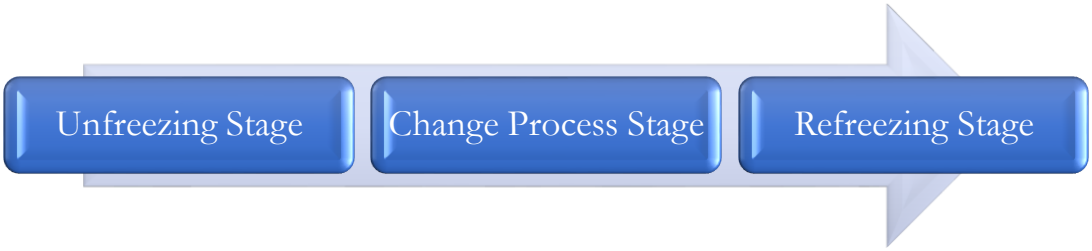


Figure 2.

Change Theory Stages (Adapted from Kmainski, 2011)

The Unfreezing Stage: This is the stage where the need for change is realised and the desire to change takes place. Unfreezing of the current behaviour that need changes is done by reflecting upon and analysing the current behaviour. Raza (2019) firmly believes that to achieve this goal of change, all stakeholders need to be involved in the process.

Change Process: People involved at this stage are convinced that change in the way things were done would be the best way. New strategies and structures will then be put in place to achieve the desired change. Since change is a very complex process, Raza (2019) advises on implementing a variety of change options, examining what works and what does not work. He further mentions 'Information and Leadership' as the most important long term and effective drivers of change implementation process.

Refreezing stage: The third stage is that of putting processes into operational standards or procedure which is referred to as the *refreezing stage.* Failure to do this will result in people reverting to the old methods of doing things, abandoning the new processes. Raza (2019) states the purpose of the refreezing stage as that of sustaining the enacting changes. In the absence of appropriate steps that reinforce and sustain the change, the previously dominant behaviour may tend to re-assert itself.

Applying this theory to the ECE sector, leadership needs to realise the impact COVID-19 has had on the sector, accept that changes are required and develop a desire to change their circumstances. In this study, entrepreneurial leaders must know the environment in pre-COVID-19 era, during the COVID-19 period and an outlook of Post-COVID-19 era. Entrepreneurial Leaders embrace change and lean toward the power of transformation. They should not be afraid to modify their vision.

Reforms are never easy; they bring some challenges with them. Even amid a storm, when everything seems to be going wrong, they see beyond the issues, and instead of staggering in pessimism, they deviate toward possible solutions. They are innovators focusing more on new methods of advancement in areas of decision-making. They are constantly looking for ways to add to their world of expertise. The understanding of this trend enables the leaders to formulate survival strategies. Receiving counselling as leaders would ease the process of desiring to change their circumstances as they will be able to reflect on what happened, what is happening, and how best they can improve their circumstances through the support they will receive. Counselling is a way of networking.

There is need to reflect on their practices as leaders, analyse their current leadership behaviour, and consider new innovative ways of working relevant to the unprecedented circumstances they face. They need to revisit their leadership style and consider the leadership style that will be able to stand the test of time. They then must put structures and strategies in place which must be made operational standards after the buying in of all the stakeholders. The strategies should be such that they will help in sustaining the sector through offering of training, celebrating success, communication, and involvement of others.

The Research Significance

The significance of this research was to bring about the alternative means that can be considered to counteract the impact of natural disaster in the ECD sector such as considering Entrepreneurial leadership for its future sustainability. The study also highlights the need for support through counselling for affected ECD personnel.

The Research Terms

Entrepreneurial Skills: These are abilities to create something new with value by devoting the necessary time and effort, assuming the accompanying financial, psychic, and social risks, and receiving the resulting rewards of monetary and personal satisfaction and independence (Hisrich & Peter, 2002).

Early Childhood Education (ECE): Early childhood development is defined as a comprehensive approach to policies and programmes for children from birth to nine years of age with the active participation of their parents and caregivers. (White paper 5 DoE).

COVID-19 Pandemic: It is a severe acute respiratory syndrome corona virus 2, SARS-CoV-2 which harbours in human cells and results in different degrees of cellular damage and is defined as a pandemic by the World Health Organization on March 11, 2020, (Sverzellati et al. 2020).

Leadership: Kruse (2013), defines Leadership as 'a process of social influence, which maximizes the efforts of others, towards the achievement of a goal'.

Counselling: It is defined as a process that might be developmental or intervening and requires counsellors focus on their clients' goals, therefore counselling involves both choice and change, and in some cases, "counselling is a rehearsal for action" (Casey, 1996, p. 176) cited in Sheppard (2015).

Sustainable Development: This is the development of knowledge, skills understanding values and actions required to create a sustainable world, which ensures promotion of social equity and encourages economic sustainability.

Problem of Study

Early Childhood Education plays a pivotal role in child developing activities. Prior to COVID-19 insurgence, ECE centres showed satisfactory performances and people celebrated all that. But due to the COVID-19 lockdown restrictions, ECE operators had to halt their operations as parents suspended their monthly payments to the centres. Even though 'Ilifa Labantwana' had mobilised support, partnership, and resources to assist the sector to recover from the negative impact of the pandemic, ECE leaders still need to rethink how they can sustain the sector. Early childhood development is key for development and deserves funding from government and stakeholders to ensure children are well groomed. In South Africa, some ECD centres do not receive adequate funding from government as they need to meet all the requirements. The sector has been doing well but after the problems induced by the COVID-19 pandemic, it shows a predictable collapsing trend as it runs out of support from stakeholders. The prediction made it imperative that entrepreneurial leadership must act now and package dynamic survival strategies to the problems faced by the sector. This study therefore sought to explore the survival strategies implemented by Entrepreneurial Leaders.

The main aim of the study was to explore the survival strategies implemented by Entrepreneurial Leaders in ECE centres in South Africa.

- This research sought to address the following three specific study objectives:
- Determine the effectiveness of innovation and preparedness on the survival of ECE centres,
- Explore the attributes of an entrepreneur,
- Identify the role and significance of entrepreneurial leadership in an organization

Research main question central to this study was:

What are the effects of entrepreneurial leadership in sustaining the ECE sector?

The research was guided by the following sub questions:

- How innovative and prepared are ECE leaders to mitigate effects of natural disasters in ECE centres?
- What are the attributes of an Entrepreneurial Leader in an organization?
- What is the role and significance of the entrepreneurial leadership in an organization

Method

Research Model

A desktop analysis method was employed in this paper to review the report by 'Ilifa Labantwana', and Entrepreneurial Leadership in Early Childhood Education for sustainable development in South Africa during COVID -19 lockdown restrictions. This secondary research method was suitable since it involves using already existing data. The data was summarised and collated to increase the overall effectiveness of the research.

Data Collection Tools/Documents

This study included research material published in a report on 'The plight of ECE Workforce: An urgent call for relief in the wake of COVID-19 pandemic', in April 2020 by 'Ilifa Labantwana' a social development wing. A qualitative approach was adopted in this paper to elucidate the concept of entrepreneurial leadership. A desktop analysis of literature was employed to define and explain the entrepreneurial leadership, its attributes, effects, and significance within an organization. Systematic review was employed. Reviewed literature was retrieved by using key terms of the title. Google scholar was mainly used to search for documents such as journal articles, reports and websites containing relevant information for the study. Reports, Journal articles and other gray literature related to ECD and COVID19 pandemic, Entrepreneurship, sustainable development and leadership were scanned for relevance to the research topic. Were possible most recent literature was preferred, however at some instances literature not older than 10 years was considered.

Results

This paper examined empirical data from research conducted in South Africa about problems induced by the global outbreak of COVID -19 pandemic from 2019 to 2021 on Entrepreneurial Leadership in Early Childhood Education (ECE) for sustainable development of the sector. To answer the research question, a review of literature focusing on definition of leadership, entrepreneurship, entrepreneurial leadership, attributes of entrepreneurship, its effect, conceptualization of entrepreneurial leadership in ECE, and the role of counselling was undertaken. Implications for policy and practice were also examined. The following literature review is an overview published works on the topic under study.

Theme 1. Elucidating the Concept of Leadership in Early Childhood Education

Consistent with the relational and entrepreneurial leadership literature, Douglas (2017) defines leadership as a process of influencing positive change to achieve a desired goal or generate a new solution to a problem. Leadership in ECE according to Hujala and Eskelinen (2013), is a holistic process that involves not only the leader and the administration but also personnel and indirectly parents and everyone else who has an influence on ECE practice. Furthermore, Stamopoulos (2012) reframes leadership as a shared responsibility amongst tertiary educational institutions, professional organizations, all professionals, and those who work with young children and their families. Douglas (2017) further delineates leadership as a process of influencing change to improve early care and education, which is not reserved just for those with formal leadership positions. In summary, leadership is the involvement and participation of all ECE stakeholders with the purpose of meeting the sector's goals to meet the needs of children.

Theme 2. Concept of Entrepreneurship

A lot is being said these days about people becoming 'entrepreneurs. Entrepreneurship is a key factor for the survival of ECD centres in an ever-changing and increasingly complex global economy. But what is entrepreneurship? Kuratko

and Hodgetts (2007) define entrepreneurship as a dynamic process of vision, change and creation, while Yemini, Addi-Raccah and Katarivas (2014) consider it to be a driving force of change and innovation that introduces opportunities to achieve efficient and effective performance in both public and private sectors. There are two parts to entrepreneurship. The first is the managerial skills needed to run a profitable business. The second is 'entrepreneurial spirit'. Both are important. According to Kuratko and Hodgetts (2007), entrepreneurship requires an application of energy and passion towards the creation and implementation of new ideas and creative solutions. York and Sarasvathy (2010), postulates that innovation in an education field would be related to school practices, standards, and policies with immediate impact at the classroom level. Figure below present visual description of the concept entrepreneurship with graphic visualisation.

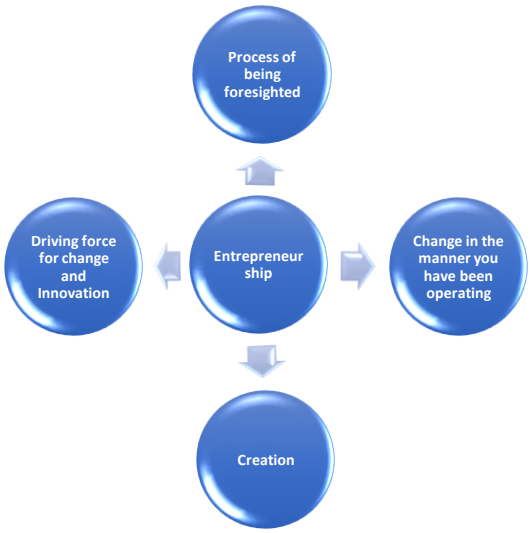


Figure 2.
Entrepreneurship Concept (Researcher's own design)

ECE and Sustainable Development

Sustainable development according to Slimane (2012) is the process of developing land, cities, and communities as well as business, if it meets the needs of the present without compromising the ability of future generations to meet their needs. In 2012, the United Nations Conference on Sustainable Development (UNCSD) met to discuss and develop a set of goals to work towards. The goals grew out of the Millennium Development Goals (MDG) that claimed success in reducing global poverty while acknowledging that there was still much more to do. The Sustainable Developmental Goals (SDG) eventually came up with a list of 17 items which included amongst other things: the end of poverty and hunger, sustainable economic growth while promoting jobs and stronger economies and sustainability to include health of the land, air, and sea. Early childhood interventions, which target children directly and aim to improve their developmental outcomes is one of the approaches that attempt to mitigate poverty's negative influence on children (Magnuson, 2013). For the ECE sector to consider strengthening their entrepreneurial prowess through adaption of entrepreneurial leadership they might meet some of the millennium goals.

Evolving Definitions of Entrepreneurial Leadership

Entrepreneurial leadership is said to be the kind of leadership role performed in entrepreneurial ventures, rather than in the more general sense of an entrepreneurial style of leadership (Leitch, McMullan & Harrison, 2013). According to Renko et al. (2015) it entails influencing and directing the performance of group members toward the achievement of organizational goals that involve recognizing and exploiting entrepreneurial opportunities. Kasim and Zakaria (2019) sees an entrepreneurial leader as a leader who is classified to achieve the same goal by using entrepreneurial behaviour. Through the adoption of entrepreneurial leadership, the ECE leaders will be able to influence the stakeholders towards the achievements of organizational goals through the change that will be put in place.

Attributes of Entrepreneurial Leadership

An important part of being an entrepreneurial leader involves recognizing new opportunities and securing resources for exploitation of the opportunities (Renko et al. 2015). The tasks of the ECE leader (principal) are that of planning and implementing an entrepreneurship development and evaluation program. A school principal according to Yulindrasari, Adriany and Rahmawati (2019), is an educator who must be transformative as he deals with human resource, this should be the same with the ECE leaders. On the surface, one can associate entrepreneurs with

leadership functions such as providing vision to the development of a new product, service, or organization (Fernald, Solomon, & Tarabishy, 2005).

An entrepreneur should have focus and should be able to concentrate with dedication on stated goals, and should not lose sight of critical issues. Success is not possible without the ability to practise sustained concentration on a task in a single direction. For example, Strive Masiyiwa of the leading telecommunications business started as a small business but through dedication and focus he did not lose hope. Dedication motivates the entrepreneur to work hard, plan and generate ideas.

Effect of Entrepreneurial Leadership within an Organization

One of the key drivers towards a need for a more entrepreneurial style of leadership is that the quality of teaching and learning needs to be such that it creates a 'citizenry with a capacity to compete successfully in the global village' (Scott & Webber, 2013). The requirement to quickly modify organizational structures and processes as a corporation pivots in search of a better business model or swings toward growth necessitates leadership behaviors that can address a wide range of paradoxes and tensions (Volery, Mueller & von Siemens, 2015). Entrepreneurial leadership, as a distinctive type of leadership required for dealing with challenges and crises of current organizational settings, has increasingly been applied to improve school performance. However, there is limited research on the impact of school leaders' entrepreneurial leadership practices on school innovativeness (Pihie, Asuimiran & Bagheri, 2014).

In complex and volatile environments, some traditional approaches to strategy may become increasingly ineffective, necessitating an entrepreneurial approach (Rahim, Zainal, Mohtar & Ramli, 2015). Organizations must be more entrepreneurial to enhance their performance, their capacity for adaptation and long–term survival. It is therefore key for ECE leaders to know the significance of shifting to or renewing their entrepreneurial leadership skills.

The Significance of Entrepreneurial Leadership

For the ECE sector to keep up with the unexpected changes and national disasters it needs leaders who are creative. The concept of creativity in education is characterised by the ability to perceive the world in new ways, to find hidden patterns make connections between seemingly unrelated phenomena and to generate solutions. Creativity is the catalyst for all new innovations. Creativity is the act of turning new and imaginative ideas into reality or the generation of ideas that result in the improved efficiency or effectiveness of a system. This is supported by

Guberina, and Wang (2021) state that Entrepreneurial leadership style aims to induce creative and innovative thinking and development of well-thought delicate strategies to utilize resources available and sustain employee resilience in the face of adversity.

Risk Taking Strategy

Leaders should be forward thinking, proactive, not afraid to take risks. Risk taking strategy is an important aspect of running an organisation. It is the tendency to take bold actions rather than being cautious thus 'venturing into the unknown'. Risk taking is defined as a calculated behaviour displayed by organisations based on their analysis to target growth and this calls for decisions involving substantial financial and human resource investment (Basu & Gupta, 2013) this spirit of creativity and rule breaking through riskiness can become critical inputs in leveraging organisational growth. Risk taking and the way it impacts on the survival of an institution operations represent critical issues in strategic management. Sozuer et al. (2017) viewed the managers' tendency to deal with the altering business surroundings prerequisites with the aid of taking incredible choices related to directing the organization's assets toward exploiting possibilities with uncertain results.

Innovation Strategy

This is another aspect for business survival. It is considered to be a critical element of entrepreneurship. The Stone Age did not end because people had run out of stones but it failed to grow because it was overtaken by changes in the environment and people's mind-sets. Innovation is key to improving the social, economic and the environmental performance of the ECD sector. Innovation is changing your business model and adapting to changes in the environment to deliver better services (Hana, 2013). The inventive part of innovation is based on people's knowledge, skills, and experience. For the innovation strategy to work, the aspect of human factor is an indispensable element as people generate ideas that might help the organisation to gain a competitive advantage over its competitors. According to Shephered and Wiklund (2020), innovation indicated the companies' activity towards adopting new thoughts to acquire an aggressive advantage, whilst Haider et al. (2017) regarded it as a business chain aimed at providing new

offerings and products or growing commercial enterprise mannequin that assist to cope with threats and seizing new possibilities that enhance the business enterprise.

Resilience

This stems from the Latin *resilire,* denoting the idea of 'bouncing back', that is rebounding or recoiling (Alexander, 2013). The concept of resilience is used in addressing complex issues such as COVID-19. It also has great influence on leaders' competency in recognizing new opportunities to improve the organization's performance (Soane, Butler & Stanton, 2015). Entrepreneurial leadership is leadership for innovation that seeks out new, better, and more adaptive solutions to complex problems (Douglas, 2018).

As another means of support, the DSD, through 'Ilifa la bantwana', has offered all eligible ECE services to apply to the Employment Stimulus Relief Fund. The challenge was the accessibility for ECE services that are in rural areas and struggle with network connectivity. This is a good gesture by government, but it is important that forums could be created where the ECE leaders are offered opportunities to speak about their good and bad experiences and be offered support through counselling sessions.

Conclusion

The research question investigated in this research paper is 'What are the effects of entrepreneurial leadership in sustaining the ECE sector?' Constructed on this research question, the results from the reviewed literature are presented in the following sequences; elucidation of key term, findings on leadership attribute, the significance of leadership in organisations and the type of support needed to be provided to ECCM to recover from the effects of the COVID-19.

Responding to the first objective which aimed at elucidating the terms 'early childhood leadership and entrepreneurship' as the main key terms of the research, the following were the findings: leadership in early childhood was found to be a shared responsibility between all the ECCE stakeholders. The findings revealed that leadership is a process that influences positive change within an organisation for it to achieve a desired goal. It was further found to be a driving force that led to change and innovation. Entrepreneurship as the key term was found to be a dynamic process.

In responding to the second objective which intended to explore the attributes of an entrepreneur of an organization, there are two parts to entrepreneurship. The first is the managerial skills needed to run a profitable business, the second is 'entrepreneurial spirit'. Both are important. According to Kuratko and Hodgetts (2007), entrepreneurship requires an application of energy and passion towards the creation and implementation of new ideas and creative solutions. According to York and Sarasvathy (2010), innovation in an education field would be related to school practices, standards, and policies with immediate impact on the classroom activities.

Entrepreneurial leadership plays a critical role in any organisation's operations and survival, more so in turbulent environments. Entrepreneurial leaders need to ensure innovation both internally and externally to ensure its sustainability amidst all forms of uncertainties. The Early childhood sector may survive if the leaders could offer the best curriculum that is implemented in the least number of resources. This requires change in the leadership styles of the ECCMs.

The findings further suggest that entrepreneurial leadership is of value to the ECE sector for its future sustainability and financial improvement. Entrepreneurial leadership develops the individual's way of thinking, functional competences, cultivates a set of change and equips people with a set of concrete strategies to implement the improvements (Pihie, Asimiran & Bageheri, 2014).

Theories of change and survival strategies have an enormous influence on understanding of Entrepreneurial Leadership. Kurt Lewin's theory suggests a process of individual and organizational change in turbulent environments such as that posed by COVID-19. The theory has a bearing on the survival of organisations such as ECD centres. This paper envisages an ECE sector that is more entrepreneurial and that enhances leaders' capacity for adaptation, long term survival and performance. The paper demonstrated the relevance of entrepreneurial leadership in sustaining and bringing economic independence to the ECE sector. It also demonstrated how entrepreneurial leadership can bring financial growth to the sector and create sustainable jobs. ECE leaders need to appropriately sharpen their entrepreneurial skills and use them to improve and sustain the economic state of their centres

Recommendations

An organisation cannot survive if it does not renew or reengineer itself. Kurt Lewin's Theory stressed the importance of change in organisations. Similarly, if leadership does not go where the wind of change takes them, they will become

stagnant. Change is uncomfortable but it marks the time to change. Entrepreneurial leaders should be constantly improving, looking for better ways of operating ECD centres. These are specific leadership implications attached to Kurt Lewin's theory. The outcomes of the exploration reported in this paper have important implications for policy and practice.

The Implications are:

Entrepreneurial leaders must see the benefit of change, which requires coaching, support, patience, and counselling. Change in ECD centres improves teaching practices. Flexibility is a trait for survival and in teaching it plays an important role in understanding the importance of change and implementing it in teaching practices.

Change makes leaders and teachers address children's needs effectively as they are the beneficiaries of school. This implies that children's needs come before anything else. Leaders should realise that children change constantly, and their needs also change day by day. Hence, pedagogical methods need to evolve to encourage them to become global citizens.

Entrepreneurial leaders should take risks associated with change. Teachers also need to be motivated and encouraged to use modern teaching methods. ECD teachers' efforts to change and take risks in turbulent times must be recognised and rewarded. Change will only occur when those who work in schools can develop new knowledge and skills, hence professional development becomes critical.

The Recommendations are:

Education in COVID-19pandemic has been an issue the international community is grappling with. The challenge has been exacerbated by say cyclones, other health disasters, among other things pandemics. COVID-19 in South Africa, has worsened woes to a dire economy, which was on unprecedented decline. Based on this observation, the following recommendations are proffered:

Policy

Registrations of ECE centres with the Government Departments should require leaders or directors who have entrepreneurial skills, through training. This will also be ascertained through the submission of a feasible business plan upon registration of the centre. It should be compulsory for the ECE sector to implement the entrepreneurship business model for running their centres and present their business plan on registration at the DSD, monitoring its implementation and providing support. A business model importance is in 'defining how the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit. It thus reflects management's hypothesis about what customers want, how they want it, and how the enterprise can organize to best meet those needs, get paid for doing so, and make a profit '.

Government is encouraged to increase support it giving to ECDs centres to help them mitigate perennial problems in the education sector. Any programme to be successful it needs the support at the highest level. It should be considered a policy that organizations and group of individuals who have experienced natural disasters be supported by government through provision of counselling to heal from the experience and to be offered an opportunity to talk about their experiences.

Practice

ECE leaders need to change their leadership behaviours to a new way of running the centres and be prepared to adjust to the circumstances brought about by change. According to Renko et.al (2015) the change environment of ECE requires:

- Intervention programmes that promote entrepreneurship and job creation to overcome slow economic growth.
- Leaders who search for opportunities, may start projects, collect, and strive to manage the resources needed. Leaders should find human resource, determine goals for the organization, guide and lead the personnel to achieve organizational goals.
- The ECE leadership may look at different ways of improving their entrepreneurial skills to create additional income and sustain the sector. They may also look at how they can improve their programmes to attract more children as well as incorporating programmes that will provide young people with more opportunities of job creation, thus empowering the community. They may introduce programmes and make them available to communities to help with job creation and at the same time bring income for the centre. Overall, leaders should develop the right focus, create the right environment, and build the right team.

Limitations of the Study

This research was limited only to the ECE sector using Desktop analysis as a method of data collection. Literature on how entrepreneurial leadership can be adopted for sustainable development in the ECE sector was reviewed. The reviewed literature was limited to "Ilifa la bantwana report on the impact of COVID-19 pandemic in South Africa. A major limitation of using desk research is that it may not answer sufficiently the researcher's specific research questions or contain specific data that the researcher requires in the study.

Acknowledgments

I would like to thank all the people close to me, my family, colleagues, my eldest son Moatlhodi Letsholo Modise, and my editors, without their generous support, the completion of this paper would not have been possible. Furthermore, I would like to thank Almighty God for giving me strength to work on the paper.

Biodata of the Author

Dr Matshediso Rebecca Modise, holds a PhD. She was born in Thabazimbi, Limpopo Province in 1964, South Africa. She obtained her Master's degree in 2004, Post Graduate Diploma in 2002 and B.Ed. Honours in 2001, all in Educational Management. Dr Modise obtained her Higher Education Diploma in Pre-Primary Education in 1995 and her professional teaching qualification 'University Diploma in Primary School in 1987. She is a Senior lecturer in the Department of Early Childhood Education at the University of South Africa. Her research interests are Leadership and Management in Early Childhood Development (ECD) and Foundation Phase (FP) which raises issues for transformative pedagogy in the early years. She has immense experience in education which started from being an Early Childhood, Foundation and Intermediate phase teacher, deputy principal and Senior Education Specialist supporting ECD/FP teachers in Language and reception year in the Department of Education at District level.

References

Brown, S. L., Brown, S. I., Brown, S. L., & Eisenhardt, K. M. (1998): Competing on the Edge: Strategy as Structured Chaos. Harvard Business Press.

Chen, F. F. (2007): Sensitivity of goodness of fit indexes to lack of measurement invariance. Structural Equation Modelling: A Multidisciplinary Journal, 14(3), 464-504.

Centre for Early Childhood Development (2019). Putting Young Children First. https://cecd.org.za/ (Accessed 27 October 2021)

Damayanti, R. W., Hartono, B., & Wijaya, A. R. (2021). Leadership competency for megaproject's complexity management: a conceptual study. *International Journal of Innovation, Management and Technology*, *12*(4).

Fernald, L. W., Solomon, G. T. & Tarabishy, A. (2005): A New Paradigm: Entrepreneurial Leadership. *Southern Business Review*, 30(2), 1-10.

Kruse, K. (2013). What is leadership. *Forbes magazine*, *3*.

Guberina, T., & Wang, A. M. (2021, March). Entrepreneurial Leadership and Fear of COVID-19 Pandemic Impact on Job Security and Psychological Well-being: A Conceptual Model. In *2021 7th International Conference on Information Management (ICIM)* (pp. 144-148). IEEE.

Haider, S. H., Asad, M., & Fatima, M. (2017). Entrepreneurial Orientation and Business Performance of Manufacturing Sector Small and Medium Scale Enterprises of Punjab Pakistan. European Business & Management, 3(2), 21–28.

Hisrich & Peter, (2002). *Entrepreneurship.* Boston: Irwin McGraw-Hill.

Hujala, E., & Eskelinen, M. (2013): *Leadership tasks in early childhood education. Researching leadership in early childhood education. University of Tampere.* http://urn.fi/URN:NBN:fi:uta-201311131585 (Accessed 20 February 2021).

IIifa Labantwana, (2020): *Report: Urgent need to support ECD operators during Covid-19*. https://ilifalabantwana.co.za/report-urgent-need-to-support-ecd-operators-during-covid-19/

(Accessed 16 February 2021).

Kasim, N. M., & Zakaria, M. N. (2019): The Significance of Entrepreneurial Leadership and Sustainability Leadership (Leadership 4.0) towards Malaysian School Performance. *International Journal of Entrepreneurship*, 2(8), 27-47.

Kaminski, J. (2011): Theory Applied to Informatics-Lewin's Change Theory. *Canadian Journal of Nursing Informatics*, 6(1), 1-4.

Khairuddin, 2015. Strategic Management. Singapore: Thompson Learning.

Kuratko, D. F. (2007): Entrepreneurial Leadership in the 21st Century: Guest Editor's Perspective. *Journal of Leadership & Organizational Studies*, 13(4), 1-11.

Leitch, C. M., McMullan, C. & Harrison, R. T. (2013): The Development of Entrepreneurial Leadership: The Role of Human, Social and Institutional Capital. *British Journal of Management*, 24(3), 347-366.

Maclnnis, D.J. (2011): A Framework for Conceptual Contributions in Marketing. *Journal of Marketing,* 754(4), 136-154.

Mishra, P., & Misra, R. K. (2017): Entrepreneurial Leadership and Organizational Effectiveness: A Comparative Study of Executives and Non-Executives. *Procedia Computer Science*, 122, 71-78.

Magnuson, K. (2013): Reducing the Effects of Poverty through Early Childhood Interventions. Fast Focus. No. 17-2013. *Institute for Research on Poverty*.

McLeod, J. (2013): *An Introduction to Counselling*. Bershire: McGraw-Hill Education.

National Planning Commission (2011): *National Development Plan: Vision for 2*030. Pretoria: National Planning Commission.

Pihie, Z. A. L., Asuimiran, S., & Bagheri, A. (2014): Entrepreneurial Leadership Practices and School Innovativeness. *South African Journal of Education*, 34(1), 75-89.

Raza, M. (2019): *Lewin's 3 Stage Model of Change Explained.* https://www.bmc.com/blogs/lewin-three-stage-model-change/ (Accessed 16 January 2021).

Renko, M., El Tarabishy, A., Carsrud, A. L., & Brännback, M. (2015): Understanding and Measuring Entrepreneurial Leadership Style. *Journal of Small Business Management*, 53(1), 54-74.

Sheppard, G. (2015). What is Counselling? *A Search for Definition. Retrieved September*.

Scott, S., & Webber, C. F. (2013): Entrepreneurialism for Canadian Principals: Yesterday, Today, and Tomorrow. *Journal of Research on Leadership Education*, 8(1), 113-136.

Scottpoulos, E. (2012): Reframing Early Childhood Leadership. *Australasian Journal of Early Childhood*, 37(2), 42-48.

Shepherd, D. A., & Wiklund, J. (2020). Simple rules, templates, and heuristics! An attempt to deconstruct the craft of writing an entrepreneurship Paper. Entrepreneurship Theory and Practice, 44(3), 371–390.

Slimane, M. (2012): Role and Relationship between Leadership and Sustainable Development to Release Social, Human, and Cultural Dimension. *Procedia-Social and Behavioral Sciences*, 41, 92-99.

Stoddard E. (2020): *Junked: Fitch and Moody's downgrade South Africa's Credit Ratings further.* https://www.dailymaverick.co.za/article/2020-11-22-junked-fitch-and-moodys-downgrade-south-africas-credit-ratings-further/ (Accessed November 2020).

Soane, Butler & Stanton (2015): Followers' Personality, Transformational Leadership and Performance. *Sport, Business and Management: An international Journal* 5(1):65-78.

Soudien, C., Reddy, V., & Harvey, J. (2021). The impact of COVID-19 on a fragile education system: The case of South Africa. In *Primary and Secondary Education During Covid-19* (pp. 303-325). Springer, Cham.

Sverzellati, N., Milanese, G., Milone, F., Balbi, M., Ledda, R. E., & Silva, M. (2020). Integrated radiologic algorithm for COVID-19 pandemic. *Journal of thoracic imaging*.

Teece, D. J. (2010): Business Models, Business Strategy, and Innovation. *Long Range Planning*, *43*(2-3), 172-194.

Teffo, L. A., & Tabit, F. T. (2020): An assessment of the food safety knowledge and attitudes of food handlers in hospitals. *BMC Public Health*, *20*(1), 1-12.

Volery, T., Mueller, S. & von Siemens, B. (2015): Entrepreneur Ambidexterity: A Study of Entrepreneur Behaviours and Competencies in Growth-Oriented Small and Medium-Sized Enterprises. *International Small Business Journal*, 33(2), 109-129.

Yemini, M., Addi-Raccah, A. & Katarivas, K. (2014): I Have a Dream: School Principals as Entrepreneurs. *Educational Management Administration & Leadership*, 43(4), 526-540.

Web site resource

https://cecd.org.za/news/covid19resources/ and https://cecd.org.za/wp-content/uploads/2021/02/save-our-ecd-workforce.pdf

Journal for the Education of Gifted Young Scientists, 9(5), Special Issue, 39-338,Dec 2021
e-ISSN: 2149- 360X
jegys.org

youngwisepub.com
© 2021

Research Article

Exploring e-tutors' technological knowledge of the design process to facilitate the design step to advance giftedness of students in an ODeL education

Mpipo Zipporah Sedio[1]

Department of Science and Technology Education (DeSTE) at UNISA, South Africa

Article Info

Received: 09 October 2021
Revised: 17 November 2021
Accepted: 11 December 2021
Available online: 30 Dec 2021

Keywords:
Design process
Design step
e-tutoring
Open Distance e-Learning
Technological Knowledge

2149-360X/ © 2021 JEGYS
Published by Young Wise Pub. Ltd.
This is an open access article under the CC BY-NC-ND license

Abstract

In an ODeL context, the design step of the design process is regarded a vital component that should be taught in the Technology curriculum. Teaching the design step in an ODeL setting places specific expectations on qualified e-tutors who can prepare students for the workplace. The central question of this research is "How does e-tutors' technical knowledge influence effective teaching and learning of the design step?" The study focused on 560 postgraduate students enrolled in a semester module in 2020. An online survey was used to investigate the technological expertise of e-tutors in order to facilitate the design process step for advancing giftedness in students in an ODeL setting. The information gathered from five e-tutor sites was analyzed. The findings reveal that e-tutors in ODeL settings lack the ability to choose technologies that will help students understand the design step content. Suggestions: based on the present model, an alternate technique for e-tutor appointments is proposed.

To cite this article:
Sedio, M.Z. (2021). Exploring e-tutors' technological knowledge of the design process to facilitate the design step to advance giftedness of students in an ODeL education. *Journal for the Education of Gifted Young Scientists*, *9*(5), Special Education, 39-48. DOI: http://dx.doi.org/10.17478/jegys.1021319

Introduction

The introduction of the Covid-19 epidemic provided chances for several higher education institutions that already had an Open and Distance eLearning (ODeL) setting to expand their concept of e-tutoring, how the design step of the design process is taught and online teaching with technology. Pownall et al. (2021) advised that uses of various technologies advance more integration with a larger population of students and also the generation of rich online content. The design step of the design process is an area of attention for online content that stands to profit from integrating technologies. However, it is yet unclear how useful the technological expertise provided by e-tutors is in facilitating the learning of design step through the usage of such technologies. For a long time, technological knowledge took centre stage and dominated important scholarly debates, allowing for more in-depth understanding of the concept. The widely held knowledge of the concept is a thought of navigating understanding outside of what has previously been understood about the concept in this work. The navigational understanding allowed for the creation of information regarding how the e-tutors' choice of technology aided the design step. As a result, it is yet unknown how much the acquisition of such technology expertise effects the e-tutors' effective facilitation of the design step.

The concept of e-tutors, who are tasked with facilitation at a distance, is central to the entire design step. According to Maré and Mutezo (2021), several ODeL institutions, including UNISA, became forerunners in incorporating the

[1] Lecturer in the Department of Science and Technology Education (DeSTE) at UNISA, South Africa. E–mail: sediom@unisa.ac.za ORCID: 0000-0001-6752

e-tutor model as part of their student assistance programs, with the goal of increasing student success rates. At the same time, the value of an e-tutor model is that it allows students to better understand the content of module programs by encouraging and supporting online cooperation for technological tools Ravioloa et al. (2021). These technological tools are intended to be used by e-tutors during facilitation to demonstrate technology competence to the students.

It's because these tools allow e-tutors to interact with students at a distance during student support. As a result, using technology tools like Franchuk and Prydacha to engage students in online lectures improves their effectiveness (2020). The ability of e-tutors to introduce technology tools developmentally is at the heart of such tools, according to Baker and Kassimer (2021), and thus their efficacy is better positioned for the facilitation of the design step.

The value of e-tutors in assisting with the design process cannot be overstated. To do so, it's crucial to understand the policy imperatives surrounding the curriculum subject in schools, as well as the policy imperatives surrounding e-tutoring. Teachers make up the majority of the institution's customers, therefore knowing the policy imperatives in schools is crucial. Teachers who are already in practice and have enrolled in higher learning institutions to increase their theoretical understanding of the subject that they already teach have two features. Another group of new teachers is still in the process of being trained. As a result, an e-tutor must be familiar with the two types of teachers they assist. At its core, the subject policy must make e-tutors a priority in order to assist the two groups of teachers. The subject is called as Technology, and it is included in the formal curriculum of South African schools for grades R through 9. It is defined as the use of knowledge, skills, attitudes, and resources to meet people's needs and desires by devising practical solutions to issues while considering social and environmental aspects Curriculum Assessment and Policy Statement (CAPS) (2011).

As a result, the (CAPS) (2011) is very precise about its purpose, goal, intention, and the significance of the design process. According to the CAPS (2011) document, the need for developing engineers, technicians, artisans, and technologically literate pupils motivated the introduction of the topic in schools. Its main goal is to help people become more technologically literate by teaching them how to design. Its goal is to familiarize students to the fundamentals of the workplace. Also, it is critical to create proficiency in civil, architectural, electrical, mechanical, and structural engineering vocations. The purpose, particular goals, and intention of the subject, as well as the importance of the subject to the design process, are all connected to what this paper intends to achieve as giftedness in students during the design step of the design process.

Furthermore, because giftedness is at the heart of this study, there are policy imperatives worth noting in relation to e-tutoring, which is viewed by e-tutors as a support mechanism for the students they tutor. Student support is considered essential for distant students in the setting in which this study was written. This came after the University of South Africa (UNISA) launched an e-tutor concept in 2013 to help students. The execution of this strategy is carried out by appointing adequately trained e-tutors to teach the modules in the university's many colleges, departments, and units. An Honours degree in the field of expertise is the policy prerequisite for a suitably trained e-tutor.

For the sake of this article, an ideal e-tutor is someone with a Technology Honours degree. Another policy requirement is that one e-tutor be provided to per hundred students in a module to provide support. This is significant because it implies that each e-tutor is chosen on their own merits and is expected to function as an individual, even if there are more than five or even more tutors assigned to the students. In this study, the individual distinctive observable evidence from the constructs that were generated for the paper will be used to assess how well an e-tutor implements the design stage curriculum. The presentation of the findings will be deduced from these based on the unique variants from individual e-tutor sites, and a judgment about the objective will be drawn.

In addition to the e-tutor approach, UNISA launched a 2013 Institutional Operational Plan in which all NQF Level 5 (1st year) modules across the University were intended to have e-tutors assigned to the students. This paper is based on one of the courses that is being considered for inclusion in the e-tutor paradigm. The official curriculum for the design process of Technology will be taught by e-tutors in the course.

There is universal agreement that professional engineers and what teachers, including e-tutors, emphasis on the facilitation of the design process, there are variations. Lin et al. (2021). E-tutors must first have confidence in their ability to communicate the design phase in a self-sufficient manner (Smith et al., 2021). Engineers, on the other hand, use specific inventive talents for the design process to uncover new opportunities more rapidly and precisely (Han et al., 2021). The distinctions in facilitation are disputed because e-tutors are only permitted to participate in the design phase. This exposition is problematic because drawings are essential in engineering and architectural education, yet the e-tutors Sung et al. (2019) are expected to teach them differently. Also, keep in mind that the usage of diagrams in the design process is considered a tough and diverse vital skill for students to develop their ability to transmit ideas

and increase and improve their communication skills. Hello, Alok (2021). In light of this, a potential issue may arise as to how the e-tutors make drawings of the design step relevant in practice, given that they lack professional drawing skills. The design step of the technological process is taught in an ODeL environment by e-tutors without the usage of drawings in this article. As a result of this mandate, there is a growing expectation about which drawings the e-tutors will use to achieve the aims of the modules they teach online. Both 2D and 3D dimensional diagrams are used to predict the success of the final items at the design stage.

2D diagrams are close representations that provide more information about themselves than drawings Ocal and Halmatov (2021). They are the foundation upon which the design step is taught. For the reasons stated, more emphasis is placed on teaching individual traits rather than generic Komatsu and Jones attributes (2020). According to Kiernan et al. (2021) one advantage of such diagrams is that it is a gateway to students' deeper learning because it provides significant insights into how their sketching imaginations grow. As a result, 2-diagram drawing is regarded as a key common communication medium between students and their teachers, despite the fact that it is dwindling due to design software (Mohammed, 2021). However, be aware that the way 2D diagrams are constructed might pose problems for pupils, as components that are not vital for a diagram receive more emphasis than those that are important (Haj-Yahya, 2021). In this study, it is assumed that e-tutors possess some fundamental knowledge from which they can benefit from the drawing of 2D diagrams using simple technologies for students.

3D diagrams depict the actual living world space and are created using models that teach pupils about spatial awareness (Ocal et al., 2021). Furthermore, 3D diagrams have been examined for decades, with their distinguishing characteristics remaining those that demand exact line drawings from many views at the same time, as well as those that fail to become simple to draw (Zhang et al., 2021). This view by Zhang et al. (2021) dismisses the relative importance in this article of how e-tutors are envisioned to contribute to a better knowledge of how 3d diagrams are taught using technological means. Nonetheless, the theory behind 3D diagrams is that they generate certain abilities that are required of students during the design stage of the design process, according to Pittalis and Christou (2010). Such abilities are required since 3D free hand drawings can be sloppy, with simplifications and distortions, resulting in the possibility of many explanations for the same diagram (Xueting et al., 2020).

It is unknown how well-equipped the e-tutors are in terms of developing specific abilities for 3D diagrams.

Theoretical Framework

The paper was based on a constructivist learning theory, which looks at how students learn from the practices that their e-tutors use to help them learn. The act of e-tutors facilitating learning means that students generate knowledge from activities that are specific to their learning. The expectation is that students will become active participants in their learning as a result of these activities.

Literature Review

ODeL institutions decided to teach the design process curriculum as a way for students to gain hands-on experience with skills that expose them to design knowledge. Distance education necessitates the use of technology by the students. Hietajarvi et al. (2020) found that certain students who have extensive encounters with technology outside of school feel alienated and disengaged at institutions in a study done on the use of such devices. According to the findings of (Tyrus & Harasymenko, 2021; Zhaldak et al. 2021), the instructional function of tools was not devoted to the cognitive processes of students at a distance, resulting in an unorganized transfer of technological skills. Vegliane and Sannicandro (2020) found that the pedagogical technological function of e-tutors is under examination since it did not bring the efficient use of technology for the design stage of the design process.

In contrast to previous findings, Franchuk and Prydacha's (2020) findings revealed that some resources (You Tube movies) were selected to engage students and serve as motivation and stimulation for their educational efforts. Franchuk & Prydacha (2020) agreed with Komatsu and Jones (2020), who found that when such tools are utilized for online learning, they have a good influence on learners who had low spatial abilities at the start. The ideas presented in this section are critical to achieving the paper's goal of achieving gifted kids during the design phase.

Hand sketching has nearly always been used to depict design ideas, however with the rising usage of digital drawing tools, 2d diagrams may be considered to benefit from such an invention (Taraszkiewicz, 2021). The same momentum as previously said sets the tone for the goal, which already attracted attention to determining the e-ability tutor's to exploit digital materials for the design step's 2D diagrams. In a study by Rohendi et al. (2021), it was confirmed that pupils found it challenging to go from 3D to 2D visuals. Simultaneously, Serrano et al. (2021) discovered that some engineers only sketched on occasion and only for 2D drawings. Anamova (2021), on the other hand, revealed contradicting findings, claiming that students mastered crucial competences when using the recommended methodologies for the design step's 2D diagrams. Further evidence of excellent study outcomes came from Philips et

al. (2021) findings, which revealed that students were able to create rich idea 2D diagrams from the specimens presented earlier.

This section of the paper previously mentioned a section of the last objective that highlighted the need of determining how e-tutors' capabilities are employed for technologies in the teaching of 3D diagrams of the design step. Some research (Evans & Sonderlung, 2021; and Kounlaxay et al. 2021) highlighted this goal in the study. According to the results of the Ocelo (2021) study on 3d spatial thinking, children exhibited a limited knowledge of 3D shapes as well as difficulty with their attributes. The findings of Ocelo (2021) were similar to those of Evans & Sonderlung, (2021), who found that pupils were unable to produce a 3D fabricated model utilizing a digital tool. The findings of Kounlaxay et al. (2021) suggested that students who took part in the survey were doubtful about their ability to construct 3D items on their own utilizing the digital tool. In contrast to the findings above, the results collected from the students who participated showed that following the use of digital tools, they were able to see the key elements that were kept although they were hidden in one diagram. Yahya, Haj-Yahya (2021). This finding was backed up by a study by Komatsu and Jones (2020), who claimed that digital tools provided a comparable experience, demonstrating that they allowed students to learn more about 3D design. At the same time, according to Formit's (2020) study, a favored digital tool fostered an easy workflow in which students were able to construct 3D diagrams with ease. Teachers said that using technology tools helped pupils better grasp the direction of 3D diagrams, according to a previous study by Benning et al. (2018).

Research Objectives

- To assess e-tutors' abilities to choose technologies that will help them conceptualize the design stage of the design process.
- To determine the e-ability tutors to use digital materials in the design process's 2D diagrams design step.
- Determine the e-tutors' ability to apply technologies for 3D diagrams of the design stage in the design process.

Research Problem

This is one of the main questions this research tries to answer.

How does e-tutors' technology knowledge influence effective teaching and learning of the design step?

Method

Research Design

To answer the main research question, this paper used a quantitative approach to examine five e-tutor sites in further depth. The focus was on the e-tutors' conversations and the students' reactions. All of the conversations were culled using a broad guideline of inclusion that required the chosen to address the technological knowledge part at the very least.

Participants

This study looked at five e-tutors who were assigned to a module with 560 students enrolled throughout the course of a semester. The observations came from exchanges between e-tutors and students at five different e-tutor sites. The five e-tutors were chosen in accordance with policy, which stated that one e-tutor should be assigned to every hundred students. In an instance when this was recognized and given as a criticism, there was some logic that aligned with the paper's quality and objective. After then, each e-tutor site was given a name, such as ETS1, which stood for "e-tutor site number 1." From E-tutor 1 to E-tutor 5 (ET1-ET5), and E-tutor Site 1 (ETS1) to E-tutor Site 5 (ETS5), five e-tutors worked on five locations in this article (ETS5). The names ETS1-ETS5 were supplied in the pictorial depiction.

Research Instruments

This study used a long-term, repeated online observation method that focused on textual interactions for a two-year module program taught at a university. To collect the textual exchanges, non-participatory online observations were utilized as an instrument. The online observations were utilized as a starting point for gaining insights into how the e-tutors' technology knowledge effects the effective teaching and learning of the design step stage. As a result, the online students' interactions with the e-tutors were observed. During my PhD research, I designed, customized, and validated an online observations instrument to capture information from discussion forum platforms. The goal was to create a structured content out of the online postings between e-tutors and students. In the event of a criticism of the instrument, the instrument became suited for the aim of this paper since its orientation was more towards a pragmatic design orientation. The instrument's practical character allowed it to capture the number of frequencies from the e-

tutors' site postings as well as the frequencies of the students' reactions. The researcher's pragmatic nature was also extended when she took a stance to count the number of postings and responses each time they occurred. Printing the postings from the five e-tutor sites for verification reasons addressed the issue of credibility. Two co-workers were provided the documents for verification and further verification.
The instrument appears as table 1 below.

Table 1.
Online Observations Data Table

Knowledge of Different Technologies by e-tutors			
Construct	**E-tutors**	**Postings**	**Responses**
		E-tutors	**Students**
E-tutors use knowledge which provided online students with sufficient opportunities to work with different technologies	ETS1	4	1
	ETS2	2	1
	ETS3	0	0
	ETS4	1	15
	ETS5	3	1
E-tutors used digital materials that map stages of the design process.	ETS1	4	1
	ETS2	1	1
	ETS3	0	0
	ETS4	4	2
	ETS5	2	0
E-tutors know and use technologies that online students can use to understand Technology Education concepts.	ETS1	3	1
	ETS2	1	0
	ETS3	0	0
	ETS4	3	2
	ETS5	4	1

Data Analysis
The descriptive data was derived from five e-tutors' postings, which were read, analyzed, numbered, and prepared for analysis using tables. Three tables were used to organize the assessments of various postings on the sites. Table 1 shows e-tutors' abilities to select technologies to conceptualize the design step; Table 2 shows e-tutors' potentialities to teach 2d diagrams using digital tools to conceptualize the design step of the design process; and Table 3 shows e-tutors' abilities to exploit technologies to teach 3d diagrams for the design step of the design process. Table 1 shows the online observation tool.

Results

e-Tutors' Abilities To Select Technologies To Conceptualize The Design Step

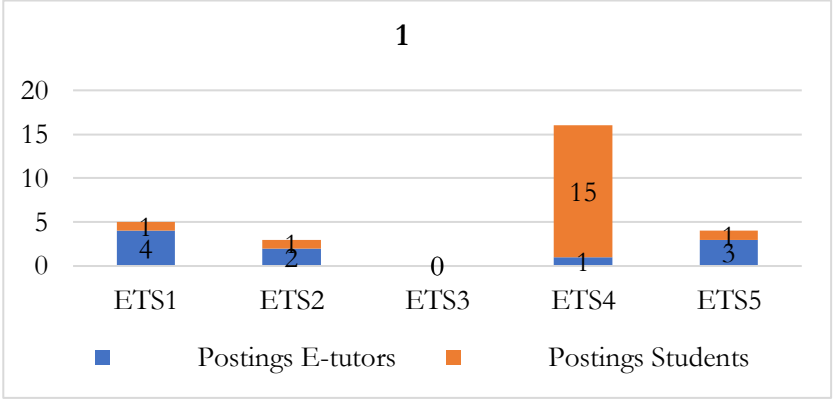


Figure 1.
The Abilities to Select Technologies to Conceptualise the Design Step

Figure 1 shows the results of an item designed to assess an e-ability tutor's to choose technologies for the design step of the design process. The observations documented the responses of five e-tutors (ETS1; ETS2; ETS3; ETS4 and ETS5) to their students' postings. ETS1 posted four times in the table, followed by ETS5 with three postings. In response to the ETS4 ads, fifteen students responded, but ETS1 received only one response. ETS2 posted twice in the same time, receiving only one response from a student. ETS5, who had posted three times on the construct, received a single response from a single student. There were no postings from the e-tutor for ETS3 in regard to the construct's ability to apply technology throughout the design step stage.

The Potentialities of e-Tutors to Teach 2D Diagrams

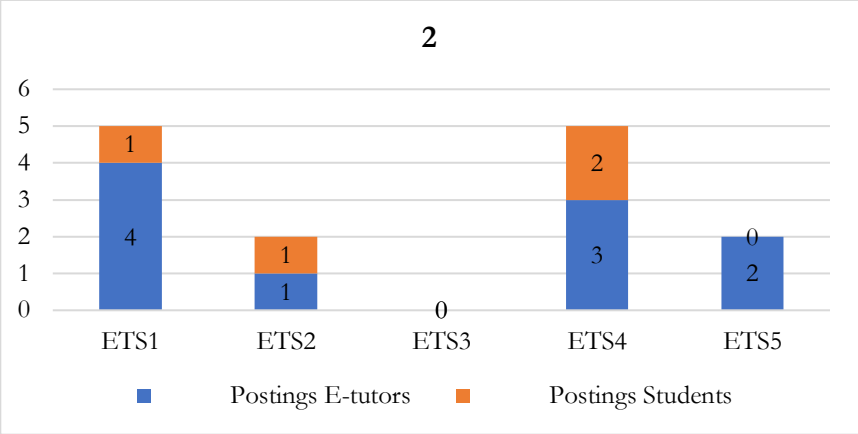


Figure 2.

The Potentialities of e-Tutors to Teach 2D Diagrams Using Digital Tools to Conceptualize the Design Step of the Design Process

Figure 2 shows the responses to a question designed to see if e-tutors have learned how to use relevant digital assets to teach the make stage of the design process. Five e-tutors (ETS1; ETS2; ETS3; ETS4 and ETS5) posted on the construct for the pupils, according to the observations. The e-tutors' postings drew a response from the students as well. A single student answered to each of ETS1's four ads. Furthermore, no student commented to the ETS5's two posts on the construct. ETS4 posted three times, with two responses from the students, according to the table. It's also worth noting that ETS2 only posted once, with only one student responding. Finally, the table indicates that ETS3 did not post for the construct.

e-Tutors' Abilities to Exploit Technologies to Teach 3D Diagrams

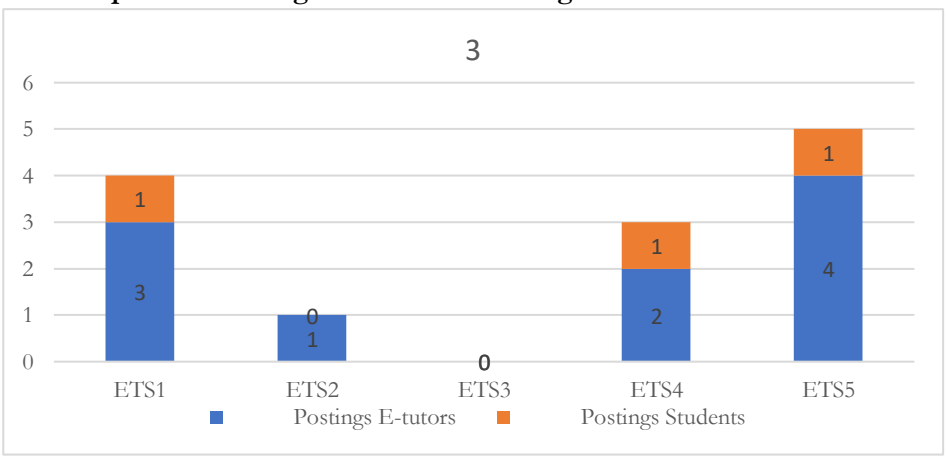


Figure 3.

The Abilities of e-Tutors to Exploit Technologies to Teach 3d Diagrams for the Design Step of the Design Process

Figure 3 shows the responses to an item designed to determine whether e-tutors have acquired knowledge and skills for delivering design process information using online technologies. Only four e-tutors (ETS1; ETS2; ETS4; and ETS5) posted for the online pupils, according to the observations. There's also a breakdown of how students responded to the e-tutors. ETS5 had the highest number of e-tutors postings (4), followed by ETS1 with three listings. In the same way, one posting from student reactions was seen on all three sites (ETS1, ETS4 and ETS5).

Discussions

The presentations of the results in this section were based on table 1.1 for the paper. The findings from research

objective 1 show that e-tutors in ODeL settings lack the ability to select technologies to assist students in learning the design step content. This finding is incidental based on the ETS3 from which it was noted that no post was done for the students in relation to the construct. At the same time, it was also evident from ETS4 that a greater number of students responded at fifteen to resounded e-tutor posting. What is observable is that had it been students were given opportunities to respond around digital abilities around their design step by their e-tutor, an opposite of what is observed might have been the case. Tyrus & Harasymenko (2021)and Zhaldak et al. (2021) made similar conclusions in the literature, stating that the pedagogical purpose of tools was not devoted to the cognitive processes of the design step, and that students were exposed to an unorganized transfer of technological abilities. According to Vegliane and Sannicandro (2020), e-tutors' pedagogical technological role did not result in the successful use of technology for the design step. In the worst-case scenario, the students who were the focus of this paper could conclusively demonstrate what Hietajarvi et al. (2020) found: students with extensive technology knowledge had been alienated and disinterested in the module allocated to the e-tutor. There is no broad agreement with the paper regarding engaged and active students who develop knowledge about the design stage, which served as the foundation for the study. In addition to what was previously stated about the purpose of the Technology subject, which was to introduce learners to the fundamentals of the work world and its importance, which is to develop excellence for careers as civil, mechanical, and structural engineers, the two are defeated based on observations in relation to ETS3. According to what is known about ETS3, students that are coached in ETS3 do not develop giftedness in the design process.

Furthermore, there was some more evidence which was obtained according to the students' category of posts, that the e-tutors' technological knowledge is not communicated in order to make the design step process education exciting. With a single potential student posting, this is obvious in ETS1, ETS2, and ETS5. This indicates that teaching in this manner is unfeasible, particularly when it comes to the critical digital abilities required for the design step of the design process. ETS1 had the most number of e-tutors' postings (4), followed by ETS4 with three postings. These findings indicate that e-tutors lack the ability to select digital materials for the stages of the design process taught in ODeL settings. The students' comments show that they only participate in the e-tutors' postings to a limited extent. In ETS1, for example, the e-tutor posted four times and received only one response.

This section of the paper was based on Figure 2 and Figure 3 which were conceptualized for the paper. The next order needed a presentation on the potentialities and the abilities of the e-tutors' presentation of both the 2D and 3D diagrams for the design step. In this paper, these were regarded as content knowledge domain for the design process where in light of the presentations, the e-tutors' technological understanding of the design step features. From which, two of the objectives which were set for the paper were conglomerated in this section of the results. The aim was to combine aspects which relate to how the design step is intended to be taught within the design process curriculum. From which, the two findings show that e-tutors lack the necessary competencies to deliver the design step process using both the 2D and 3D diagrams for the design step material in ODeL settings using online technologies. The claim concerning the two discoveries is based on what has been observed conclusively about two ETS3. One major issue is that students who receive assistance will have distorted knowledge of both 2D and 3D diagrams. The students were not given opportunities to enhance their grasp of both 2D and 3D diagrams, which implies that they were not given opportunities to advance their understanding of both 2D and 3D diagrams. In relation to the characteristics of students who were assisted, such as those who are currently serving as teachers and those who are still undergoing training, According to ETS3, the two cohorts of students will not gain crucial knowledge regarding both 2D and 3D diagrams in the schools where they are appointed or will teach in the future. As a result, what is known from Alok (2021) is perpetuated by ETS3 in that students will continue to perceive both 2D and 3D diagrams as difficult to draw, and therefore such key abilities will be lost. Sung et al. (2019) described earlier correlates nicely with what is seen in ETS3 in that the narrative that the same diagrams taught in engineering and architecture are forgotten when it comes to e-tutors because they teach the diagrams differently to engineers. This contradicts what was said about the subject's importance in terms of preparing students for employment as civil engineers, architects, electricians, and mechanical and structural engineers. From the students, their results, like the e-tutors', suggested that the e-tutors' understanding of online technologies did not get their technological knowledge learning completed, which would mimic their learning of the design step process. The results of a study by Rohendi et al. (2021) confirmed that students found it difficult to go from 3D to 2D visuals. Simultaneously, Serrano et al. (2021) discovered that some pupils only sketched on occasion and only for 2D drawings. In addition, data from Ocelo (2021) on 3D spatial thinking revealed that students had a limited comprehension of 3D shapes as well as difficulty with their properties when it came to 3D diagrams. This was similar to Ocelo (2021), whose findings were similar to Evans & Sonderlung, (2021), who found that students were unable to produce a 3D generated model utilizing a digital tool. Similarly, the findings of Kounlaxay et al. (2021)

indicated that students participating in the survey were doubtful about their ability to design 3d items using the digital tool on their own.

Conclusion

How does an e-technical tutor's knowledge influence effective teaching and learning of the design step? This was the key research topic. Three key objectives were established with the goal of answering the study topic. The first goal was to assess the e-tutors' ability to choose technologies that would help them conceptualize the design step of the design process. The findings revealed that e-tutors in ODeL settings lack the ability to choose technologies that will help students learn the design step process. This means that students who are aided in achieving this goal will be short-changed because their theoretical knowledge of key technology will be limited. A potential issue for the two cohorts of teachers is that they would not contribute significantly to the field by exhibiting competences in the selection of technologies that would aid in crucial insights into the design stage of the design process. Furthermore, because many kids already have extensive cognitive talents and familiarity with technologies outside of school, they will miss out on key world of work prospects. Hietajarvi et al. (2020) further on this by stating that some of them students get alienated and disengaged at institutions. According to findings from studies (Tyrus & Harasymenko, 2021; Zhaldak et al. 2021), the instructional function of tools was not devoted to the cognitive processes of students at a distance, resulting in an unorganized transfer of technological skills. According to Vegliane and Sannicandro (2020), e-tutors' pedagogical technological role did not result in the successful use of technology for the design stage of the design process. The theoretical framework that was used to root the research was constrained by its goals, which were to emphasize the importance of students who are actively involved in the generation of information for the design step.

The second set of findings came from the paper's two aims. From the first to the second aim, the e-ability tutor's to exploit digital materials for the 2d diagrams design step of the design process was assessed. The findings of some studies, such as Rohendi et al. (2021), confirmed that pupils found it difficult to transition images from 3D to 2D Serrano et al. (2021) contributed and discovered that some engineers only sketched once in a while and just for 2D drawings. Less desirable outcomes occurred from the observations for the third and final objective, which intended to identify the e-tutors' potentialities to employ technology for the 3D diagrams, of the design process. The findings revealed that e-tutors lack the requisite skills to deliver the design phase process in ODeL settings using online technologies using 3D representations for the design stage material. The need to examine how e-tutors exploit digital materials and use their potentialities for their students became less heightened within the theoretical framework framed for the paper as the need to examine how e-tutors exploit digital materials and use their potentialities for their students with both need cognitive skills for both the 2d and 3d diagrams became less heightened. Studies (Evans & Sonderlung, 2021; Kounlaxay et al. 2021 & Ocelo, 2021) have found that their findings agree with those in the publication that attracted attention to this goal. According to the findings of Ocelo (2021), pupils' 3D spatial thinking abilities were characterized by a lack of knowledge of 3D shapes as well as issues with their attributes. Evans & Sonderlung (2021) verified Ocelo's (2021) findings, reporting that students found it difficult to create and use digital tools for a 3D produced model. Similar findings were found by Kounlaxay et al. (2021), who found that students in the survey were doubtful about their ability to produce 3D items utilizing digital technologies. These findings highlight to the need for more training opportunities for e-tutors whose appointments help students have a better theoretical understanding of the design stage in the design process curriculum.

Recommendations

The findings in this paper were based on literature, a theoretical framework, and online observations. The online observations ranged from ETS1 to ETS5 and were based on online observations between an e-tutor and the students. It was demonstrated that e-tutors in ODeL settings lack the ability to select technologies that would assist students in learning the design step content, according to the paper's aim 1.

This section stated two objectives for the paper that were combined because each target was particular to two crucial diagrams for the design step of the design process. Two of the findings suggest that e-tutors lack the requisite competences to provide the design step phase within the design process in ODeL settings using online technologies using both 2d and 3d diagrams for the design stage content.

Limitations of the Study

This research was carried out in an ODeL institution with a global student population of 300,000 students. Out of the whole student population, this paper concentrated on 560 postgraduate students who registered for a module (n=560), which proved to be a restriction. There was an additional limitation because the same ODeL institution positioned its

qualifications through seven colleges and institutions, although this article is specific to a single college. Despite the fact that departments teach a range of modules, this constraint was likely exacerbated by the fact that this paper focused on only one college and one module within a department. The institutional professional plan for e-tutors provides for e-tutors across the institution, colleges, and departments, which might be regarded a high number of e-tutors and result in a limitation in that only five e-tutors participated in this study. An instrument became a constraint because it was developed and utilized as a practical tool for a certain purpose. Following that, a list of restrictions was published in this document, with no indication that the paper would be accorded little weight or authority. In conclusion, there is a need to examine these restrictions in order to not generalize the findings, but to pay attention to them so that they may be applied to other studies.

Acknowledgement

I acknowledge the e-tutor participants and my mentor.

Biodata of the Author

Dr. Mpipo Zipporah Sedio is a lecturer in the Department of Science and Technology Education (DeSTE) at UNISA. She graduated with a PhD in Technology Education. Her research interests focus on Technology Education and Open Distance eLearning. E-mail: sediom@unisa.ac.za

References

Alok, A. (2021). Sketching- an iterative tool for engineering problem solving. *Journal of Engineering Education Transformation, 34*(4), 51 – 57.

Anamova, R. R. (2021). Engineering and graphic education during and after the COVID-19 pandemic: challenges and opportunities. *AIP Conference Proceedings* 2389, 100007. https://doi.org/10.1063/5.0063501

Baker, A. H., & Kassimer, J. L. (2021). Using a connected learning framework to promote democratic education during a transition to online learning. *Middle Grades Review*, 7(1),1-15. https://scholarsworks.uvm.edu/mgreview/vol7/iss1/2.

Benning, L., Linsell, C., & Ingram, N. (2018). Using technology in mathematics: professional development for teachers. In Hunter, J., Perger, P., & Darrah, L. (Eds), *Proceedings of the 41st Annual Conference for Mathematics Education Research Group of Australia (MERGA) making Waves, Opening Spaces* (pp.146- 153). Auckland.

Department of Basic Education. (2011). *Curriculum and Assessment Policy Statement*. (CAPS). Technology. Grades 7-9. Department of basic Education: Pretoria.

Evans, P., & Sonderlund, C. (2021). Prototyping remotely together with 2d, 3d and immersive virtual reality design tools. *International Conference on Engineering and Product Design Education*. 9-10 September.

Franchuk, N.P. & Prydacha, T.V. (2020). Organization and conduct of classes in educational institutions during distance learning. *Journal of Physics: Conference Series*. 1-11. Doi;10.1088/1742-6596/1840/1/012054.

Han, J., Gu, L. Y., Chen, D. (2021). Application of innovative design thinking in product design, intelligent waste-paper recycling machine design case. 1-5. *E3S Wed Conference*. https://doi.org/10.1051/e3scomf/202123604062

Haj-Yahya, A. (2021). Can a number of diagrams linked to a proof task in 3d geometry improve proving ability? *Mathematics Education Research Journal.* https://doi.org/10.1007/s13394-021-00385-8.

Hietajarvi, L., Lonka, K., Hakkarainen, K., Alho, K., & Salmela- Aro, K. (2020). Are schools alienating digitally engaged students? Longitudinal relations between digital engagement and school engagement. Frontline Learning Research, 8(1), 33-55.

Kieman, N., Manches, A., Seery, M.K (2021). The role of visuospatial thinking in students' predictions of molecular geometry, 1-14. *Chemistry Education Research and Practice*. https://doi.org/10.1039/DORP00354A.

Komatsu, K., & Jones, K. (2020). Interplay between paper-and-pencil activity and dynamic- geography-environment use during generalisation and proving. *Digital Experiences in Mathematics Education*, 6. 123-143.

Kounlaxay, K., Shim, Y., Kang, S. J. Kwak, H. O & Kim, S. M. (2021). Learning media on mathematical education based on augmented reality. *KS11 Transactions on Internet and Information Systems*, 15(3),1015-1029.

Lin, K. Y., Wu, Y. T., Hsu, Y.T., & Williams, P. J. (2021). Effects of infusing the engineering design process into STEM project-based learning to develop preservice technology teachers' engineering design thinking. *International Journal of STEM Education*, 8(1),1-15. http://doi.org/10.1186/s40594-020-00258-9.

Maré, S., & Mutezo, A.T. (2021). The effectiveness of e-tutoring in an open and distance e-learning environment: evidence from the university of south Africa. Open Learning: The Journal of Open, Distance and E-Learning, 36(2), 164–180.

Mohamad, T. (2021). "The eight grids: a new method to enhance students' sketching skills in the schools of architecture. *Architecture And Planning Journal (APJ)*, 27(1),1-13.

Ocal, T., & Halmatov, M. (2021). 3d geometric thinking skills of preschool children. *International Journal of Curriculum Instruction*, 13(2), 1508-1526.

Phillips, C., Sunderlin, D., & Addy, T. (2021). Adapting to new modes of teaching during COVID-19: developing instructional approaches that empower learners and facilitate virtual learning experiences. *Journal of Transformative Learning*, 8(1),10-21.

Pittalis, M., & Christou, C. (2010). Types of reasoning in 3D geometry thinking and their relation in spatial ability. Educational Studies in Mathematics, 75(2), 191-212.

Pownall, M. J., Brook, E. E., & Pashley, K. (2021). H.I.I.T, High intensity ideation training- facilitating group design ideation in a digital space. *International Conference on Engineering and Product Design Education,* 9-10 September, 2021. Via Design, Via University College, Herning, Denmark.

Ravioloa, P., Simoneb, M.G., Mauroc, I., & Rondonotti, M. (2021). *Blended Learning in Online Teaching. Design Strategies and Future Developments*, Proceedings of the First Workshop on Technology Enhanced Learning Environments for Blended Education (teleXbe2021), January 21-22, 2021, Foggia, Italy. https://ceur-ws.org/Vol-2817/paper22.pdf.

Rohendi, D., Utami, N., Anna, A., & Sukandar, A. (2021). Projection simulation media in technical drawing for vocational students. *Journal of Engineering Science and Technology*, 16(1), 385-397.

Serrano, A., Chen, B., Wang, C., Piovarci., Seidel, H.P., Didyk, P., & Myszkowski, K. (2021). The effect of shape and illumination on material perception; model and applications. *ACM Trans*. 40(4), 1-16. https://doi.org/10.1145/3450626.3459813

Smith, S., Talley, K., Ortiz, A., & Sriraman, V. (2021). You want to teach me to engineering? Impacts of recurring experiences on K-12 teachers' engineering design self-efficacy. Familiarity with engineering, and confidence to teach with design -based learning pedagogy. *Journal of Pre-College Engineering Education Research (J-PEER),* 11(1), 26-44. https://doi.org/10.7771/2157-9288.1241.

Sung, T. R., Kelly, T. R. & Han, J. (2019). Influence of sketching instruction on elementary students' design cognition: a study of three sketching approaches. *Journal of Engineering Design*, 30(6), 199 – 226.

Taraszkiewicz, A. (2021). Freehand drawing versus digital design tools in architectural teaching. Global *Journal of Engineering Education,* 23(2), 100-105.

Tyrus, Y. V., & Harasymenko, I. V. (2021). Approaches, models, methods and means of training of future IT-specialists with the use of elements of dual education. *Journal of Physics: Conference Series in Press.*

Vegliante, R., Sannicandro, K. (2020). The role of the e-tutor in the university context and in distance learning: an exploratory research. *Journal of e-Learning and Knowledge Society*, 16(3),76-85.

Xueting, L., Sifei, L., Kihwan, K., Shalini, D.M., Varun J., Yang, M., Kautz, J. (2020). *Self-supervised single view 3d reconstruction via semantic consistency*. asXiv preprint arXiv:203.06473,

Zhaldak, M.I., Franchuk, V.M., & Franchuk, N.P. (2021). Some applications of cloud technologies in mathematical calculations. *Journal of Physics: Conference Series In press*.

Zhang, H., Zhou, H., Zhou, Z., Zeng, H., Zhang, X, Yang, J & Lei, H. S., Han, F.S. (2021). Energy absorption diagram characteristic of metallic self-supporting 3D lattices fabricated by additive manufacturing and design method of energy absorption structure. *International Journal of Solids and Structures*, 226-235.

JEGYS

Journal for the
Education of
Gifted
Young Scientists

Young Wise Publishing

ISSN: 2149-360X