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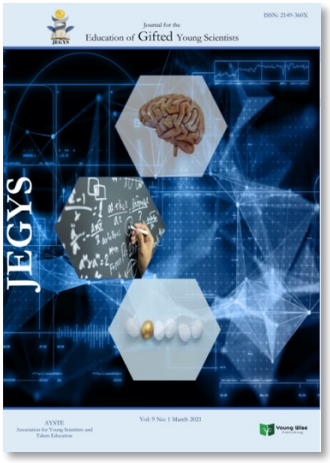

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From the Editor: Sustainability in education after the pandemic

Abstract
The main problem in training activities, especially in training focused on talent development, is to meet the talent need. This situation pushes us to take some important decisions. These decisions are the group that is the driving force that should not be lost in education. After the pandemic, the main focus should be on the sustainability of education. It is clear that more practice and research will be needed in areas such as young scientists training and talent training, new learning software, and individual mentoring.
Keywords: Talent education, ICGYSE congress, sustainability of education, new school concept

Dear Authors, Readers, Reviewers, Editors

Nowadays, the continuity of education is among the most important topics discussed and researched. The pandemic has caused disruption in education. Many families have been worried about this. The most important problem for students seems to be the problem of returning to education and adaptation. The administrations have made serious efforts to succeed in opening schools. However, the most basic question is: Is the concept of "school" an old school concept? Because it is difficult to realize the continuity of education only with the concept of "school" classical school. Therefore, both the concept of school and the concept of sustainability in education should be dealt with intensively in educational practices and research.

The fact that many articles published in JEGYS are indirectly related to sustainability in education is of interest to us as editors. As it is known, the idea that talent training can be realized through difficult processes was put forward by Anders Erickson. Self-regulation theorists such as Zimmerman (2002) also point out this. In my study on "self-regulation skills should be included in gifted education" (Tortop and Eker, 2014), I wanted to emphasize that self-regulation is an important element for sustainability in education. All of this actually pushes JEGYS researchers into a new field. We have determined this area thematically as the theme of our congress that will be held in December 2021. I hope that the studies in this field will increase.

We invite all our authors to the 2nd International Congress on Gifted Youth and Sustainability of the Education (ICGYSE).

Table 1.
September 2021 Issue Article Review Process Data

Articles ID	Reviewers number	Review Time (Average)	Contributions to Field	Countries
972540	2	119 days	Differentiation	Jordan
973469	2	85 days	Underachievment	Nigeria
884337	2	204 days	Creativity	Cyprus
832239	2	299 days	STEM	Indonesia
980968	2	80 days	Sustainability	South Africa
954829	2	80 days	Differentiation	Indonesia
946606	2	119 days	Talent education	Iran
Total	At least 2 reviewers	123 days	Gifted education	6 different contries

As seen in Table 1, articles from 6 different countries were published in the September 2021 issue, with at least 2 referee evaluations and review processes that lasted an average of 118 days, all of which would contribute to the topics in gifted education. Thanks to our referees in this review process. Academicians who want to work as referees can send an e-mail to editorjegys@gmail.com or click the reviewer request button on web site. The late referee turnaround times are 20 days and the response rate of the appointed referees is 75%.

In this issue, Tahani. M. Alebous from Jordan contributed her article "The extent to which teachers of science subjects use virtual scientific laboratories during corona virus pandemic: the reality & hope", Oluseyi Akintunde Dada and Anne Ndidi Meremikwu from South Africa contributed article " Identifying mathematics underachieving gifted in classroom ", Eda Yazgın from Cyprus contributes her article "Toys and creativity", Maya Fahrudatul Isdianti, Harun Nasrudin, And Erman Erman from Indonesia contributed their article "The effectiveness of STEM based inquiry learning packages to improving students' critical thinking skill", Kgaogelo Johanna Masemene and

Sikhulile Bonginkosi Msezane from South Africa contributed their article "Exploring environmental literacy components in promoting sustainable behaviour: a case study of rural primary schools", Poppy Yaniawati and collegues from Indonesia contributed their article " Using of sigil software in math education: e-module development and effects on self-regulated learning skills", Elaheh Rahiminia and collegues from Iran contributed their article " Investigating and analyzing the situation of the talented students of shahid Beheshti university of medical sciences: a qualitative study", Mohammad Zahri and collegues from Indonesia contributed their article " Analysis of students' mathematical communication ability in solving mathematical problems ".

We are working hard to ensure that JEGYS continues to be the most followed, cited, read and trend-setting academic journal in the field of education. I thank the referees, editors, authors and designers for their contributions.

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

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Research Article

The extent to which teachers of science subjects use virtual scientific laboratories during corona virus pandemic: the reality & hope

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Virtual laboratory
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Teachers of science subjects

Abstract

The study aimed to identify the reality of the use of virtual scientific laboratories when teaching science subjects at the basic stage in Amman's public schools which is the capital city of Jordan. The descriptive analytical approach was used.. The study population consisted of all teachers of sciences; mainly, the teachers who teaches the science subjects for the first grades in the public schools available in Amman. A questionnaire was prepared, and used to collect data and information consisting of (49) items (see the appendix) with two fields which are the reality of the use of virtual laboratories in teaching science subjects and obstacles and the teachers' viewpoints towards the use of the virtual laboratory and significance. The findings of the study showed the following: (1) there are many obstacles that prevent the use of virtual scientific laboratories technology in teaching science subjects at the basic stage including the lack of infrastructure and the lack of the financial capabilities necessary to secure the needs of the virtual laboratories, (2) teachers of science subjects are fear of taking responsibility while using the virtual laboratory when teaching science subjects, and (3) teachers of science subjects are not satisfied with using the virtual laboratory because it takes too much time while teaching sciences classes through educational platforms. Moreover, many students do not have enough internet. The study recommended the necessity to find an infrastructure for virtual laboratories and to train teachers to use them in order to reduce any educational loss in science subjects during crises particularly Corona Virus pandemic.

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Introduction

Knowledge and technological openness are the main features of the current time during Corona Virus pandemic which led to a change in lifestyles and the educational process. Since we live in the era of the Corona Virus pandemic, the traditional methods of dealing with knowledge are no longer sufficient to meet the students' technical and scientific needs. So it is necessary to overcome all obstacles that may reduce the benefits of e-learning in the light of the Corona Virus pandemic. As a result, the significance of technology in education has increased and the term "educational technology" that came up as a scientific formula for development. Therefore, most countries have adopted e-learning as a systematic way in designing, implementing and evaluating the entire educational process, using all available resources and capabilities to secure this sudden transformation imposed by the Corona Virus pandemic and developing teaching strategies that go with the nature of such a crisis. The recent trends in the field of scientific education and science teaching confirm the significance of the laboratory and the practical activities that are practiced there, assuming a prominent role because of their role in the success of the science programs and curricula. Technological techniques including E-learning, virtual labs, and dynamics-based virtual systems are all features of education in the future.

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The vocational education system in secondary schools including widely used information and communication technology (Peinazo, et al. 2019). The form of advanced technology applications has been integrated into various learning activities including virtual laboratories (Cambronero-López et al. 2017) that aim to develop learning performance and get students to learn independently (Ramírez-Romero et al. 2020).

Students' acquisition of laboratory work skills is an essential objective of teaching science subjects in all educational levels. So, laboratory activities are considered as a significant part of the curriculum itself. Wherever science is taught, the laboratory must be used (Zaytoun, 2005). Since the curricula is a tool to prepare students for scientific thinking and teaching methods are one of the components of the curricula, these methods are based on memorization; consequently, they must be reconsidered. That's because indoctrinate itself may lose students the ability to understand and to think very well (Crowell, 1989). Science subjects need to be taught and interpreted to use the laboratory that is considered as an integral part of practical education and science teaching. So recent trends in practical education takes a great care of the laboratories because they have to do with the scientific subjects and achieving the goals of teaching science in general (Zaytoun, 2004).

According to international experiences and models, virtualization in education and research is distinct particularly in the field of laboratories (Al-Hazmi, 2016). But what are the differences between real-life experiences and those formed in a computer screen?

Through virtual labs, students gain a tool by which they can experiment without any restrictions of space or time. Unlike school laboratories, they are all available all the year. They are also limited to a specific location and for a limited period of time. Using virtual environments makes students acquire better computer skills, which can be considered as skills for lifelong process learning. Using such technologies also make topics of science, technology, engineering and mathematics (STEM) to be combined together and provides great resources for more comprehensive workshops (Doukeli, 2012) and (Tselfes, 2002).

The subjects of science are one of the most ones related to technology. Such a relation is a cognitive one by integrating technology into the development of students' level. The education is supposed to be meaningful. In addition, many educators confirm the significance of integrating information and communication technology into science education.

Given the significance of scientific laboratories, new methods have emerged in conducting laboratory experiments using technology and providing the virtual world through the use of computers to facilitate students' understanding of scientific concepts and increase their motivation towards science. Martinez (2003) indicates that virtual laboratories have to do with computer applications in teaching science subjects to be used in addressing a huge number of problems facing sciences teaching in general. The use of the simulation system is essential in the possibility of simulating dangerous experiments that actually need complex devices.

The simulation system can overcome all these difficulties and can be even used in an ideal form that simulates reality without any troubles in the process of conducting it. The virtual laboratory system is one of the most important and valued systems since it is distinguished compared to other educational means by using simulation of global phenomena, as the student then can find the solutions to any problem he or she may find in any experiment. The experiments as well as the process of simulating them are one of the most important advantages of applying the computer system in science subjects. The virtual laboratory is determined in the absence of real laboratory, but it is sometimes possible to use a traditional laboratory with appropriate modifications in to enhance its effectiveness. Therefore, appropriate methods should be used to achieve the goals of science teaching and improve development outcomes. These methods include practical presentation, computer simulation method and the laboratory which is a successful method in achieving the goals of science subjects teaching. The use of virtual labs makes the cost of teaching reasonable. The use of virtual labs by students makes the content itself more effective through the usual methods in which the student feels free (Fenrich, 2003).

The use of virtual labs contributes to transform abstract concept into concrete ones and to provide multiple and varied experiences too. It also helps students in facilitating their understanding of scientific concepts since primary school students tend to have concrete skills in acquiring knowledge according to Piaget's classification. One of the features of the virtual lab that it allows weak students to do the experiment steps more than once. So the student can be able then to do experiments again outside the school. This allows teachers to get their students involved in scientific experiments in way that takes the individual differences among students into consideration. Thus, every student can be developed according to his or her individual abilities.

The virtual environment is an educational system established in a world created by the computer and combines the various tools and means of teaching and learning including the computer and the Internet, employing them in improving the inputs of the educational learning process, maximizing its outputs (or outputs) and helping to activate the interaction (at its various levels) among the parties to the process of scientific education. The quality of education has a great interest in most countries of the world to the extent that thinkers call this era by the era of quality as it is one of the main basics of the successful management model. Therefore, defining the basic and building quality occupy a great importance within the framework of its practical application in various institutions including schools and universities.

According to Zaytoun (2005), Nour (2011) and Martines et al. (2003), there are several features of virtual laboratories as follows: (a) compensating for the lack of real practical capabilities due to the lack of funding issues, (b) the possibility of conducting practical experiments that are difficult to be implemented in real laboratories as they are dangerous, (c) the possibility of visual presentation of phenomena that cannot be presented through real experiments because they contains tools that help support the experiment such as graphs, animations and analyses, (d) the synchronization between explanation of theoretical ideas and practical application, (e) the flexibility of use by students at any time, anywhere and at any speed, (f) the possibility of conducting the experiments several times according to the learner's ability so that he or she can comprehend without the presence of a human monitor and (g) virtual environments allow students to observe the process with more scientific details compared to the lecture method in a traditional classroom.

Moreover, the virtual laboratory environment enhances attention and motivation towards scientific topics by supporting cross-platform discussion among partners, peers, students and educators (Dobson, 2009).

Because of the laboratory work is important in linking the theoretical aspects with the practical process, and the teacher being the cornerstone of the educational process, he or she must be provided with laboratory skills that help him or her in translating theoretical content into practical activities that translate abstract concepts into concrete ones through the use of the virtual laboratory. This should be noted by taking into consideration the difficulties that prevent science subjects' teachers from using the virtual laboratory during the Corona Virus pandemic. Virtual learning environments enable learners to repeat events several times without hesitation, or zoom in and out, and monitor slowly the experimental processes achieves the desired teaching objectives (Tuyuz, 2010).

So, this study is to investigate the extent to which teachers of science subjects use virtual scientific laboratories during the Corona virus pandemic, the reality and the hope. It is a realistic study that contributes to highlight nature if virtual labs use and to develop the necessary solutions in order to achieve the desired goals of e-learning during dangerous crises such as the Corona Virus pandemic.

Statement of the Problem

Most public Jordanian schools suffer from low academic achievement by students in scientific subjects. This was confirmed by the study of students' achievement in science and mathematics in international tests (TIMSS). It is noted that Jordan's participation in this test from (1999) to (2015) that the results indicate that in (1999) it was (450), and in (2003) the score went up to (25) points to be (475). While in (2007) it reached (482), then it returned and went down in (2011) to reach (449) points. It also decreased very significantly in (2015) to reach (426) less than the result of (2011). The result returned and went up by an average of 26 points in science subjects in 2019 (National Center for Human Resources Development, 2019) . These fluctuations call for sounding the alarm and reconsidering all elements of the educational system. Despite the efforts by the Ministry of Education through the development of school laboratories, there are indications that teaching science subjects through laboratories did not receive an attention from those in charge of the educational process.

So the point of transition and transformation to using the electronic method of teaching is one of the goals of the teaching process and contemporary education programs. However, That requires a change in quality and development of the educational process in light of the requirements of the labor market. So the fundamental transformations must be done according the methods of teaching and learning in order to transform the educational model from closed learning environments represented by traditional methods. In the shadow of circumstances of Corona Virus pandemic in distance education, it is necessary to compensate for the educational loss in teaching science. This study is to identify reality of using virtual scientific laboratories in teaching science subjects during the Corona Virus pandemic.

The Research Significance

The current study is gaining importance through the importance of the topic addressed by a degree of science teachers to use virtual scientific laboratories during corona virus pandemic Researcher has sensed in the light of previous

experience in the Ministry of Education and qualitative variation in transmission impact of training programs to the classroom and through improving the professional competence of teachers and the development of strategies for their practices in a variety of teaching, especially in the science curriculum.

It is hoped that the results of this study will be useful to the following: (a) those in charge of the educational process in Jordan, as they will have an idea of the importance of activating the virtual laboratory and the follow-up of teachers to implement it and principles of public schools to provide it, (b) the universities and colleges that implement programs for preparing and training teachers of science subjects, and (c) the administrators in the Ministry of Education, as they will provide and activate virtual laboratories in the educational learning process. In addition, this study is very necessary as it may reveal the reality of employing virtual laboratories in teaching science subjects during Corona Virus pandemic and identify the most prominent problems facing the use of virtual laboratories in the education of science subjects.

Moreover, the current study is to reveal the teachers' opinions and the most prominent challenges they may face when employing the virtual laboratory. The study contributes to providing educators with the requirements of virtual laboratories necessary to teach science subjects as an interactive environment that may simulate real laboratories. It also contributes to informing officials of the Ministry of Education in Jordan about the features of the virtual laboratories and the significance of using such labs in teaching science subjects, to cover the shortage in research dealing with laboratory technology and to get the researchers of educational field pay attention to the importance of the virtual laboratory itself.

The Research Terms

The Virtual Lab: it is a place where simulated experiences, new ingredients are created and added. The student then is free to make decisions without any negative effects. Woodfield (2005) defined virtual laboratories as "an open environment in which the real science laboratory is simulated and the theoretical side is linked with the practical side and through which thinking skills are taught. The students then can have a complete freedom to make decisions without the negative consequences (p. 1728).

Corona Virus Pandemic: It is a global epidemic similar to severe influenza that is transmitted from one person to another by sneezing or coughing if the nose and mouth are not covered very well. Another way of transmission is touching something that the infected person has already touched. Some people do not realize they are infected with the virus until they find out symptoms of illness. That's why everyone must wear protective masks, use sterilization, wash always hands and keep social distancing (Meredith and Kalpart, 2021, p.1).

Science teachers: All teachers who teach science for the first grades of the Ministry of Education.

Literature Review

Electronic education is a type teaching that is based on electronic means during the educational process. Ismail (2003) defined the electronic education as a teaching system planned, prepared and implemented electronically via communication and information means available on the Internet. Most education was changed into electronic because of Corona Virus Pandemic. Alexiou et al. (2008) indicated that virtual labs are one of the new technologies and part of the electronic simulation. One can get good results from the real labs. Al Mouhameed (2003) in his research that aimed to identify the reality of virtual lab and its effect on teaching sciences for the eighth grade in Amman as well as the students' tendency towards, found out that the number of experiments that were conducted by males were less than those done by females. He also found that the number of labs in female schools is more than those labs available in male schools. The research sample consisted of (634) students, (40) principles and (15) labs.

Barakah (2014) found that the tendency of students towards using the virtual chemical lab when learning the practical part of Chemistry allowed them to identify the positives and negatives of the developed computerized software. Therefore, their tendency towards the virtual lab was positive. Al Baltan (2011) aimed to recognize the impact of using the virtual labs on teaching science subjects for secondary stage in Saudi Arabia. The researcher used the quantitative method. The research sample consisted of (325) teachers. The results showed that the virtual science laboratories are available in about (37%) of secondary schools in the Saudi Arabia. The reality of science subjects' teacher is very proficient in operating and dealing with computers. The level teachers' awareness of the nature of the virtual laboratory is fair. In the meanwhile, Al Haaj (2015) confirmed the effect of using virtual labs in the academic achievement in Chemistry for secondary stage students. Kamtoor and Ahmed (2015) aimed to identify the reality of using the scientific laboratory technology in teaching chemistry at the Sudanese secondary stage. The descriptive analytical approach was applied. A survey was used as a tool for collecting data and information. The study population consisted of all (80) secondary schools chemistry teachers in Bahri area. Secondary schools in Bahri area do not have

scientific laboratories. If any lab is available, it is incomplete in terms of tools and equipments. There is a complete agreement by teachers about the necessity of using scientific laboratories technology in teaching chemistry at the secondary stage. Anbesaw & Daba (2016) in their research paper aimed to clarify the factors that effect in the practical activities applied to teach science subjects in the public schools of Affar area that is located in southern Ethiopia. Both researchers followed the analytical method and the collected data and information via both a survey and interviews. The research sample consisted of (404) teachers. The results indicated that there is a lack of laboratory equipments and the lack of teachers who do not use practical activities in teaching science subjects. The local government and the school administration interest in the practical activity of students is weak because of those two previous obstacles. Kawu (2017) investigated the impact of the virtual labs on the levels of academic achievement and whether the students' gender who study chemistry has to do with their willingness in Nigeria. The research sample consisted of (60) students who was randomly selected from two secondary schools in Nigeria. The results showed that the grades of students who learn within homogeneous groups in virtual labs are better. Al Shehry (2016), Taha (2016) and Fernández-Avilés et al. (2016) all indicated that there is a positive impact of using virtual labs on the academic achievement of learners in science subjects.

The Research Objectives and Questions

This study aims to identify the reality of teaching sciences and using virtual labs by identifying the point of views given by the teachers of science subjects towards using the virtual labs. The research questions are as follows:

- What is the reality and obstacles of using the virtual labs in teaching science subjects?
- What is the reality of using the virtual labs in teaching science subjects in the basic grade according to the point of views given by the teachers of science subjects?

Method

Research Model

The methodology adopted in the current study is the descriptive approach, due to its suitability for the purposes of the study. The current research is to identify the reality of the use of virtual scientific laboratories in teaching science at the basic stage in Amman's public schools which is the capital city of Jordan.

Population & Sample of the Study

The sample of the study which consisted of (600) teachers (who teach science to the first three grades), in the directorate of education of Marka District in the first semester for the year 2020-2021, was selected randomly. The sample of the study represents 82% of the population of the study which is consisted of all the teachers of these grades in the District for the same year which are estimated by 731 teachers.

Data Collection Tools

Based on the literature review related to the variables of the current study, A questionnaire was developed by researcher , included two fields (1) the real situation of virtual labs use to teach sciences and the obstacles (2) Opinions of teachers towards virtual labs use and significance.

Table 1.
The Scale of Analyzing the Reality of the Use of Virtual Scientific Laboratories in Teaching Science Subjects at the Basic Stage in Amman's Public Schools

No	The Field	Item No
1	The reality and obstacles of using the virtual labs in teaching science subjects	1-35
2	The reality and obstacles of using the virtual labs in teaching science subjects	36-49
Total		49 Items

To achieve the goal of the study, and to answer the questions, the researcher built a questionnaire to measure the the reality of the use of virtual scientific laboratories when teaching science subjects at the basic stage in Amman's public schools. Where the process of building this resolution passed the following steps:

- A review of the literature relevant to teaching strategies virtual scientific laboratories.
- Drafting paragraphs of questionnaire according to the five-Likert scale, as has been the primary (55) paragraphs, was shortened to (49) paragraph after presentation to the arbitrators.
- In order to achieve internal honesty and inferential virtual paragraphs tool that has been built, presented the initial image on the arbitration committee to detect the degree of honesty to measure what they are intended

to measure, the number of arbitrators reached (14) of university professors and members of the curricula in disciplines (science teaching methods). In light of the views of the arbitrators was the opinion of the majority to amend some paragraphs, delete some paragraphs to become finalized (49) paragraph.

- To make sure of reliability of study tool (questionnaire), has been consistency coefficient was calculated in a manner the internal consistency of the sample individuals as Cronbach's alpha equation, by applying this tool once on the study sample, in order to discover the extent of their use of virtual scientific laboratories, where The total reliability coefficient of questionnaire is considered acceptable for the purposes of the study.

The Validity and Reliability of the Survey

For A questionnaire to be regarded as acceptable, it must possess two very basic characteristics, which are reliability and validity (Litwin & Arlene, 1995).

Reliability

To reduce the memory effects and make sure the respondents answer A questionnaire different from the way they answer in the first time, the researchers gave A questionnaire the same group of respondents at a later point in time and repeated the research. Then, the researcher compared the responses at the two times. The results showed the responses were different in both times.

Validity

To ensure the items of A questionnaire are clear and the correlate to the objectives of study and each item is correlated to the field, the survey itself was reviewed by (14) members including academic staff whose majors are in science and teaching methods as well as educational supervisors. They recommended to do some refinements including deleting (6) items and paraphrasing another ones. Moreover, the reliability coefficient of the test was calculated using the Cronbach – Alpha and Pearson correlation coefficients as follows table (2)

Table 2.

The Reliability of the Scale

N	The Field	Cronbach Alfa	Pearson Coefficients
1	The reality and obstacles of using the virtual labs in teaching science subjects	0.84	0.82
2	The reality and obstacles of using the virtual labs in teaching science subjects	0.79	0.82
Total		0.85	0.86

The scale was eventually transformed to an electronic form by Microsoft Forms to make sure it reaches easily to all teachers in accordance to the health conditions in the light of the continuing Corona Virus pandemic.

Results and Discussion

What is the reality and obstacles of using the virtual labs in teaching science subjects? To answer the first research questions, the total means of the both fields of the applied survey was calculated via SPSS as shown in the following table.

Table 3.

The Total Means, Standard Deviations and Degrees for the Fields of the Used Survey in the Current Study

Rank	No	Field	Mean	Sd	Degree
1	1	The reality and obstacles of using the virtual labs in teaching science subjects	3.66	0.43	Fair
2	2	Opinions of teachers towards virtual labs use and significance	3.58	0.51	Fair
Total			3.62	0.47	Fair

As mentioned above, it is clear that the reality and obstacles of using the virtual labs in teaching science subjects is fair as the total mean of the scale is about (3.66) just similar to Al Baltan (2011). According to such a result, it is noted from Table (4) that the reality of using the virtual laboratory in teaching science subjects and obstacles in general is fair with the mean (3.66) the standard deviation (0.43).

Table 4.

Means and Standard Deviations of the First Field (The Reality and Obstacles of Using the Virtual Labs in Teaching Science Subjects)

Rank	No	Item	Mean	Sd	Degree
1	3	Lack of the financial capabilities necessary to secure the needs of the virtual laboratory.	3.75	0.90	High
1	5	Fear of bearing responsibility for the failure of modern educational devices and materials during their high use in sciences teaching by teachers.	3.75	0.90	High
1	7	Disability to produce virtual lab software that helps me teaches sciences.	3.75	0.90	High
1	11	Weakness of students in using modern technologies (such as tablets, smart boards and virtual laboratories)	3.75	0.89	High
1	19	The school administration is interest in the knowledge and the achievement sides while ignores of the skill side.	3.75	0.89	High
1	23	The school prepares ways to support the teacher's application of the virtual laboratory in the sciences class	3.75	0.89	High
1	34	The virtual laboratory achieves objectives related to students' scientific thinking skills	3.75	0.89	High
8	1	The lack of internet within the laboratory hinders the use of the virtual laboratory in teaching sciences	3.74	0.89	High
8	9	Dissatisfaction with using the virtual laboratory during the Corona Virus pandemic limits my use of the virtual laboratory in teaching sciences	3.74	0.90	High
8	13	Using a virtual lab takes more time to teach sciences	3.74	0.90	High
8	17	Difficulty in carrying out experiments of the lessons	3.74	0.89	High
8	21	The school administration believes that the laboratory is just a waste of money	3.74	0.90	High
8	29	Virtual lab technology helps me simplify information for students.	3.74	0.89	High
14	15	The school management believes the laboratory as a waste of time	3.73	0.91	High
14	31	Computer simulation programs help the teacher to clarify some of the scientific concepts contained in sciences curricula more than traditional laboratories.	3.73	0.91	High
16	27	The teacher sets a clear study plan for applying the virtual laboratory in the sciences class.	3.72	0.92	High
17	8	Poor computer software skills.	3.65	1.05	High
18	2	The density of content in sciences curricula hinders the use of modern technologies.	3.64	1.05	High
18	4	Class time is not enough to use modern technologies in sciences teaching.	3.64	1.06	Fair
18	6	Unavailability of educational software that includes scientific experiments implemented in a virtual laboratory in Arabic on the Internet.	3.64	1.06	Fair
18	12	The school administration's lack of interest in addressing problems related to the use of modern technologies related to sciences teaching	3.64	1.06	Fair
18	30	The teacher uses the school's electronic library to enrich the sciences topics and curricula.	3.64	1.06	Fair
23	10	Low effectiveness of educational devices and technologies available in schools.	3.63	1.06	Fair
23	16	The way the book is organized and presented does not help in using the laboratory in teaching.	3.63	1.07	Fair
23	18	There is no practical activity guide accompanying the textbook	3.63	1.06	Fair
23	20	There are no lab classes according the school schedule	3.63	1.06	Fair
23	22	There is a necessity of having a specialist in virtual laboratories to help obtain the appropriate technology when needed	3.63	1.06	Fair

23	25	The teacher provides necessary support and guidance to students while using the laboratory in their sciences classes	3.63	1.01	Fair
23	32	Sciences educators understand the interrelationship between the application of virtual labs and the general education curriculum.	3.63	1.07	Fair
23	33	The application of virtual laboratories is based on integration with the study program that students are in.	3.63	1.06	Fair
31	14	The Ministry of Education has absolutely no interest in establishing virtual scientific laboratories.	3.62	1.07	Fair
31	24	Learning activities of applying the virtual laboratory in an active class are characterized by science	3.62	1.06	Fair
31	28	The teacher has mastered the design of teaching to integrate virtual laboratories into education	3.62	1.07	Fair
31	35	Teachers are interested in achieving goals specific to students' scientific thinking skills in the virtual lab classes.	3.62	1.06	Fair
35	26	Students interact positively while using the virtual lab in sciences lessons.	2.88	1.39	Fair
			3.66	**0.43**	Fair

The items ranged between fair and high as the means ranged between (3.75-2.88). The following items (3, 5, 7, 11, 19, 23, 34) came with a high degree. The items include lack of financial capabilities necessary to secure the needs of the virtual laboratory, fear of taking responsibility for the failure of modern educational devices and materials while they are used in teaching science subjects by teachers, weakness in producing virtual laboratory software that helps teachers teach science subjects, students' weakness in using modern technologies (such as devices, tablets, smart boards, and virtual laboratories), the school administration's interest in the knowledge and the achievement sides, and the neglect of the skills side, the school prepares ways to support the teacher's use of the virtual laboratory in the science class and the virtual laboratory achieves goals related to students' scientific thinking skills. Whereas the items (14,23,28,34,35) came with a fair degree. These items include the following: the Ministry of Education is not interested at all in establishing virtual scientific laboratories, the learning activities of using the virtual laboratory in a class are effective in science, the teacher is mastering the design of teaching to integrate virtual laboratories into education and the teachers are interested in achieving goals related to students' scientific thinking skills in the virtual laboratory classes. According to the given results, the reality of virtual lab use when teaching science subjects and obstacles is generally fair. The most basic obstacle is the lack of required physical capabilities to secure the needs of virtual lab. These results goes with the study of both Anbesaw & Daba (2016).

The major obstacles of virtual labs use include taking the responsibility of any damage in devices during teaching science subjects by teachers, who are not actually able to produce virtual labs software that may help them to teach sciences, weakness of using the modern technologies (Tabs, clever boards and virtual labs) by students, most administrations at schools are interested in cognitive and academic achievement rather than skills, some schools do not support the use of virtual lab during the science class. Moreover, most respondents do not agree that the virtual lab may achieve goals related to the skills of scientific thinking by students. This proves why there is a kind of fear of using the virtual lab when teaching sciences by teachers who suffer from lack of experience. Most teachers believe that using virtual labs is useless to teach science subjects during Corona Virus Pandemic. The results of the first question revealed that there is a gap between the reality and hope concerning with activating virtual labs. The items that go with such a result are fair including integrating the virtual labs during the science classes by teachers, achieving private goals related to scientific thinking skills by students during the virtual lab classes, teachers are not given a chance to use the modern technologies to stay up to date with the scientific developments and their need to train. All above mentioned can be happened with out a vital role led by the ministry of education to overcome the difficulties of using the virtual lab classes. One can conclude the obstacles whether they are technical or physical seem very usual. However, identifying such obstacles helps in overcoming them in the future. Corona Virus Pandemic highlighted the significance of technology in the educational process by finding a well-prepared infrastructure to help students to learn all subjects particularly the scientific subjects. This can be done by finding an alternative, which is the virtual lab instead of the traditional one that teachers can use during crises such as Corona Virus Pandemic.

What is the reality of using the virtual labs in teaching science subjects for the basic grades according to the views of teachers of science and significance?

To answer this question, means and standards deviation of the second field of survey have been calculated as shown in table (5).

Table 5.
Means and Standard Deviations of the Second Field (Opinions of Teachers towards Virtual Labs Use and Significance)

Rank	No	Item	Mean	Sd	Degree
1	39	Teachers show inquiry-based teaching strategies while implementing the virtual lab	3.74	0.90	High
1	45	I focus on the theoretical side because it achieves success for the student	3.74	0.90	High
3	41	Virtual lab software provides opportunities for students to practice higher mental skills.	3.73	0.90	High
3	47	Laboratory use is a waste of time	3.73	0.89	High
5	40	The learning environment during the implementation of the virtual laboratory provides opportunities for effective communication between students and students	3.64	0.89	High
6	36	The sciences teacher have got the necessary professional knowledge and skills to enable learners to employ virtual laboratories in sciences teaching	3.63	0.89	High
6	43	I have enough experience to conduct experiments	3.63	0.89	High
6	49	Experiments in the lab are just indispensable teaching aids.	3.63	0.89	High
9	38	Teachers link science skills and processes with students' practices in a virtual lab application	3.62	0.90	High
9	42	I am convinced of the usefulness of using laboratory technology in teaching sciences	3.62	0.90	High
9	44	I am afraid that the experiment will fail in front of the student	3.62	0.89	High
9	48	The use of the virtual laboratory is related to the efficiency of the teacher	3.62	0.90	High
13	46	The preparation of teachers in university colleges is weak in the field of laboratory experiments	3.61	0.89	High
14	37	Schools provide the appropriate digital equipment for the application of virtual laboratories in sciences teaching	2.57	0.91	High
Total			3.58	0.51	Fair

It is obvious from the results available in table (5) below that the teachers' view of the virtual laboratory and its significance in teaching sciences in general is fair with the mean (3.58) and a standard deviation (0.51). Some items came with a high rank while others came with a fair rank since the means ranged between (3.74 to 2.57). Item number (37) that states, "Schools provide the appropriate digital equipments for the application of virtual laboratories in science subjects teaching" came in the last rank with a mean (2.57) and a standard deviation (1.36). To put it simply, teacher's points of views towards the virtual lab use and significance is fair in general. Most teachers focus on the theoretical field since it helps student to succeed. That's because most teachers are convinced with the knowledge itself. They believe that the use of virtual labs during the Corona Virus Pandemic is just a waste of time. Moreover, they do not have the enough required skills to conduct experiments when using the virtual labs during the sciences classes.

Conclusion

The virtual laboratory is an educational software that achieves educational and scientific standards to get to the hoped goals of virtual learning during Corona Virus pandemic. The reasons for the lack of use of the virtual laboratory may be due to the failure to activate the laboratory in most public schools available in Amman. In addition, teachers do not have enough time to use the virtual laboratory due to the large number of topics in the sciences curricula. As it became clear from the results of the survey that the reality of not using virtual laboratories is fair due to several reasons, the most basic obstacle is the poor equipment and infrastructure of public schools. Moreover, most school administrations are convinced with the use of virtual laboratories in teaching science subjects. Teachers' lack of skills to use the laboratory while teaching science through platforms during Corona Virus pandemic is another basic obstacle. The responsible authorities should work to secure the needs of the virtual laboratory in terms of software, equipment, tools, computers and display screens to overcome the obstacles facing the use of virtual laboratories. Activating the virtual laboratory requires providing the appropriate educational environments for all various aspects.

Achieving positive results in activating virtual laboratories requires technical skills that can be acquired by supervisors and teachers during their last classes in the university.

Recommendations

- It is highly recommended to Ministry of Education to activate using of virtual laboratory technology that has proven its effectiveness in achieving the objectives of teaching science subjects in general.
- Provide tools and devices for virtual scientific laboratories in a way that helps activate the use of scientific laboratories during the Corona pandemic.
- Hold courses to train teachers on how to activate the use of virtual scientific laboratories technology, establish virtual laboratories affiliated to the Ministry of Education and circulate them to all schools in Jordan.
- Train the supervisors of the Ministry of Education on the virtual laboratory and science teachers; apply virtual lab technology in science teaching because of its positives
- Set virtual lab sites on the learning platforms of the Ministry of Education, allow teachers and students to benefit from this technology, work on overcoming the difficulties facing the activation of the virtual laboratory through, and allocate an enough budget to secure the schools' needs of virtual laboratories and the inclusion of training programs for teachers to use modern technologies.
- Applying virtual laboratory technology in teaching science experiments in the basic stage to face crises such as the Corona pandemic.
- Hold a workshop to school managers about the importance of using the virtual laboratory to encourage their teachers to use the virtual laboratories.
- Conducting other studies to identify the effect of using virtual lab technology on science teaching and student achievement.

Limitations of Study

Human borders: it is limited to science teachers of basic stage belonging to the Directorate of Education in Amman /Marka. Spatial boundaries: It was conducted in a school belonging to the Directorate of Education in Amman/ Marka. Time limits:. First academic semester 2020/2021. Items of the instrument used in the study

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Appendix 1.
The Questionnaire

Name: (optional) ……..
Gender: Male ( ) Female ( ) **The Subject:** Sciences ( ) Others ( )
Qualification: Bachelor ( ) Higher than bachelor ( )
Years of Experience: Less than 5 Years ( ) 5 to 10 Years More than 10 Years ( )

No	Item	Strongly Agree	Agree	Neutral	Disagree	Strictly Disagree
1	Lack of the financial capabilities necessary to secure the needs of the virtual laboratory.					
2	Fear of bearing responsibility for the failure of modern educational devices and materials during their high use in sciences teaching by teachers.					
3	Disability to produce virtual lab software that helps me teaches sciences.					
4	Weakness of students in using modern technologies (such as tablets, smart boards and virtual laboratories)					
5	The school administration is interest in the knowledge and the achievement sides while ignores of the skill side.					
6	The school prepares ways to support the teacher's application of the virtual laboratory in the sciences class					
7	The virtual laboratory achieves objectives related to students' scientific thinking skills					
8	The lack of internet within the laboratory hinders the use of the virtual laboratory in teaching sciences					
9	Dissatisfaction with using the virtual laboratory during the Corona Virus pandemic limits my use of the virtual laboratory in teaching sciences					
10	Using a virtual lab takes more time to teach sciences					
11	Difficulty in carrying out experiments of the lessons					
12	The school administration believes that the laboratory is just a waste of money					
13	Virtual lab technology helps me simplify information for students.					
14	The school management believes the laboratory as a waste of time					
15	Computer simulation programs help the teacher to clarify some of the scientific concepts contained in sciences curricula more than traditional laboratories.					
16	The teacher sets a clear study plan for applying the virtual laboratory in the sciences class.					
17	Poor computer software skills.					
18	The density of content in sciences curricula hinders the use of modern technologies.					
19	Class time is not enough to use modern technologies in sciences teaching.					
20	Unavailability of educational software that includes scientific experiments implemented in a virtual laboratory in Arabic on the Internet.					
21	The school administration's lack of interest in addressing problems related to the use of modern technologies related to sciences teaching					
22	The teacher uses the school's electronic library to enrich the sciences topics and curricula.					

23	Low effectiveness of educational devices and technologies available in schools.					
24	The way the book is organized and presented does not help in using the laboratory in teaching.					
25	There is no practical activity guide accompanying the textbook					
26	There are no lab classes according the school schedule					
27	There is a necessity of having a specialist in virtual laboratories to help obtain the appropriate technology when needed					
28	The teacher provides necessary support and guidance to students while using the laboratory in their sciences classes					
29	Sciences educators understand the interrelationship between the application of virtual labs and the general education curriculum.					
30	The application of virtual laboratories is based on integration with the study program that students are in.					
31	The Ministry of Education has absolutely no interest in establishing virtual scientific laboratories.					
32	Learning activities of applying the virtual laboratory in an active class are characterized by science					
33	The teacher has mastered the design of teaching to integrate virtual laboratories into education					
34	Teachers are interested in achieving goals specific to students' scientific thinking skills in the virtual lab classes.					
35	Students interact positively while using the virtual lab in sciences lessons.					
36	Teachers show inquiry-based teaching strategies while implementing the virtual lab					
37	I focus on the theoretical side because it achieves success for the student					
38	Virtual lab software provides opportunities for students to practice higher mental skills.					
39	Laboratory use is a waste of time					
40	The learning environment during the implementation of the virtual laboratory provides opportunities for effective communication between students and students					
41	The sciences teacher have got the necessary professional knowledge and skills to enable learners to employ virtual laboratories in sciences teaching					
42	I have enough experience to conduct experiments					
43	Experiments in the lab are just indispensable teaching aids.					
44	Teachers link science skills and processes with students' practices in a virtual lab application					
45	I am convinced of the usefulness of using laboratory technology in teaching sciences					
46	I am afraid that the experiment will fail in front of the student					
47	The use of the virtual laboratory is related to the efficiency of the teacher					
48	The preparation of teachers in university colleges is weak in the field of laboratory experiments					
49	Schools provide the appropriate digital equipment for the application of virtual laboratories in sciences teaching					

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Research Article

Identifying mathematics underachieving gifted in classroom

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Abstract

Underachievement in Mathematics among gifted children has been a serious concern of most parents, teachers, school administrators and government. The first step towards appropriate intervention in an inclusive classroom is the identification of the vulnerable children from the population. The identification of gifted child's underachievement in Mathematics has generated a debate which is why a position is needed to elaborate on this issue in the context of classroom management. This paper thus viewed the cause of mathematics underachievement among gifted children from two perspectives: environmental and personality factors. The environmental factors are from two areas namely; school and peer influences. A school that does not support ability or anti-Mathematics ability peer influence contributes greatly to mathematics underachievement. Similarly, personality factors such as Mathematics self-concept and achievement motivation are considered critical to mathematics achievement of gifted children. This paper therefore, revealed characteristics to observe, screen, test as well as procedure to be taken in the appropriate identification of the children who have high potential but underachieve in mathematics. It was therefore recommended that schools should adopt the procedure elucidated in this paper so as to plan for early intervention.

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Introduction

Underachievement is an unimaginable problem of large number of gifted learners (Bélanger, & Gagné, 2006)) that is frustrating to learners, teachers and parents. There can be evidence of high academic potential, but with low actual performance (Shaw & McCuen, 1960). The problem of mathematics underachievement is growing at a fast rate even among gifted children. Seeley in Ufford (2008) estimated that 15% to 40% of high ability children experience significant Mathematics underachievement while Van Tassel-Baska (2000) reported about 63% who underachieve among academically gifted children.

It is possible to understand and discover underachievement through the behaviour of child over time. Davis and Rimm (2004) pointed out that, poor teacher motivation in Mathematics; negative child's attitudes toward Mathematics teachers, or use of poor learning style that does not challenge child's knowledge level sufficiently, may block current test scores from detecting Mathematics underachievement in a gifted child. The implication is that, there is need to check back to see if a child's old tests results show higher scores, indicating early potential, and if gone now, is an evidence of Mathematics underachievement in that child.

Using less comprehensive criteria would create an unmanageable number of Mathematics underachievers and would likely include most of the gifted population who are rarely challenged to use their abilities. As early as 1980, Whitmore reported that, if the scores of children on Mathematics aptitude tests were compared with their level of performance in Mathematics as many as 70% would probably be underachieving. Gifted child complicate identification by being aggressive and act out their frustration sometime in seeking attention negatively, or they may

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withdraw and quietly allow their potential to waste away. Generally, every one of us is underachieving because we continue to use only a small percentage of our potentials; this is surely more so gifted children than for typical children.

Procedures for Identifying Gifted Child in Classroom

Certain procedures must be followed in identifying gifted children. Considering some initial recommendations and answering the following questions will help in developing the recommendations:

- What resources (material and personnel) are available in school or community for identification exercises for advanced learners?
- Are the resources adequate to provide for Mathematics ability to be identified?
- If not, which areas should be included in programmes?

Intellectual ability should always be included; areas of general and specific academic abilities should also be included to any meaningful school programme for the gifted children (Gynnild, Tyssedal & Lorentzen, 2005). Creative ability should be included as ability in these areas support the cognitive, intellectual functions and are not totally sub component in which the learner could choose to participate. Appropriate identification process of gifted children has been viewed to involve three steps that should be consecutive. The steps are searching, screening and identifying (Clark, 2008).

The first procedural step in the search procedures is nomination. Nomination should be obtained from teachers, principals, psychologist, parents, peers and self for gifted attributes (Coleman, Gallagher and Foster, 1994). Peers have been extremely helpful in identifying potentially able children for screening. Children' information that has be found to indicate Mathematics ability includes evidence of high potential, levels of abstract reasoning ability, advanced vocabulary, advanced academic performance and honour or recognition of outstanding performance or accomplishments (Smith et al. 1990). The nomination of the teachers is of high significant to the identification search. The place of self-nomination should not be over-emphasized also. All these will constitute a poll of likely children who are gifted in Mathematics or exhibit high ability in mathematics.

Most literature posited that teachers are most familiar with the child and best qualified to make such an identification. One teacher may however work with 35 to 45 children during the day in most secondary schools. The number can be four folds greater in some schools. This is a serious impediment to the accurate nomination by the teachers because, the teacher does not have the closeness to know the children well. The attitude of the teacher is another critical issue, whatever the teacher values will be the criterion for selection. Often, the quiet, well behaved and well-dressed youngster who gets good grades is a prime target on teacher's selection. Unfortunately, teachers in High School in the study conducted by Pegnato and Birch (1959) were found to nominate the children whose behaviours were related to their own behaviours. This problem will exist even to a greater extent in primary schools where behaviours are expressed without caution. So, lack of teacher's knowledge is a serious impediment to accurate nomination

Teachers must be both effective (correctly nominating a high percentage of children who have high ability), and efficient (having a high percentage of those they nominated identified to really fit gifted programme. A way to improve teacher's nomination is to conduct training programme to increase effectiveness without loss in efficient (Clark, 2008). The teachers' concept about gifted should also be made positive, because Siegle and Powell (2004) reported that some teachers have of the opinion that when a child is sent to a special programme, the teacher of such child is incapable to teach.

Teachers must be part of the selection, the limitation notwithstanding. Clark (2008) outlined reasons why teacher must be involved in the screening for gifted children to include;

- They have data to provide, that are not available to other members of the identification team
- They need to become aware of, understand, and support the programme for gifted learners if it is to succeed.
- Without involvement in the selection process teachers will be less likely to cooperate in contributing to any further planning or implementation.

It should be realized that, the significance of identification is for appropriate placement and provision for the development of a children' potential. It is very important to identify children who can be served by a particular programme that the society is willing to offer. A child who is mathematically able will be frustrated by a programme that is limited to the study of advanced books only. Hence, opportunity provided to the children must match the needs that were identified.

Smith et al. (1990) suggested a multi-dimesional model that will encopass the following:

- Proof of exceptional performace when compare with grade-level mates;
- Proof of the children's array of potentials and needs;
- Process that measures potential as well as achievement
- Methods that seek out children from varying linguistics, economics and cultural background from special population
- Implication for educational planning

In summary, effective screening should be multidimensional and pluralistic. The following section gives the description of various criteria that should inform appropriate identification

Nomination forms

Designed for use by the teacher, principal, school counsellor, psychologist, parents, peers, the child in question, or any others who work with the children;

Teacher Comment of child performance

This includes intellectual, physical, social and emotional functioning; learning style; and motivation;

Family history and child background

This set of information should be provided by parents, and should–include historical and developmental data on the child, the health and medical records of the child and the family, the educational and occupational backgrounds of the parents, a description of the family unit, anecdotes of the child in the home that indicate unusual capacity and early development, family activities and interest, and children' extra curriculum activities and interest;

- **Peer identification;**
- **A child personality inventory-**of self-concept, values, interests, and attitudes toward school and out-of-school activities;
- **The child's work and achievements;** and
- **Multidimensional testing-**both traditional and non-traditional including aptitude and achievement.

For best result, none of these data should be used alone; instead, all should be used in combination as part of the data bank for the identification process.

Identification Indices of Gifted Child with Mathematics Underachievement in Classroom

It is necessary at this point to highlight some of the possible characteristics that are observable in gifted child who underachieve in Mathematics. Teachers in the inclusive classroom should observe a number of traits in the identified gifted child. Potential children including those with Mathematics potential but who underachieve are identified with one or more of the following characteristics (Davis and Rimm, 1994; Frey, 1989; Janos and Robinson, 1985; Karnes and Pearce, 1981; Laffon, Jenkins-Friedman and Tollefson, 1989; Redding, 1990; Rimm, 1986; Whitmore, 1980; Dada & Fagbemi, 2018).

- Have low Mathematics self-concept: negative evaluations of self; feelings of inferiority demonstrated by distrust, indifference, lack of concern, and or hostility toward those doing well in Mathematics.
- Are socially more immature than achievers; lack self-disciple, procrastinate, refuse Mathematics tasks deemed unpleasant; highly distractible; highly impulsive; unwilling to face realities and consequences.
- Have feelings of rejection; believe no one likes them; feel that parents are dissatisfied with their Mathematics achievement.
- Have feeling of helplessness in Mathematics; may externalize conflict and problems, avoid Mathematics challenges.
- Do not see the relationship between their efforts and subsequent Mathematics achievement outcomes; negate personal responsibility for Mathematics failure.
- Are irresponsible, rebellious, feelings of being victimized; have poor personal adjustment to calculation.
- Have poor interest in Mathematics
- Are unpopular with peers. Hold lower status in class, have few friends.
- Are hostile toward adult authority figures, distrust adult in general.
- Are resistant to influence from Mathematics teachers or parents.
- Have lower aspirations for future; lack future plans or career goals; resist Mathematics goals that have been set for them

- May withdraw in Mathematics class and be less persistent, less assertive.
- Lack study skills and academic curiosity; have weak motivation for Mathematics tasks.
- Dislike school and teachers; choose companions who also have negative attitudes toward Mathematics.
- Often leave Mathematics work incomplete; frequently nap during Mathematics time; often test Mathematics phobic.
- Perform at higher levels on tests that require synthesizing than on or convergent problem-solving tasks that require precise and analytic Mathematics processing

Behaviuor of mathematics gifted underachievers comes in diverse patterns, although no one child would be expected to have all or even more than a few of the traits outlined. The most prevaleent predictors of mathematics underachievement poor self-efficacy, negative attitudes toward mathematics and or teachers, low motivation regarding Mathematics achievement, classroom Mathematics exercises and assignments, and Mathematics goal evaluation (McCoach & Seigle, 2003). Other attributes often found are poor self-regulation, including the use of cognitive and metacognitive strategies and self-management are areas often minimally developed in underachievers.

Underachieving children are reported to attribute success to innate ability and do not believe that achievement is related to effort. Anger, frustration, hostility, and rebelliousness may be present. Poor study habits, lack of persistence, dependency and impulsiveness will probably be part of the profile. The key features found to distinguish achievers from underachievers are the goals set for themselves and the effort they make to achieve those goals (Clark, 2008). In addition to the larger group of consistent underachievers, there is another group of children with different characteristic who underachieve with some regularity and are at risk academically. Delisel (2004) calls them "Selective Consumers" or "Non producers" and Coil (2004) calls them "Hidden Underachievers". These are children who get fairly high grades most of the time, but do very little, just enough to get by. They see themselves as academically competent and expect a good grade, but are reticent to put forth much effort, especially when "busywork" is assigned. The level of performance or evaluation that is the outcome of their work does not bother them. They look for the easiest problems and by avoiding challenges; they do not build their potential or find the excitement of intellectual pursuits.

The Role of Intelligence and Aptitude in Giftedness

Intellectual ability is a measure of knowledge or skill a learners has developed through training or self-discovery McBee, (2010). These are the potentials intelligence test sought to measure but does not explain the whole attribute of a gifted child (Dada & Ogundare, 2017). Aptitudes are those inclinations, tendencies, talents, and potentials that are part of the child's character or uniqueness and often show themselves in intense interests during learning. The work of Feuerstein (1978) was focused on assessment of learning potential and has produced instruments aimed at finding aptitude rather than skills or abilities that have been developed. So, assessment of a gifted child is not complete without the IQ and aptitude scores in addition to various other formal and informal assessment.

The measurement of intellectual abilities has often depended on the results of IQ tests, although the limited tasks on such tests narrowly reflect the possibilities for the growth of human intellectual abilities. Researchers in the 1970s and 1980s (Hunt & Kirk, 1971; Sternberg, 1985; Rigby, 2005) perceived a need for a different way of assessing intellectual development. They felt that our reliance on tests comparing people against a standard or norm (decided by taking the average of what many people can do and assigning a score to it) prevented us from developing more useful measures. They believed that we must discover which activities and skills include both cognitive and motivational ability and in what sequence these activities or skills usually appear. From that information, criterion measures could be established that would indicate not only what the present level of a children' achievement is, but also which experiences would best create the challenge for further achievement growth.

Sternberg (1981) believes that the weakness of these tests is not the kind of items they contain, but rather their lack of viable theory base. For this reason, Sternberg and others have focused their work on developing a theoretical base for intelligence in an information-processing framework. These researchers believe that such a theory base will prove more useful than has the factor analytic, psychometric base previously used for measuring, understanding, and nurturing intelligence. It can be asserted that the conventional standardized tests currently in use measure analytic abilities fairly well, but fail to measure synthetic abilities-those allowing for invention, creativity and personal contribution to achievement in academic areas like Mathematics. It has been reported that, no single test can measure the entire universe of intellectual abilities, the most commonly used individually administered tests of linear, rational cognitive ability are the Stanford-Binet Intelligence Scale and the Wechsler Intelligence Scale for Children (WISC).

The choice of any IQ test should consider the adaptation to cultural and language factors that may undermine the giftedness in a child.

Aptitude in Identification of Mathematics Underachievement in Gifted Child

Aptitude tests are used to measure specific abilities and more specifically, can predict how well children will do on particular school subject like mathematics or career related disciplines. Generally, the best predictor of optimum academic achievement in a particular subject is the potential ability. However, for a present academic or subject matter mastery like in mathematics, achievement tests are used. Cautions should be taken in the use of achievement tests to identify ability or academic placement particularly for the gifted. Too often such tests do not reflect the extent of the knowledge or skill the children have developed. As with some of the intelligence tests, children may reach the ceiling of the test without reaching the extent of their mathematics achievement (Dada & Akpan, 2019).

The mathematics underachieving gifted child is however identified as one who has shown high performance on standardized Mathematics Aptitude and Intelligence Tests, but who, nevertheless show poor Mathematics performance in school as evidenced in grades, teacher reports and scores less than 70% in Mathematics Achievement Test. Once a child scores at the 85th percentile or higher in either aptitude or intelligence score in a class, any testing in mathematics achievement is expected to produce equivalently the same score, if significant growth has occurred (Dada & Dada, 2014). This could be easily handled the problem of identifying mathematics underachievement in the classroom. Classroom teachers or school psychometric testers therefore need to modify the testing procedure to allow more accurate result in using aptitude, intelligent and mathematics achievement scores in the identification of gifted underachievers in mathematics.

Conclusion

Mathematics underachievement among gifted children is a reality that can be termed brain waste or underdevelopment of potentials. It has generated great concern to parents and teachers consequently demands urgent attention and intervention. The paper conceived that identification of Mathematics underachieving child with high potential is overlooked by majority of teachers in the regular classroom. The negligence was as a result of lack of skill and procedure for identification apart from ignorance of the existence of the problem among the children hence, there is need for the knowledge of the identification as the first step towards reversing the problem of mathematics underachievement among gifted.

Recommendations

- School guarding counsellors should collaborate with teachers to conduct school-wide assessment to discover potential students who underachieve in mathematics and update the record yearly.
- Schools should explore the feasibility of adopting the procedure and techniques appraised in this paper in identifying the mathematics underachieving gifted child.
- Teachers should be trained and retrained on evolving characteristics and behaviour of gifted children for accurate recognition of such child in classroom.

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Research Article

Toys and creativity[1]

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Abstract

The historical, anthropological and developmental research shows that play has been universal in all cultures, and children's play is supported by toys and play materials produced by adults. Children are prepared to learn what they need to learn with passion and pleasure, and quality toys, when used appropriately provide children with a wealth of opportunities for creativity, social interaction with adults, and effective participation. Throughout history, children's play has undergone various changes due to cultural, political and socioeconomic factors without losing its virtues and importance. Therefore, research based evidence on specific types of play and toys which support learning and development most effectively, needs to be multiplied. This text emphasizes the aspects of toys related to creativity. Relevant to our day, the threats to the place of play and toy in the life of the increasingly lonely child are also discussed.

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"Having the sense of creative activity is a great joy and the greatest proof of being alive."
Matthew Arnold

Toys as Objects of Creativity in History

The most brilliant feature of childhood is the opportunity for children to dream up entire worlds of their imagination, for them and for us. To that end, everybody likes to play, and everybody likes toys. Children create their own, personal legends using toys. Toys give children the opportunity to imagine and create. How does something truly novel form? The answer ultimately lies in play. To love, work and play are the three main motives that drive humans to think and act throughout their lives. Friedrich Froebel, founder of the formal concept of kindergartens, conceptualized twenty open ended handicraft projects that would allow children to create their own realities using a variety of plastic materials. In time, play and play objects/toys have evolved in accordance with the conditions of the times. Changes in societies and lifestyles have influenced the extrinsic conditions and partially the content of play. For example, in retrospective investigations into remembrance of play, playing with unique toys made from natural materials is more prominent in memories of play as the participant age increases (Sandberg and Vuorinen, 2008). Play and childhood memories researchers also found that participants remembered social play with friends or siblings more strongly than individual play (Sandberg and Pramling Samuelson, 2003, 2005; Wickerius and Sandberg, 2006).

Young children are extremely sense focused. Educators such as Montessori and Steiner strongly emphasize 'senses' in the education of children. Toys made out of natural materials, such as wood, clay, plants, etc. radiate a sense of warmth and comfort that is often lacking in synthetic materials. It is important to note that touch is a very strong

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sensory experience. Hence, the relaxing and destressing effects of natural materials for especially young children should always be kept in mind in the manufacturing or selecting of toys (Elkind, 2007).

Photo 1.
Indian Wooden Toys (Photo credit: Author)

Photo 2.
Wooden Horse from Munich (Photo credit: Author)

Why are toys important? What is the meaning of toys for societies? Why do toy museums exist prominently? Anthony Burton states as such: "The greatest attraction of toys is that they show us out world miniaturized." (Onur, 2010). Toys help children realize their own strengths and adapt to the adult world. Toys have developed subject to

the socio-economic conditions of societies and can be thought as snapshots of cultural history; in other words, toys are witnesses to the age they were made in. It is often the case that toys are made by adults for the entertainment of children, and hence reflect the adult life of the age they were made in. This allows toys to reflect the past in many angles and be valuable historical artifacts passed on from generation to generation, besides their function of entertaining or educating children. Research indicates that the development of toys reaches its peak roughly between 1700-1850; this coincides with an increase in the awareness of the importance of the education of children. In 20th century, toys reflected largely the changing technology not only in the design but also the manufacturing and material content of toys.

Photo 3.
Portuguese Doll (Photo credit: Author)

Photo 4.
Puppets from Munich, Germany, (Photo credit: Author)

It is stated that a majority of toy designs of today are rooted in the past. However, despite their connection to the past and unchanged functions, toys are changing. That is due to the change in children and the understanding of childhood. Toys are increasingly mirroring individualism, ownership and consumerism, whereas toys of traditional societies would hold subsistence, productivity and creativity in priority. In evaluating toys in the context of their times, the criticism of toys is a criticism of their times. However, toys are nonetheless universal; an examination of toys, play objects and toy museums reveals this notion.

Play is a dynamic and vital activity of human life that has persisted throughout history. Archaeological, historical, anthropological and sociological research on children has shown play has been everywhere and child's play was supported greatly. Oftentimes, play was and still is simplified in thought. However, as scientific literature shows, the natural playfulness of children has vital function in physical and mental development. It is then imperative that parents and teachers be aware of this and provide space and time for free play.

For both children and adults, play has been a common activity throughout the ages. In all societies and cultures, the play was supported by adults as well as toys and play materials. Archaeological findings show the existence of play since prehistoric times. Excavations in ancient China, Peru, Mesopotamia and Egypt have revealed miniature models made of pottery and metal, most probably used as toys for children and drawings showing depictions of people playing and play objects such as tops, dolls and rattles (Frost, 2010).

The origin of toys is prehistoric. The oldest children's toys found to date are thought to be 4,500 years old("Magical new 4,500 year old find," 2017). Dolls representing infants, animals, and soldiers, as well as representations of tools used by adults are readily found at archaeological sites. The earliest-known written historical mention of a toy comes from about 500 BC in a reek reference to yo-yos made from wood, metal, or painted terra-cotta. It is believed, however, that the earliest form of yo-yo originated in China as early as 1000 BC (Winner, 2017).

Cultural attitudes, transmitted to the children predominantly through the behaviour of their parents, affect how much play is encouraged and supported, to what age individuals are regarded as children who are expected to play, and the extent to which adults play with children.

Attitudes to gender in different cultures also impact upon children's play. In cultures in which there is rigid separation between adult male and female roles boys and girls are prepared for these roles through the toys and games provided, with boys play often being more competitive, physical and dangerous and girls play being more focused on their future domestic role, involving play with household objects, such as pots and pans, tea-sets, and dolls. Historically, children in all cultures consequently the children play more with other children unsupervised by adults, in spaces not especially structured for play, and with naturally available objects rather than manufactured toys Within this general position it is well established that materials and toys support play most effectively when they are open and flexible and provide children with a wealth of opportunities for creativity, for social interaction with their peers and adults, for authorship and for deep engagement (Gauntlett et al. 2010). However, beyond this there is currently a paucity of research as to the qualities of specific types of materials and toys, related to the different types of play, which most effectively support playfulness, creativity, learning and development.

Recent studies by Howard and colleagues, for example, have shown that a key factor in children engaging with and learning most effectively from activities with toys and other materials, is that they perceive the situation to be playful (Howard, 2002; McInnes, K., Howard, J., Miles, G., and Crowley, K., 2009, 2011).

Photo 5.
Korean Toys (Photo credit: Author)

Deprived of Play Means Deprived of Creativity

An extensive anthropologic study in the USA reported a direct correlation between the decrease in free play time within the last half century and the increase in mental health issues in children. Studies such as this focused on the relationship between opportunities of free play and mental health, as well as environmental and social factors supporting or hindering play, the effects on mental health of deprivation of play, and the therapeutic effects of play. Studies that investigated factors that support play and mental health have focused on secure connection and children's knowledge on stress. It was determined that in early childhood, play exerts influence on secure connection, healthy mental development, emotional control, empathy, managing emotional relationships (i.e. friendships with other children), determination and playfulness. Playfulness has major importance on healthy social and emotional development in terms of forming and maintaining friendships. Secure emotional connection, on the other hand, is fundamental in coping with stress and anxiety. In children who are deprived of emotional support and exposed to toxic stress such as poverty, insufficient parental attention, in-family stress, etc. such stress is characterized with mental health issues and lack of play. In contrast, children who are emotionally supported and provided a rich, stimulative environment experience 'positive stress' which is associated with playfulness and emotional flexibility.

It has been reported that in the UK there has been a 36% increase in children's mental health service referrals between the years of 2013-2016. According to the 2016 NHS Annual Report, 695.000 children between the ages of 5-16 (approximately 10% of the age group) were clinically diagnosed with mental health issues. The most reported issues consisted of anxiety, depression, behavioural disorders and tendencies to self-harm and suicide. These alarming results show the importance of approaches to improving and maintaining children's mental health. One important topic within this context is play and activities that the child will initiate and maintain on their own volition and spend in. It has been observed that properties of free time have changed extensively in the last few generations. According to a UK National Trust report, the indoors space used by children to spend unsupervised time in their homes has been reduced by as much as 90% from the 70s. On the other hand, rising stress levels in children due to changes in educational policies and 'exam pressure' has also been reported (Whitebread et al. 2012).

Results of animal research are greatly referred to while researching the effects of play deprivation on child mental health. According to neuroscientific studies on animals, deprivation of play negatively affects the development of the prefrontal lobe. The child's capacity of emotional and behavioural self-control, ability to focus and attention span is related to the maturation of anterior lingula, orbitofrontal cortex and DLPF cortex. Due to these considerations, it

may well be useless, even harmful to start structured, curricular education before the age of 6. In a review that investigates the effects of play therapy in children with autism, play has been found to facilitate development of friendly relationships, progress in coping behaviour, reduction in lonely play, and competence in social relationships (Lindsay et al. 2017).

There are different types of play that are categorized based on their various attributes. 'Risky' or 'adventurous' play supports the development of independence and contributes to positive stress. Studies show that this type of free play supports physical and mental development in children. During adventurous play in open space, children challenge themselves and test their limits, gain awareness and learn emotional self-control.

It is clear that play is ubiquitous among humans, both as children and as adults, and that children's play is consistently sponsored by adults in all societies and cultures, most clearly in the manufacture of play equipment and toys.

A significant body of research asserts the importance of play in contributing to children's physical, cognitive and social development (Else, 2009; Pellegrini & Jones, 1994; Singer, 1994; Trawick-Smith et al. 2011). The 'right toys', that are indispensable to children's play, support early childhood development significantly and reduce the risk of developmental delays. Children are driven largely by play. Therefore, children's experiences with toys and social environment through play constitute the contextual matrix that directly influences behavioural development and learning. Children with richer play experiences grow to be more attentive, responsible and resilient individuals (Bateson and Martin, 2013). Thus, toys in preschools should be carefully selected in accordance with children's play needs and areas of interest, in a way that encourages meaningful and quality play.

Toys may serve as a context and influence the nature and content of play (Pellegrini & Jones, 1994). For instance, a child is more likely to play chef than to play doctor if s/he is given a pretend-play cooking set. More realistic toys that represent common objects in the home are often needed by very young children in order to facilitate imaginative thought and engage in make-believe play, even though such dependence tends to decrease as their language and thinking develop (Singer, 1994).

Children's various styles of play also influence how toys are used as resources. Children seem to exhibit most sophisticated forms of play when they interact with toys they prefer and with children and adults they encounter regularly. In this sense, toys do not just have a unidirectional effect on young children; rather, toys and the social environment a child experiences form the aforementioned "contextual matrix (Pellegrini & Jones, 1994). Children develop skills of imitation and roleplay through toys, by experiencing various adult roles. This, in turn, enables toys to act as activators of children's imagination and support their socialization within 'adult culture'.

The importance of play in early childhood education has been stressed many times throughout this chapter. It is, then, perhaps important to note some factors that may be negatively affecting this important aspect. One major modern example would be the prominence of (multimedia) technology in our lives; the presence of 'screens' reduce the time babies use for self-directed, spontaneous experiments in learning (it should be noted that American Academy of Pediatrics strongly discourage screen time for babies younger than 2). Babies and toddlers spend a lot of the day in sleep; therefore it is very important that they spend their awake time in active communication with others (parents, caretakers, etc.) and exploring their emotional world via active play. Parents that play, talk and sing with their children give far more benefit to them than technological appliances ever could. The most important stimuli for healthy development of children are loving human interaction (Elkind, 2007).

In a globalizing world, creative and unique, simple, sincere and authentic toys and playtime, that a traditional life would allow children to produce, are being replaced by industrial toys that are products of global trends and business dynamics, and structured games that more often than not represent values such as competition, success and individualism that are valued in Western civilization (Inal, 2007). Most toys of today are made to be 'products' that are detached from childhood and are incompatible with a child's naïve and innocent world. With complex user manuals, structural setting up that require certain skills, brands, patents, intellectual properties and copyrights, logos and images, catalogues, structured educational purposes etc. toys are frankly being produced more for adults' interests–with their designers and marketing and outlets–rather than children's. Toys are no longer majorly within the initiative of the child as in the rural child picture. As plastic toys (be it their material or their nature) become prominent, the childhood of the child is being deferred (Inal, 2007). Children that continually play with electronic or mechanized toys are being exposed to EM radiation and likely undergo deficiency in their neuromotor and cognitive skills (Inal, 2007), whereas development of the hands-brain connection, through manipulative play, is critical to facilitating creativity.

Developmental Functions of Toys

Toys train children to develop dedication for a single activity and focus on a particular occupation for a prolonged time. It is important to support and encourage children in their self-directed activities.

We see that learning via play and development go hand in hand in babies and young children. It is possible to summarize learning as a product of experiences that are derived from play, which is determined by the child's mental development level. Once children associate objects in a continuity, they begin grouping up similar and dissimilar ones; the start of 'classification'. If they are provided the materials and set free, children can keep on with these important mental activities for a very long time. On the other hand, toys also develop focus and concentration in children.

Play is also vital for child development because it contributes greatly to cognitive, physical, social and emotional well-being. Toys are an instrument within play that serves to establish a complete, interactive relationship between the child and the parents and/or other caretakers. As critical facilitators of (especially neural) development, the suitability of toys to children is a subject of importance. In the "American Academy of Pediatrics 2019 Report", the play-based interactions of adults with their children influence rich growth in various aspects of child development including problem solving, imagination, creativity, language skills, etc. Throughout the last 20 years, the effects of toys on children's development, self-regulation and executive functions have become more apparent for parents.

High quality toys, via adult-led play-based interactions, provide significant support on especially language development and skills such as creativity, imagination and pretending. Such rich interactions are proven in especially early years to be beneficial to brain neuroplasticity (Suskind, 2018). Suskind comments that research by Hart and Risley show that the size of the vocabulary spoken within a family may influence substantial differences in development.

Traditional toys are categorized in various ways. A categorization in functions is as follows: 1- Symbolic (dolls, toy cars, cooking sets), 2- Fine motor manipulation (blocks, puzzles), 3- Artistic (play dough, ceramic and clay), 4- Language and conceptual (card games), 5- Gross motor/physical (larger cars, bicycle, push-and-pull toys). Quality toys of any of these categories facilitate parent-child interaction and enhance imagining. Toys, from infancy, function to facilitate cognitive development, linguistic interactivity, imaginative and pretend play, problem solving, social interaction and physical activity. Toys, toy characters and other play objects in imaginative play provide opportunities for word usage, narration, imitation and portrayal, and coping with challenges and emotions. In addition, during imaginative play the child brings to life not only toys but also their own identity in other roles (Göncü, 2007).

Blocks and puzzles can be shown as main examples to traditional toys that allow for problem solving via play. Such toys, along with reinforcing fine motor skills, develop spatial and early mathematical skills. On the other hand, the usage of toys such as balls in physical activity is a potential opportunity for gross motor development as well as self-regulation and teamwork.

Conclusion

Without a doubt, the best toys are those that align with children's developmental skills and faculties and support the development of new skills. Some studies on the developmental functions of toys indicate that play that involves parents and parental interaction is more beneficial for development than playing alone; this is due to the involvement of verbal interaction and scaffolding. Toys, in turn, have been found to contribute significantly to learning via such interaction. Other mutual activities such as shared book reading have a similar effect as well. This leads experts so emphasize to parents and other caretakers the contribution of play involving toys and adult interaction to social, linguistic and other fields of development. However, unfortunately the limited free time of parents in our day is increasingly becoming unable to accommodate quality play time. In the absence of interpersonal interaction, alternatives such as electronic toys are far from having the potential to provide the adequate opportunities critical for healthy development that interactive play provides. It is hence important to give scientific and political efforts to enable children to benefit from the developmental effects of interactive play with their parents. This is all the more true for children in poverty, as they often have less access to appropriate toys. There are hence various programmes being developed that address these issues on a societal level.

As Rollo May recounts (May, 1975), Alfred Adler described creativity as part of a 'compensation' mechanism. This mechanism means that people 'create' in order to compensate for their shortcomings and issues. Child's play, and the process of acquiring life skills through creative play, also play a similar role in compensation. The creative process is the utmost expression of emotional wellbeing and self-realization. Then toys, as objects of creative and communicative value, facilitate both intrapersonal reflection and interpersonal communication.

As a final remark, adults, parents and educators often need to be able to look at the world through the eyes of a child, in order to ensure the wellbeing and healthy development of the child. Play and toys are the most powerful tools of this ability, since play is the art of growth for a child. Of course, it is crucial to remember that no toy can be more valuable than the social interaction it may facilitate.

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Research Article

The effectiveness of STEM based inquiry learning packages to improving students' critical thinking skill

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Abstract

STEM is integrated learning which consists of four aspects namely science, technology, engineering, and mathematics. The 5M inquiry is a learning model that is being promoted in Indonesia to increase the critical thinking skills of students. In this study, the 5M inquiry learning activity was integrated with the STEM aspects in developing students' critical thinking skills in learning packages of simple machine materials. This study aimed to determine the effectiveness of STEM-based inquiry learning packages in simple machine material for improving the critical thinking skills of junior high school students. This type of research used quasi-experimental research with a one-shot case study pretest-posttest design. The research was replicated in four of 2nd grade of Junior High School 1 Pamekasan which conducted to 112 of students. The sampling technique used purposive sampling based on the fact that students were quite familiar with excavators. Data collection was used by tests of students' critical thinking skills and questionnaires of students' responses. The critical thinking skills test was given to students before and after the learning process, students were given the same initial test (pre-test) and final test (post-test). Questionnaires of students' responses were given to students after the learning process with STEM-based inquiry learning. Data analysis used descriptive analysis, normalized gain (N-gain) score, and paired t-test. The results showed that: 1) the increase of critical thinking skills based on the N-gain score is the high category; 2) the result of paired t-test showed that there is a significant difference in students' critical thinking skills before and after learning with STEM-based inquiry learning; 3) the student's response is the positive response with very good criteria to STEM-based inquiry learning. Based on the study, STEM-based inquiry learning packages were effective in improving the critical thinking skills of junior high school students.

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Introduction

STEM (Science, Technology, Engineering, and Mathematics) have an important role in learning for improving the abilities of the 21st century (Bybe, 2010; Hernandez, et al. 2014). Facing the globalization of the world, 21st-century abilities such as collaboration, digital literacy, critical thinking, and problem-solving are very important for individuals (Partnership, 2016). Learning was directed to practicing analytical thinking skills and collaboration to solving the surrounds of problems (Marsono et al. 2017). Thibaut, Sitjin and Haydee (2018) stated that professionalism is needed for dealing with problems in the 21st century. Ostler (2012) stated that this ability involves STEM aspects for overcoming these problems. Human work requires mastery of STEM (Rothwell, 2013). STEM learning involves interdisciplinary, authentic, and contextual knowledge, that is science, technology, engineering, and mathematics (LaForce et al. 2016; Holmlund et al. 2018). STEM emphasizes activities that involve problem-solving with inquiry

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activities (Baharin et al. 2018). STEM learning is related to inquiry activities through the formulation of questions that are designed and then solved through investigation (Kennedy & Odell, 2014).

Inquiry learning is a signal of paradigm friction from teacher-centered learning to student-centered learning (Ramnarain & Mupira, 2018). Students were directly involved in problems solving, making decisions, and not just thinking passively. Students were prepared to make decisions about social life around. Inquiry learning encourages students to learn through complicity in real contexts (Ghaemi & Mirsaeed, 2017). Students are accustomed to thinking about the problems around them. Inquiry learning can improve the academic performance and critical thinking skills of students (Byker et al. 2017).

According to Ennis (1993), critical thinking is reasonable and reflective thinking which focuses on deciding what to believe or do. Critical thinking allows students to evaluate evidence, assumptions, logic, and the language that underlies the statements of others (Larmer & Mergendoller, 2010). Critical thinking as a constructivist analysis process is used in defining a problem, determining actions to be taken, deciding, and evaluating what is happening (Duran & Şendağ, 2012). Critical thinking has become a necessity in the competition to face all kinds of problems in life today.

Students' critical thinking skills in the 21st century can be developed through proper management of the learning process (Tunkham, Donpudsa & Dornbundit, 2016). Learning is carried out by actively involving students to construct their knowledge. Beers (2011) stated that STEM (Science, Technology Engineering, Mathematics) as an innovative effort consists of 4Cs, namely creativity, critical thinking, collaboration, and communication for overcoming the problems. In STEM learning, students are allowed to solve problems around them through the concepts and knowledge they have (Baharin et al. 2018) by trying new things to face new things (Linder et al. 2016). Tomkin et al. (2019) stated that STEM forming students' cognitive abilities to think critically well.

STEM is a scientific methodology that teaches each STEM concept in an integrated and inseparable manner covering aspects of science, technology, engineering, and mathematics (Brown et al. 2011). STEM teachers are expected to be able to connect learning with real-world contexts (Morrison, 2006) by developing STEM-based learning activities (Tunkham et al. 2016) which can be done through learning packages. Learning activities that involve students directly with integrated concepts in the STEM aspect (Stachwell & Loepp, 2002) as authentic learning which aims at STEM literacy (Ciolan & Ciolan, 2014).

STEM provides opportunities for students to use their learning experiences to encourage critical thinking skills, problem-solving, and rhythm (Stohlmann, Moore and Roehrig, 2012). STEM is an integrated approach that involves students actively (Shernoff, 2013) in accordance with the constructivism paradigm (Martin & Hansen, 2018). STEM shows motivation in learning activities, designing solutions, and utilizing technology (Tillman, An, Cohen, Kjellstrom & Boren, 2014). STEM can stabilize student interest and motivation (Chittum et al. 2017). Learning experiences that are student-centered, meaningful, interesting, and involve higher-order thinking and problem solving, related to STEM learning (Stohlmann, Moore & Roehrig, 2012) make students innovative, independent, proficient in technology, creative and making a decision based on thinking (Kenndedy & Odell, 2014).

Learning requires students to support and formulate questions or problems and answer questions through scientific activities (Šorgo, Dojer, Golob, Repnik, Repolusk, Pesek, Virtič, Špernjak, & Špur, 2018). The involvement of students will gain the ability to hypothesize, design activities, evaluate and reflect (Baharin, Kamarudin & Munaf, 2018) for solving real life problems with inquiry activities (Chinn & Malhotra, 2002). Taber (2013) stated that students can reconstruct their understanding based on previously acquired knowledge to learning becomes meaningful. Drake (2012) stated that STEM-based inquiry is a meaningful learning which makes students active and innovative.

In STEM learning, the four aspects of science, technology, engineering, and mathematics must be studied as one unit, but the facts that occur in Indonesia generally only study aspects of science and mathematics. Erman (2017) stated that in general students experience misconceptions, students have difficulty understanding science concepts. Students who are still difficult to understand science concepts will find it very difficult to learn through STEM. Inquiry learning using the 5M scientific approach applied in Indonesia generally experiences difficulties due to the limited scientific abilities of both students and teachers (Erman et al., 2018; Šorgo et al. 2018). Students also generally have difficulty learning science through socio-scientific issues (Erman et al. 2020; Šorgo et al. 2018). Currently, Indonesia is implementing 5M inquiry learning at elementary to high school to support the improvement of scientific literacy and students' critical thinking skills (Erman et al. 2020).

In this study, we assessing the effectiveness of STEM-based 5M inquiry learning packages which we have developed on a simple machine material. Simple machine material was chosen because it involved aspects of science, technology, engineering, and mathematics which were quite familiar and easy to find for students in their surroundings.

Through STEM-based inquiry, students explain excavator technology products in the aspects of science, technology, engineering, and mathematics after learning and explaining the concept of a simple machine which is integrated into 5M inquiry who is familiar with Indonesian science teachers in general.

Problem of Study

Based on research shows that the STEM-based inquiry learning packages were valid to improving students' critical thinking skills, then an analysis of the effectiveness of STEM-based inquiry learning packages was carried out to improving students' critical thinking skills. In practice, this study conducted several analyzes including:

- How are students' critical thinking skills using STEM-based inquiry learning packages?
- How are students' responses to STEM-based inquiry learning packages?

Method

Research Model

This type of design research is a pretest-posttest design with a repeat design (Fraenkel et al., 2012). Repetitions were carried out on 4 groups of 2nd-grade students of Junior High School.

Table 1.

Research Design Model

Group	Design
1 2 3 4	O_1 X O_2

O_1 = pretest; X = treatment; O_2 = posttest

Participants

The population in this study were students of 2nd grade or VIII classes of Junior High School 1 Pamekasan. The research was conducted in 4 classes of class VIII students amount of 112 students. Repetition in 4 classes is carried out as a form to determine the consistency of effects in the learning carried out. The sampling technique was carried out by using the purposive sampling technique. The choice of this technique is based on the fact that students are quite familiar with excavators so it is assumed that it is easier to follow STEM-based inquiry learning on simple machine material to improve their critical thinking skills.

Data Collection Tools

The instruments in this study were a test of critical thinking skills and a student's response questionnaire. This instrument has been validated by 3 experts in the field of education/science using the scoring mode score given by the validator. The validation sheet contains components of assessment of the content, format, use of sentences, and conformity with learning indicators. The validation results show a value of 4 with very valid criteria to be used, while the mean of value the Conbrach Alfa reliability shows 0.848 degrees which it can be relied on in collecting data (Basuki & Hariyanto, 2014).

Students' Critical Thinking Skills

The instrument of critical thinking skills was multiple choices from which were accompanied by reasons and was given before and after learning using the packages developed. This form of assessment was not just right or wrong as a form of interpretive activities that students have done in learning (Rosebery et al. 2015). The test consists of 12 items covering critical thinking indicators (Ennis, 2011) with 3 questions of basic clarification indicator, 2 questions of decision indicator, 2 questions of inference indicator, 3 questions of advanced clarification indicator, and 2 questions of supposition and integration indicator.

Students' Responses

The student response questionnaire was a questionnaire given at the end of the learning process to find out the student's response to the learning is given to STEM based inquiry learning. The components of the assessment of student responses include aspects of learning renewability, interest, motivation, easily and expectancy in classroom learning. The criterion for the percentage of student responses uses a Likert scale. The rubric score used is from numbers 1-4, with a score of 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree.

Data Analysis

The research data were analyzed descriptively quantitatively. After obtaining the pretest and posttest scores on the students' critical thinking skill test, then a different test was carried out by a paired t-test statistical analysis with the

criteria if the value was sig. > α (= 0.05): there is no difference in test results before and after using STEM-based inquiry learning (H0) and if the value is sig. <α (= 0.05): there are differences in test results before and after participating in STEM-based inquiry learning (H1). Furthermore, the increase in students' critical thinking skills was calculated using the N-gain formula. According to Hake (1999) N-gain (Ng) can be calculated with the following formula:

$$Ng = \frac{Sf - Si}{Smax - Si}$$

Sf is the posttest score; Si is the pretest score, and Smax is the maximum score of the test results. Furthermore, the results of the normalized gain calculation are interpreted according to the following criteria: 1) Low criteria if the scoreNg<0.3; 2) Medium criteria if 0.3 ≥ Ng < 0.7 ; 3) High criteria if 0.7 ≥ Ng ≤ 1.0.

The students' responses data given by students were analyzed using qualitative descriptive. Student's responses data are used to answer questions about how students respond whose using STEM-based inquiry learning packages to students' critical thinking skills. The percentage of student responses (P) uses a Likert scale, with the following calculations (Gronlund, 1981):

$$P = \frac{A}{B}\ x\ 100\%$$

A = number of answers; B = maximum number of answers. The interpretation of the student response criteria is as follows: 1) The fewer criteria if the score is ≤ 25; 2) Medium criteria if 25> P ≤ 50; 3) Good criteria if the score is 50> P ≤ 75; 4) The very good criteria if 75 > P ≤ 100.

Learning packages of STEM-based inquiry

Research Procedures

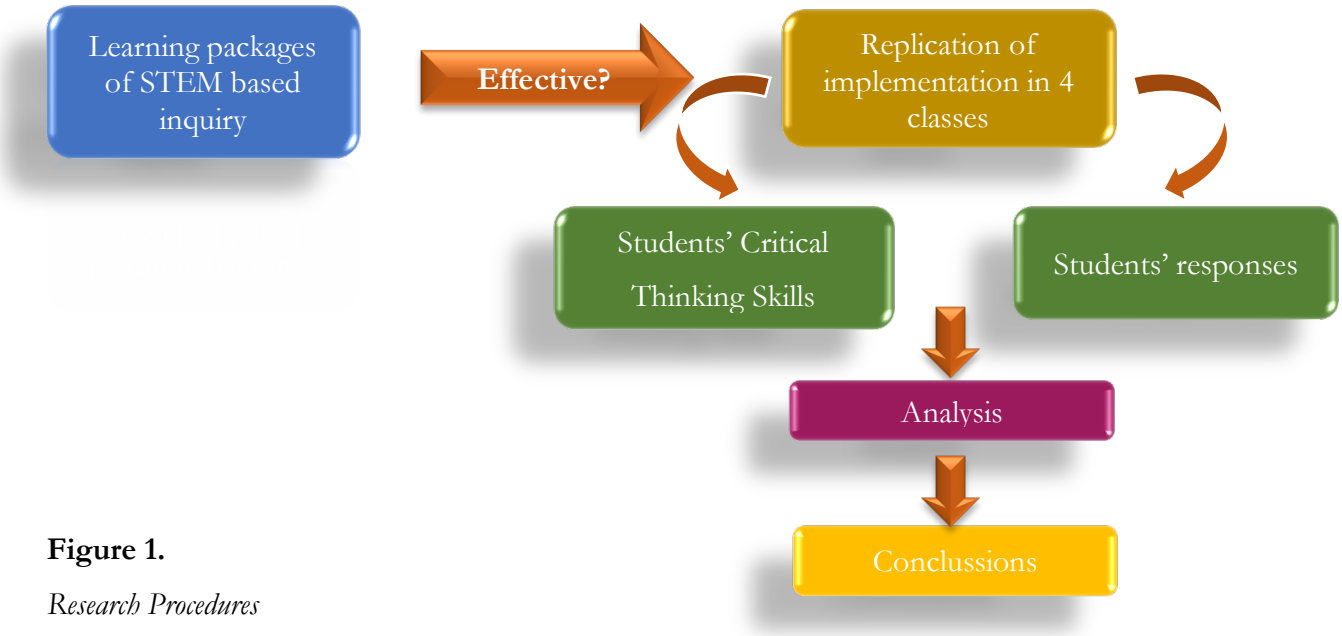


Figure 1.

Research Procedures

Result and Discussion

The effectiveness of this learning can be determined based on the research data on the test scores of critical thinking skills and student responses to STEM-based inquiry learning.

Results about Students' Critical Thinking Skills

In this study, the results of the critical thinking skills test were measured on each indicator of students' critical thinking. The results of the paired t-test show that there is an effect of using a STEM-based inquiry learning package to increasing critical thinking skills as follows:

Table 2.
The Value of Critical Thinking Skills' Indicator (CTSI) at VIII A (n = 28)

CTSI	Pretest		Posttest		t score	Sig.
	M	SD	M	SD		
Basic clarification	2,82	1,827	20,82	1,982	-33,217	0,00
Decision	2,36	1,569	13,00	1,656	-53,049	0,00
Inference	2,54	1,551	13,18	1,744	-24,183	0,00
Advanced clarification	3,32	1,765	21,04	1,856	-45,675	0,00
Supposition and integration	2,54	1,503	13,18	1,701	-25,623	0,00

Tabel 3.
The Value of Critical Thinking Skill's Indicator (CTSI) at VIII B (n = 28)

CTSI	Pretest		Posttest		t score	Sig.
	M	SD	M	SD		
Basic clarification	2,79	1,833	20,79	1,853	-34,316	0,00
Decision	2,32	1,588	13,04	1,598	-52,311	0,00
Inference	2,54	1,551	13,14	1,693	-24,416	0,00
Advanced clarification	3,29	1,718	21,07	1,864	-44,883	0,00
Supposition and integration	2,50	1,528	13,25	1,735	-25,048	0,00

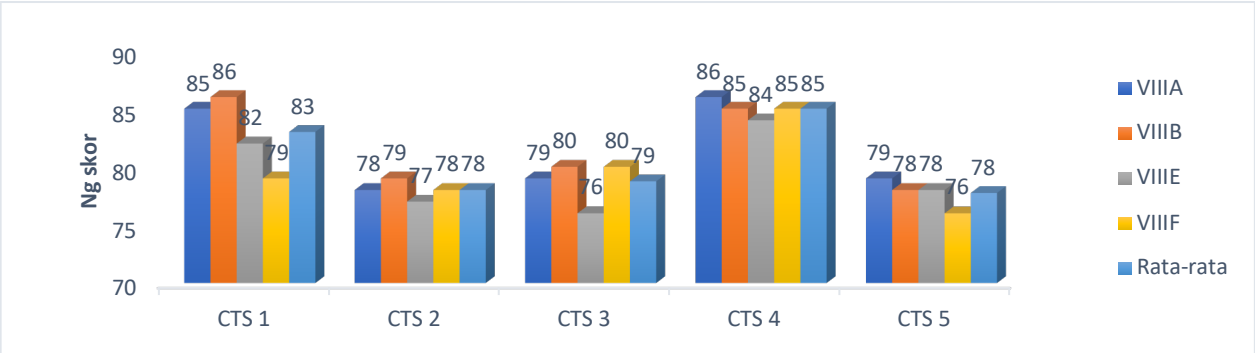
Tabel 4.
The Value of Critical Thinking Skill's Indicator (CTSI) at VIII C (n = 28)

CTSI	Pretest		Posttest		t score	Sig.
	M	SD	M	SD		
Basic clarification	2,86	1,758	20,32	1,765	-39,731	0,00
Decision	2,32	1,588	12,86	1,380	-53,826	0,00
Inference	2,54	1,551	12,75	1,506	-29,886	0,00
Advanced clarification	3,25	1,713	20,75	1,713	-47,411	0,00
Supposition and integration	2,50	1,528	13,04	1,551	-24,574	0,00

Tabel 5.
The Value of Critical Thinking Skill's Indicator (CTSI) at VIII D (n = 28)

CTSI	Pretest		Posttest		t score	Sig.
	M	SD	M	SD		
Basic clarification	3,14	1,758	19,68	1,765	-99,299	0,00
Decision	2,32	1,588	13,04	1,551	-43,571	0,00
Inference	2,50	1,528	13,25	1,713	-58,822	0,00
Advanced clarification	3,32	1,765	20,82	1,362	-100,331	0,00
Supposition and integration	2,54	1,551	12,75	1,713	-37,968	0,00

Table 2-5 shows a significant increase in each indicator of critical thinking skills based on the mean pretest and posttest scores, besides it shows that the significance value of students' critical thinking skills is 0.00 < 0.05. Based on this significance value, it can be concluded that H1 is accepted, so there is a significant difference in students' critical thinking skills before and after learning with STEM-based inquiry learning. The increase of critical thinking skills based on the Ng score is the high category. The following figure llustrates the Ng score in each indicator of students' critical thinking skills:



Note: CTSI 1 (basic clarification); CTSI 2 (decision); CTSI 3 (inference); CTSI 4 (advanced clarification); CTSI 5 (supposition and integration)

Figure 2.

N-gain Score of Critical Thinking Skill's Indicator

Students' Responses

Student responses are student responses to the learning process using STEM-based inquiry learning packages on simple machine materials that have been developed previously at the end of learning. This questionnaire contains 15 questions about student responses to the learning that has been carried out. The results of the student response questionnaire showed very good criteria for STEM-based inquiry learning, as follows:

Table 6.

Student Response Questionnaire Results (n = 112)

No.	Statement	Percentage of Students Agree				Mean
		VIIIA	VIIIB	VIIIC	VIIID	
I	**Recency of learning**					
1.	Studying science by inquiry	71	76	82	82	78
2.	Hear the term STEM	79	76	76	79	77
3.	Studying science with STEM	79	89	89	86	86
II	**Interest in learning**					
1.	Learning condition	86	100	89	89	91
2.	Apply the concept in life	93	89	86	89	89
III	**Motivation**					
1.	Motivation to learn	93	93	93	86	91
2.	Motivation for observations and experiments	76	82	82	86	81
3.	Motivation to critical thinking	82	86	96	82	86
4.	Motivation to discussion	89	86	82	96	88
5.	Be confident in presenting the results of the discussion	86	93	82	89	87
IV	**Easily to learn concepts**					
1.	Associating material with life	86	89	86	89	87
2.	Understand the material	79	89	86	76	82
3.	Integrated STEM' aspects	93	96	89	86	91
4.	Obtain meaningfull learning	96	93	92	93	93
V	**Learning Expectation**					
1.	STEM based inquiry learning in other science materials	93	96	96	96	**95**

Discussion and Conclussion

Students' Critical Thinking Skill

The results of the critical thinking test show that each critical thinking indicator has increased in a high category with STEM-based inquiry learning. This is in line with the opinion of Stohlmann et al. (2012) that STEM can improve critical thinking skills through learning experiences. Byker et al. (2017) explained that inquiry activities improve students' critical thinking skills. In principle, inquiry learning can help students think critically (Erman & Sari, 2019; Erman et al. 2018) because it requires students to support and formulate questions or problems and answer questions

through scientific activities (Šorgo et al. 2018). Viorel and Viorel (2015) state that scientific thinking aims to achieve critical thinking skills. STEM-based inquiry learning activities are designed to develop students' critical thinking skills. The insertion of each aspect of science, technology, engineering, and mathematics with the 5M inquiry stage in learning can construct students' knowledge in thinking.

Students are trained in solving problems according to the indicators of students' critical thinking skills. STEM is not only a learning approach but is a necessity to improve the quality of education. (Sujeewa et al. 2017). Learning with STEM is a necessity in the education of the highest quality. The analysis of the different test results of the critical thinking skills test shows that there are significant differences in the results and students' critical thinking skills before and after learning with STEM-based inquiry learning. This is in line with the opinion of Beers (2011) that STEM is an effort for students can find innovative solutions to the problems faced which consist of 4C, namely creativity, critical thinking, collaboration, and communication. Students are invited to solve problems in everyday life with reason and get meaningful learning.

Indicators of students' critical thinking skills are well developed in student activities while participating in STEM-based inquiry learning on simple machine (lever) materials. In the basic clarification indicator, for example identifying the type of lever based on the location of the fulcrum, PowerPoint, and load point; explain the working principle and the mechanical advantages factor obtained by the PhET simulation balancing-act activity; as well as explaining the role of the lever in the excavator's work. In the decision indicator, for example, the activity of determining the choices that must be made when several options are selected along with reasons. In the inference indicator, for example by concluding actions taken based on data and graphics along with the reasons. In the advanced clarification indicator, for example by mentioning daily equipment that applies a lever based on the type and reason; identify aspects of STEM in learning excavators. In the supposition and integration indicator, for example by analyzing mechanical advantages based on the load point on the use of a lever; find or design a technology tool that has a lever principle.

Learning activities can train students' critical thinking skills well. Maulucci et al. (2014) stated that STEM can develop students' abilities through inquiry, collaboration, and technology insertion in their learning. Borich and Ong (2006) stated that the inquiry learning orientation concerns the student's ability to solve a problem so that it focuses on students' critical thinking and on developing students' intellectual abilities. Students are trained and accustomed to critical thinking in the learning process. Figure 2 shows students experienced a high increase in each critical thinking indicator test. This is in line with Gnagey (2016) that STEM learning can increase student learning achievement. Becker and Kyungsuk (2011) stated that STEM has a positive effect on improving learning outcomes.

Students' Responses

Most of the students gave positive statements about the STEM-based inquiry learning tool. Student responses to the novelty of learning, interest, motivation, ease of learning concepts, and expectations in other science learning are very good criteria. Students are directly involved to apply the concepts (Burrows & Slater, 2015) they learn in their daily lives. This is in line with the opinion of Ghaemi (2017) that inquiry learning involves students in a real context in everyday life. Students feel more motivated (Tillman, An, Cohen, Kjellstrom & Boren, 2014) to learn, conduct experiments, think critically, discuss and be more active in learning activities using STEM-based inquiry.

Peters (2010) states that the learning environment formed by students who learn actively makes meaningful learning. Students understand and relate the material to everyday life, integrate aspects of STEM, and obtain meaningful learning (Stohlmann, Moore & Roehrig, 2012). According to David Ausubel's learning theory (meaningful learning) that learning will be more meaningful if the concepts to be taught are associated with concepts that have been learned by students. STEM-based inquiry learning is group learning which has been shown to get very good responses from students. In line with the principles of learning in Vygotsky's theory (Slavin, 2011) that social interactions can trigger students' cognitive development. Through their study groups, students can discuss and exchange opinions. STEM encourages group interaction in collaboration which can help in critical thinking. Students also hope that STEM-based inquiry learning can be implemented in other science materials. STEM encourages group interaction in collaboration which can help in critical thinking (Lee et al. 2015).

Based on the research results, it can be concluded that STEM-based inquiry learning packages are effective in improving students' critical thinking skills. Analysis of the paired t-test shows that there are differences in the results of students' critical thinking skills with STEM-based inquiry learning. This is also shown by the results of the increase in N-gain scores on students' critical thinking skills in the high category with the use of STEM-based inquiry learning packages. Student responses also showed a very good category for STEM-based inquiry learning.

Recommendations

Further study can be carried out for other materials in science, subject, moreover to levels of education. Moreover, further study can be carried out for development or improvement to other skill of the abilities 21st century which are very important in this life. Furthermore, STEM-based inquiry learning is effective to improve students' critical thinking skills.

Limitations of the Study

This study only focusses on the simple machine materials of lever taught for 2n grade of junior high school students. The focus of the study also to improve students' critical thinking skills with indicators of basic clarification, decision, inference, advanced clarification and supposition, and integration.

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Research Article

Exploring environmental literacy components in promoting sustainable behaviour: a case study of rural primary schools

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Abstract

This study explored environmental literacy level of both teachers and learners in rural primary schools, with the focus on knowledge, attitude and skills components. The study further examined how the components promote sustainable behavioural change in rural schools. A qualitative multiple case study design, guided by the interpretivist paradigm was employed where three rural primary schools, from Sekhukhune District in Limpopo Province of South Africa were conveniently sampled. Data were collected through observations, document analysis, semi structured and focus group interviews. Three Grade 7 teachers each teaching Social Science, Natural Science and Technology, and 18 learners were purposively sampled to participate in semi structured and focus group interviews. Data were deductively and inductively analysed using content analysis. The findings revealed both nominal and functional environmental literacy levels of both teachers and learners, with limited contribution to sustainable behavioural change. The findings are attributed to teacher's lack of expertise in Environmental Education (EE) content; the limitations of a curricular framework in equally addressing the knowledge, attitude and skills components; and absence of policies and framework guiding sustainable behaviour. The study recommended reorienting and aligning the EE content curriculum with teachers' preservice training; ongoing in-service development and support; and the inclusion of polices that guide lifestyle and practices guiding sustainable behavioural change. This research provided insight into the progress of developing environmental literacy in rural primary schools.

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Introduction

Developing environmental literacy for sustainable development is a global concern with some of its responsibilities bestowed upon formal education, with the purpose of promoting individuals behavioural change towards a more sustainable lifestyles and practices (UNESCO, 2018). The need to develop environmental literacy arose out of concerns about environmental degradation, due to human behaviour globally (Ever, 2012; Msezane, 2017). This includes extensive population growth, increasing consumption patterns, inequality, poverty, the loss of biodiversity, land degradation, the high rate of waste generation and climate change, the list is endless, across developing and developed countries, rural and urban regions alike (Sharma & Rani, 2016). These global crises call for the integration of EE, with the objective of developing an environmental literate citizenry, and promoting behavioural change (UNESCO, 2018).

Environmental Literacy and South Africa

Despite efforts aimed at of introducing and integrating EE in formal education more than two decades ago, studies globally have shown that EE is not achieving its goal of developing environmental literacy in schools (Erdoğan et al. 2009; Kaya & Elster 2019). Most countries still suffer from what could be called an environmental literacy gap which

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appears to be growing rather than shrinking (Huston, 2016). The environmental literacy gap exist not only because of what is being taught by teachers in schools, but because of how the curriculum has been developed and evaluated (Huston, 2016). Schools' inability to provide a basic understanding and skills needed to make informed decisions on people's interactions and their relationship with the natural environment, serve to exacerbates developmental efforts in terms of environmental literacy (Roth, 1992).

South Africa also sought to meet its international obligation to develop an environmentally literate citizenry, by integrating EE content into the school curriculum. The main aim of the Department of Basic Education (DBE) was to infuse the principles and practices of sustainable development (SD), social and environmental justice, and human rights into schools (DBE, 2011). South Africa's' development of environmental literacy is however still a major challenge in both rural and urban schools. The absence of Continuous Assessment Policy Statement (CAPS) enabling guidelines, in teaching EE content and the lack of significant teachers training contribute to this scenario (Loubser et al. 2001; Hebe, 2019). This called for a need to explore the environmental literacy levels in schools, with the focus on knowledge, attitude and skills related competencies, and their effectiveness in developing sustainable behaviour.

Roth (1992), the founder of the concept "environmental literacy", defines it as the person's capacity to perceive and interpret the state of an environmental system as well as the appropriate actions for managing, restoring and improving the system. It is the development of knowledge, attitude and skills components on a continuum that unfolds on the nominal, functional and operational levels (Roth, 1992). It is built on an ecological paradigm and its presence must be defined in terms of observable behaviours (Hungerford & Volk, 1990). Knowledge competencies are regarded as fundamental in developing the environmental literacy of both teachers and learners (Hollweg et al. 2011). Teachers are expected to possess both appropriate and specialised knowledge, and to be able to present that knowledge to learners, using appropriate methods for developing their environmental literacy (Hollweg et al. 2011). Although knowledge is fundamental to the development of environmental literacy, the attitude underlying the whole process requires an intention to take action, which is key to develop skills based competencies (Kidman & Casinader, 2019). The environmental literacy components of knowledge, attitude and skills are required to achieve SD and bring about a sustainable and just society (UNESCO, 2018). People with an acceptable level of environmental literacy should be able change their practices and lifestyles so as to contribute to more sustainable behaviour.

The Importance of the Study

The focus of the study was on rural primary schools as those communities continues to experience numerous socio economic challenges (Saiti et al. 2014). A lack of resources due to poverty, unemployment and high levels of illiteracy continues to entrench inequalities in rural communities thereby limiting any developmental possibilities that might be achieved through education (Saiti et al. 2014; Tsakeni, 2017). Under rural conditions, inhabitants need to find a balance between maintaining sustainable lifestyles and the socio-economic conditions they deal with (Saiti et al. 2014). Therefore, the development of environmental literacy in rural school communities is important in strengthening learners' capabilities and competencies, to adopt behaviours and practices that will counter the environmental challenges their communities are facing.

Empirical Studies

Although the ultimate goal of EE is to develop environmental literacy in schools, the extent body of literature suggest that insufficient emphasis is given to studies on how best to develop environmental literacy in terms of its components, and through behavioural change (Forbes & Zint, 2010). Krnel and Naglic, (2009) highlight the importance of addressing both the knowledge and awareness components of environmental literacy, to produce responsible environmental behaviour in both eco and ordinary schools. Wong et al. (2018) mirror the importance of understanding the components of environmental literacy, their links to pro environmental behaviour, and the factors considered when assessing EE programmes and interventions.

The literature also suggests the importance of teaching and learning strategies in developing environmental literacy in schools. A lack of service learning and practices is deemed to affect the development of environmental literacy in schools (Gbadamosi, 2012). Kidman et al. (2019) also emphasise the importance of inquiry-based practices, and suggest that progressive pedagogies in the form of inquiry -based teaching are foundational in developing learners' environmental literacy. South Africa's failure to develop environmental literacy in schools is attributed to the absence of CAPS in enabling guidelines in teaching EE content, and a lack of significant teacher training (Loubser et al. 2001; Hebe, 2019).

Theoretical Framework

A theoretical framework provides a foundation for literature review, research methods and analysis of any study (Grant & Osanloo, 2014). In this instance, Self-Efficacy theory was selected having originated from the Social Cognitive

Theory of Albert Bandura. Social Cognitive Theory holds that people can learn through observing others, and be motivated to obtain information, gain skills, develop beliefs and adopt strategies through the interrelationship between themselves, their environment and their behaviour (Bandura, 1977). Self-efficacy refers to beliefs about their capability to produce designated levels of performance that exercise an influence over the events affecting their lives (Bandura, 1977). It determines how people think, feel and act through diverse effects including the cognitive, motivational, affection and selection of processes (Dermici & Teksöz, 2017). People's beliefs about their self-efficacy are developed by four main sources of influence, including performance accomplishment/ mastery of experiences, vicarious learning, verbal encouragement, and psychological and emotional states. See figure 1.

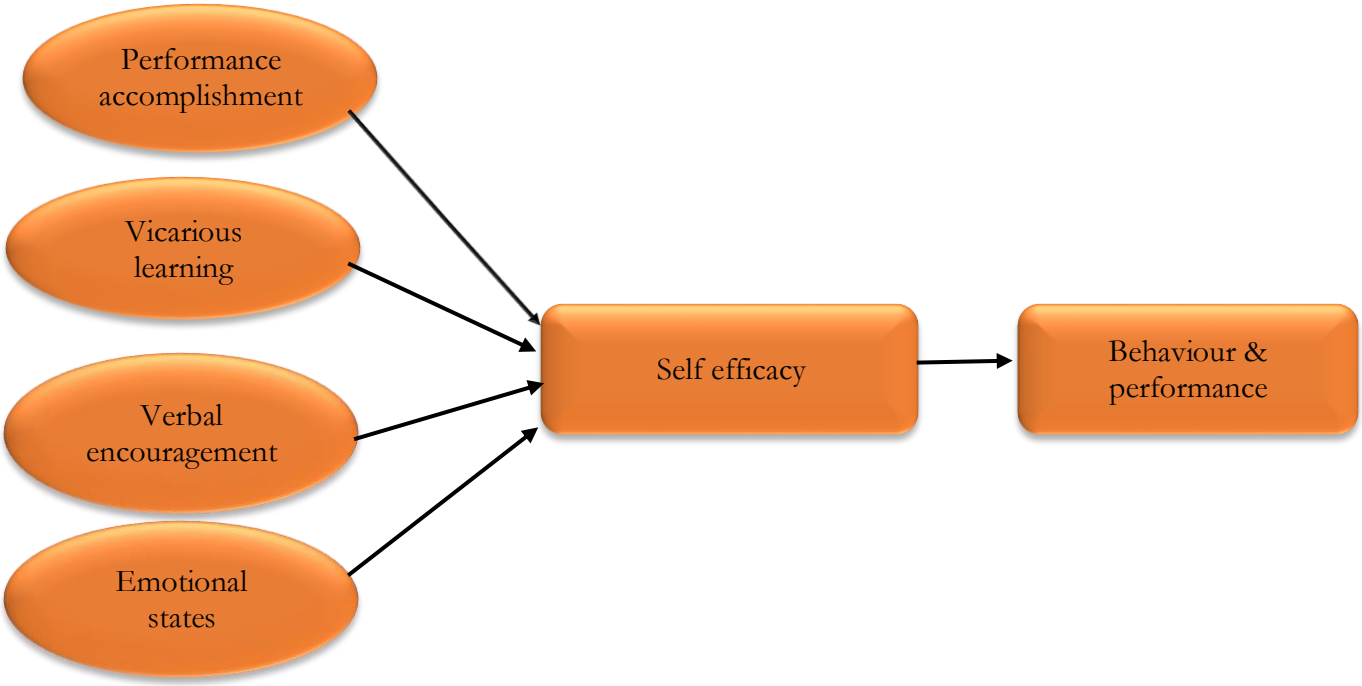

Figure 1.
Components of Self-efficacy (Source: Bandura 1997)

The performance accomplishment or mastery experience was found to be the strong hold for self-efficacy belief (Almashard, 2017). Such experiences relate to a specific area or field, and the skills and practical procedures, used to apply a skill which serves to bring about the expected behavioural change. (Kostadinova, 2013). Teachers with performance accomplishment are expertise in the field of EE. They have acquired knowledge, and skills based competencies in applying a variety of EE approaches, to develop environmental literacy in their learners. They are involved in EE programmes and projects, and apply their skills to solve environmental problems.

Vicarious experience provides a social model which involves seeing people who are similar to one self- succeed. That raises the belief that they one also has ability to master such activities. EE learning for the development of environmental literacy and behavioural change, requires collaborative effort, teamwork and support, to overcome the challenges faced in the course of the process.

Social persuasion in the form of verbal encouragement or incentives motivates people to try harder to succeed, and drives them to perform the desired behaviour. Sustainable behaviour can be encouraged and motivated through support and incentives for engaging in sustainable practices.

Emotional state is associated with the perceived ability to cope with negative emotions, and the ability to organise them (Kastiadinova, 2013). Self-efficacy belief contributes to the motivation process and decisions in respect of behavioural change (Kastiadinova, 2013). The above-mentioned components present a link between environmental literacy and self-efficacy belief. If teachers are not well equipped with knowledge, expertise and experience to teach EE content, they are unlikely to develop confidence or to be motivated to teach the content to develop learner's environmental literacy, and will not have the desire to engage in sustainable practices.

Problem Statement

The study arose out of the authors' interest on the effective development of environmental literacy in rural primary schools. Although EE content is integrated in CAPS subjects, insufficient attention is paid to it, and little support is offered for its implementation, in addition, a lack of resource management is evident. Sikhosana et al. (2020) confirm

that EE is not effectively integrated in teaching and learning processes. Bopape et al. (2021), also highlight lack of support in terms of funding and resources to support the sustainability of school resources. This prompted the researchers' interest in conducting a study, which explores the following main research question:

How effective are the environmental literacy components of knowledge, attitude and skills, in promoting the sustainable behaviour of both teachers and learners in rural primary schools?

The following sub questions assisted in answering the main research question:

- Which EE content knowledge is taught and learnt in rural primary schools?
- How does acquired knowledge lead to positive attitude towards sustainable behavioural change?
- How effective are the skills acquired, in taking action towards solving environmental problems?

Methodology

The methodology guided the plan for generating and analysing data (Creswell, 2014).

Research Design

The aim of the study was to explore the environmental literacy levels of teachers and leaners with the objective of examining their sustainable behaviours. The study employed a qualitative interpretative multiple case study design to provide in-depth, relevant information, understanding and interpretation, of the extent of environmental literacy development in selected South African schools (Yin, 2009; Creswell, 2014). The design allowed for multiple methods of collecting data from different sources, which is important for the triangulation of data, to ascertain the validity of inferences obtained from multiple data sources (McMillan & Schumacher, 2010). The design also allowed the selected content analysis method to explore the differences and similarities amongst cases, in order to compare the environmental literacy levels in schools (Baxter & Jack, 2008).

Research Location

The study was conducted in three primary schools resorting under the DBE, in Sekhukhune District, in Moutse, Limpopo Province, South Africa. The schools are Senior Primary, which caters for learners from Grade R to Grade 7. The location of the schools can be seen in figure 2.

Figure 2.

The Location of Research

Participant Sampling

Three cases were conveniently sampled based on their geographical proximity, to allow easy access and efficiency in terms of time and costs. The population for the study included three Grade 7 teachers and 18 learners. Only teachers who were eligible to teach Natural Sciences, Social Sciences and Technology subjects were purposively sampled, based on the perception that they would hold the rich, relevant information necessary to answer the research questions (Creswell, 2014). Grade 7 learners were sampled because they are at the exit level of primary school, and are perceived to have developed the accepted level of environmental literacy needed to answer the research questions. Pseudonyms were used to ensure the confidentiality and anonymity of cases and participants, for instance C1 for case 1, T1 for teacher 1 and L1-6 for all learners in C1 (Gentles et al. 2015). A total population of 21 participants was sampled for this study.

Data Collection

The study employed document analysis and observations during the first phase and semi structured face-to-face interviews with teachers and focus group interviews with learners during the second phase of the data collection process. The use of these data collection methods assisted with the triangulation and credibility of the collected data (Denzin & Lincoln, 2011). The triangulation of data ascertained the validity of inferences obtained from multiple data sources (Denzin & Lincoln, 2011).

Document Analysis

The CAPS curriculum and schools' environmental policy documents were analysed. The curriculum was analysed to explore the integration of EE content in Technology, Natural Science and Social Science subjects, and how the EE content, pedagogies and assessment are framed and guided. Each schools' environmental policy was supposed to provide insight into the guidelines and framework for implementing EE projects and programmes in schools, the practices and lifestyles that promote the sustainable behavioural change.

Observations

Both field and classroom observations were conducted, to gain insight into, and an understanding of the role which schools played in conservation and the sustainable use of resources.

Semi-Structured Face-to-Face Interviews

Semi-structured face-to-face interviews were conducted with one teacher in each case, to explore their environmental literacy levels. The focus was on the teachers' knowledge of EE content, pedagogical approaches to such content, methods of assessment and the teacher's involvement in EE programmes and projects in schools.

Focus Group Interview

The focus group interviews were conducted with a group of six learners in each case to explore their environmental literacy levels of learners, and to triangulate data obtained from other tools (Rabiee, 2004).

Trustworthiness

The trustworthiness of the study can be enhanced by meeting four criteria including credibility, dependability, transferability and conformability (Denzin & Lincoln, 2011). Credibility was ensured through the use of a multiple case study approach and multiple data-collection methods that provided saturated data (Shenton, 2004). Dependability was achieved by clarifying the main concepts guiding the study, to bring common understanding, and provide full details on the methods and procedures for data collection and analysis (Shenton, 2004). Transferability was enhanced by providing transcripts of the raw data collected to illustrate how themes and categories were developed (Zach, 2006). Conformability was attained through the presentation of raw data, and the use of direct quotes, and by transcribing recorded data verbatim, to present the true feelings and experiences of participants (Shenton, 2004).

Data Analysis

Qualitative content analysis method was employed in analysing, presenting and interpreting data. The researchers were guided by the ability of this method to explore and categorise textual information, and to use predetermined themes to ascertain the patterns of words, their relationships, as well as any similarities or differences (Grbich, 2013). All interview records were transcribed verbatim, guided by pre-determined themes, which, were deductively used to guide the coding of subthemes and categories (Neoendorf, 2019). Subthemes and categories were inductively developed form the data (Vaismoradi et al. 2013). A pre-determined scheme of analysis guided the selection of the relevant data, to maintain consistency and cohesion during the coding processes (Vaismoradi et al. 2013; Ngulube, 2015). The coding process is outlined in table 1:

Table 1.
Coding Process

Aspects	Codes
Case 1	C1
Case 2	C2
Case 3	C2
Teacher 1	T1
Teacher 2	T2
Teacher 3	T3
Learners C1	LC1:1-6
Learners C2	LC2:1-6
Learners C3	LC3:1-6
Themes	1,2,3 etc.
Subtheme	1,2,3 etc.
Categories	C1, C2 C3 etc.
Category aspects	C1A, C1B,C1C etc.

Cases were coded as C1, C2 or C3; teacher participants as T1, T2 or T3; learner participants as LC1:1-6, LC2:1-6, or LC3:1-6. Themes and sub themes were chronologically numbered according to the research questions. Category names were abbreviated as C, and labelled numerically as C1, C2 and C3 etc. Category aspects were further labelled alphabetically as C1A, C1B, CIC, etc.

Table 2.
Coding Process for Semi Structured Face-to-Face Interview

Theme 1:Knowledge	**Theme 2:** Attitude	**Theme 3:** Skills	**Theme 4:** Sustainable behaviour
Sub-theme 1: Specialisation and expertise	**Sub-theme 2:** Value, Respect and commitment	**Sub-theme 3:** Inquiry - based practice	**Sub-theme 4**: Sustainable practices
Categories (C1) C1A: Experience C1B: EE concepts and content. C1C: Content interrelatedness C1D: Knowledge of ecological processes **Sub theme 2**: Pedagogical content **Categories(C1E)** Integrative approach C1F: Assessments	**Categories (C2)** C2A: Appreciation C2B: Perception C2C: Motivation and Confidence C2D: Development and support	**Categories (C3)** C3A: Identifying environmental problems C3B: Solutions to environmental problems C3C: Assessment practices	**Categories (C4)** C4A: Resources conservation and management. C4B: Policy systems.

Table 3.
Coding Process for Focus Group Interview

Theme 1:Knowledge	**Theme 2:** Attitude	**Theme 3:** Skills	**Theme 4:** Sustainable behaviour
Sub theme 1: EE concepts and content.	**Sub-theme 2:** Appreciation and commitment	**Sub-theme 3:** Inquiry-based practice	**Sub-theme** 4: Sustainable practices
Categories (C1) **C1B**: Knowledge of EE concepts. **C3**: Knowledge of ecological processes	**Categories (C2)** **C2A**: Perceptions **C2B**: Personal responsibilities	**Categories (C3)** **C3A**: Identifying environmental problems **C3B**: Solutions to environmental problems **C3C**: Taking responsibility.	**Categories (C4)** **C4A**: Sustainable lifestyle and practices.

Results and Discussion

The results of cases were presented to compare differences and similarities following the findings of the document analysis, observations, Individual semi-structured and focus group interviews across all cases.

Classroom Observations

The finding from the lesson observation revealed a level of uniformity across cases, the learning approach was teacher centred, yet C3 offered learners different opportunities such as gardening, making compost, sorting of waste than C1 and C2 did. Assessment strategies were limited to question and answer-methods, and there was no demonstration of action skills.

Field Observations

Table 4.
Observation Tool

Categories	**C1**	**C2**	**C3**
Landscaping and sustainable food gardening	Some tree plantings, no food gardening.	Few plantings and no food gardening	There is multiple plantings including indigenous medicinal trees, shrubs and flowers. Rain water is channelled to plants, there is a fully functioning food garden.
Waste management	Waste papers are burnt or buried in a pit. No indication of waste recycling.	Waste papers are burnt or buried in the pit. No indication of waste recycling.	Waste papers are burnt or buried in the pit. No indication of waste recycling.
Water saving programs	Borehole water use, no indication of rainwater harvesting, leaking taps.	Borehole water use, learners drink water from buckets, leaking taps, no indication of rainwater harvesting.	Use of boreholes, tap automated and some locked no indication of leakages, no indication of rainwater harvesting.
Energy-saving projects	Some lights are left on, electricity is the only source of energy	High electricity consuming bulbs, solar energy used in the kitchen.	Energy saving bulbs are used, electricity is the only source of energy.
EE projects and Programmes	No indication of EE projects or programmes	No indication of EE projects or programmes	There is an organic compost project on site.

The field observation findings from C1 and C2 showed a lack of conservations, and no sustainable use of resources. The absence of sustainable practices, the lack of EE projects and programmes suggested a lack of knowledge of the EE processes and skills necessary for developing environmental literacy. The observation findings of C3 suggest some knowledge and understanding of the importance of conservation and the sustainable use of resources, which constitutes an acceptable level of environmental literacy.

Document Analysis

CAPS curriculum analysis for Natural Science, Social Science and Technology for grades 7-9 revealed that EE content was integrated to varying degrees across the subjects, while the concept of EE is not mentioned in the curriculum. . The curriculum suggests both theoretical and practical assessment activities which teachers can use to assess learners including, (but not limited to) reading, investigating, illustrating, making use of scenarios, case studies, projects, etc. (DBE, 2011). Notably, no explicit reference is made to the pedagogical methods and skills teachers should use to teach the integrated EE content. This argument was drawn from the statement that "content and the associated concepts must be integrated with the aims and skills across all subjects" (DBE, 2011). It was seemingly left to teachers' expertise, experience and their own interpretations to effectively integrate EE content in developing learners' environmental literacy.

The intention behind analysing each school environmental policy was to explore how it provides a framework for planning and coordinating EE projects and programmes, and how it complements the CAPS curriculum in developing environmental literacy in schools. Unfortunately, no School Environmental Policy was available in any of the cases, but in C3, the garden project was guided by Green Gardens policy. The absence of a school environmental policy suggested that there were no frameworks to guide practices or entrench a lifestyle aimed at promoting sustainable behaviour.

Table 5.

Semi Structured Interviews with Teachers

Theme 1. *Knowledge.*

Interview questions	Responses
C1A: Knowledge of EE content	**T1**: No workshop or in-service training have been conducted."
Have you received any pre and in service, training on EE related content?	**T2**: No.
	T3: My pre service included environmental science. I also attended a UNISA course on gardening
What is your understanding of EE as a concept and its content?	**T2**: CAPS is not extensive in teaching EE in technology.
C1B:Content interrelatedness	**T1**: In social science, the Geography part talks about pollution.
How are the subjects you are teaching linked to EE content?	**T2**: In Technology, they talk about recycling and safety.
	T3: In Technology, they talk about material and their composition.
C1C Ecological content and processes	**T3**: When we burn the papers there is a lot of carbon dioxide that is going into the atmosphere and is going to form global warming and cause acid rain.
How does your actions affect the natural environment?	**T3**: There are microorganisms living in water and they get affected by pollution.
	T1: Burning of waste affects us.
	T2: There are other natural things which becomes extinct.

The findings on Theme 1 revealed that teachers portrayed both basic and adequate knowledge of EE content. On C1A, the responses of T1 and T2 denoted that they had received no training on EE content. T3s' responses showed that she had received pre and in-service training on EE content. On C1B, T1 and T2 were aware of EE related content in their subjects but seemed not to be aware of the concept of EE. They confused EE-related content with the concept "environment". Similarly, the CAPS curriculum do not make mention of the concept "EE". Therefore, teachers' background in terms of pre and in-service training on EE is important to understand the concept EE as a process of learning about the environment and its other components, its specialised and distinctive approaches (Dhull,

&Verma 2017). T3 portrayed more knowledge of ecological concepts and processes than T1and T2 did. The ecological concepts and processes were found to be key to the development of teacher's environmental literacy and that of learners (Hollweg et al. 2011)

Table 6.

Subtheme 2: Pedagogical Content

Interview questions	Responses
C1E: Integrative approach How is EE content guided in the CAPS curriculum?	**T1**: CAPS documents encourages an integrative approach. That brings additional content in our subjects. **T2**: I was not putting much emphasis on environmental content, I was putting much emphasis on solving technological problems related to technology not getting much into EE content. **T3**: CAPS is not saying much about EE, but only its content.
How do you integrate EE content in your subjects?	**T1**: Now I am aware that my EE integration to my subjects is not as it should be. This study has opened my eyes. **T2**: Teachers must be trained in teaching EE content to develop the environmental literacy of learners. **T3**: I include projects like compost manufacturing, gardening, using case study on dangers of animals feeding on plastics. The projects, however, waste time which is needed to finish the syllabus on my subjects.
C1F: Assessments How do you assess EE competencies of learners?	**T1**: Actually, honestly we are assessing knowledge; we are not focussing much on the practical part. **T2**: Our EE activities are knowledge based. We only do projects in Technology. **T3**: Our assessment is knowledge based. We also do projects such as compost and gardening.

The findings on C1E indicated that teachers were aware of EE content integration in the CAPS curriculum, but that they identified EE content as being supplementary to their subjects. T1 and T2 indicated that they did not effectively integrate EE content in their subjects, but focused more on their subject content. These findings highlights the participating teachers' lack of curriculum content knowledge on an interdisciplinary approach, and appropriate skills for effectively implementing EE content in lessons, aimed at developing environmental literacy in learners (Fundisa for Change, 2013). T3 used different integrative approaches to teach EE content including projects and case studies but, regarded such approaches as a waste of time preventing her from concluding the subject syllabus. The C1F findings revealed that assessments on EE content were knowledge based, but T3 reported including EE practical assessments. The findings on C1E highlighted the need for teachers' development in terms of an interdisciplinary approach to the CAPS curriculum.

Table 7.

Theme 2. Attitude

Interview questions	Responses
C2A: Perception What is your perception on teaching EE content in your subject?	**T1**: It is important. We encourage learners not to litter. Those who come late to school pick up litter. **T2**: It is important, learners clean the surrounding when they come late. **T3**: I am tasking the learners to pick up waste.
C2B: Motivation and Confidence How motivated and confident are you in teaching EE content	**T1**: I can be confident and motivated if I am capacitated. **T2**:The motivation is there but I am not confident like when I teach my own subjects. **T3**: I am very much confident, but it comes with lot of work.
C2C: Support How are you supported in effectively teaching EE content?	**T1:** As a principal, I am not supported and therefore, I cannot support teachers. **T2**: No, I am not supported, sometimes we don't understand these EE issues and their projects. **T3**: People from Loskop sometimes do practicals with us and they donate trees.

The findings on C2A showed that participants were aware of the importance of teaching EE content in schools. This indicated a positive attitude but they seemed to be using EE activities as a disciplinary measure against learners rather than developing an attitude of care and protection for the environment (NAAEE, 2012). Understanding and making diverse use of EE activities can internalise the character of caring for the natural environment (Arent et al. 2020). CB2's findings showed the participants' confidence in teaching their subjects but revealed that they were not equally confident about teaching EE content. If teachers are motivated to teach EE content, motivation will guide their persistence and performance, and build their confidence (Mbatha, 2015). The C2C responses also showed that schools were not given much support to effectively implement EE content. Support, in the form of resources and development in EE, will provide teachers with strategies and approaches to broaden their teaching experiences while enhancing learning opportunities for learners in developing environmental literacy (Rosenburg et al. 2009).

Table 8.

Theme 3: Skills

Interview questions	Responses
C3A: Identifying environmental problems Which environmental problems does your schools experience, and what are the causes?	**T1**: I have acknowledged that we have a problem with littering, children are littering around." **T2**: We practise air pollution everyday by burning waste. **T3**: Waste is our big problem, we are burning waste, we have a problem with pampers littering in the community and animals are eating them.
C3B: Solving environmental problems How do solve identified environmental problems?	**T1**: With recycling practically, we failed, because there are financial disadvantages instead of benefits. Our hands are tied. We just encourage learners to pick up papers. **T2**: Recycling of waste is expensive, there are no recycling centres around us. **T3**: We encourage reusing and recycling although is expensive.

From the C3A responses, evidently the study participants could identify environmental problems, and were aware of their actions that harmed the environment, but CB3 showed some socio economic limitations in solving environmental problems. The ability to identify environmental problems can persuade individuals to participate in decision making aimed to solving those identified problems (Ever, 2012). The responses also showed that although the participants could identify environmental problems, their skills based competencies and their socio economic

conditions limited their ability to address the environmental problems affecting their schools and the surrounding communities.

Table 9.

Theme 4: Sustainable Behaviour

Interview questions	Responses
C4A: Sustainable practices and lifestyle Do you have vegetable gardens?	**T1**: We had a vegetable garden, which we have ceased because of water shortages. **T2**: Our vegetable garden was functional last year, this year we had some challenges and the pressure of time. **T3**: We do have a functioning vegetable garden. We went for a gardening course, the principal and myself we won R30 000 to improve our gardens.
How do you manage your waste?	**T1**: On waste management, with recycling we have practically failed because we are working at a loss. **T2**: The waste is not beneficial to the school, we have organised people who are coming to collect our waste. **T3**: We send some waste for recycling. Other papers we just burn them every day to avoid spreading. We make compost with our green waste.
How do you manage and conserve your water?	**T1**: With water, we try to use taps that automatically close. **T2**: With water saving, we have buckets in each class and we do not allow learners to continuously go to the compounds. **T3**: We have some reservoirs to channel runoff, plant indigenous trees; use kettles to irrigate plants and use automated taps.
How do you manage and conserve your electricity?	**T1**: In the kitchen we use firewood, we are still waiting for the electrification of the kitchen. **T2**: We have just installed solar, we were using firewood and it became scarce. **T3**: We use a gas stove and sometimes firewood. We use energy saving bulbs.
How do you manage your school grounds?	**T1:** Our grounds are cleared, we have few trees because of lack of water. **T2**: We try to clear the grounds, we sometimes burn the shrubs, we have few trees that provide shade. **T3**: Loskop people donate us trees, we plant indigenous trees and shrubs that attract and host insects, bees and butterflies.
Which EE activities are you involved in e.g. EE calendar days?	**T1:** We are aware of some but they are not observed **T2:** Actually, let me say we do not do anything. **T3:** We observe heritage day, water week etc.
C4B: Policy systems How do you encourage conservation and sustainable ethics in school?	**T1:** Actually we don't, I think we need to have a policy to practice all this things. **T2**: We really don't have any. **T3**: Its just us with our innovative ideas and the love for nature.
C4B: ***Barriers and challenges*** What are your challenges of managing resources?	**T1**: Some of the things we cannot do them, because of our rural context. Like recycling, it is difficult for us to implement it, because it's expensive." **T2**: We had a vegetable garden, but because of pressures of time it ceased. **T3**: Unavailability of training and support

The findings of the above theme showed that sustainable practices were not effective, especially in C1 and C2, which led to less sustainable lifestyle changes. In cases where sustainable practices were implemented, it was for

convenience, and not to sustain resources, and were further not guided by any policies i.e. (switching from firewood to solar energy because of firewood scarcity). The participants were seemingly unaware of economic gains of managing and saving resources. C3 also had problems with managing waste but stated that some resource sustainability were practiced, and there were indications of lifestyle changes. The participants reported collaborating with other stakeholders to observe and honour important environmental days. Environmental literacy is observed through people's practices and lifestyle, which are core competencies of sustainable behaviour (Leicht et al. 2018).

Focus Group Interviews.

Table 11.

Theme1: Knowledge

Interview questions	Responses
C1A: Knowledge and understanding of EE content Have you learnt anything about the natural environment and if so, in which subject have you learnt it from?	**C1, L1**: is like things that are on nature that we use, Life Orientation, from Social Science. **C2, L3**: We once heard about it in Grade 6, They said is recycling, from Technology. **C3, L1**: The areas that we live in, atmosphere, temperatures, water, climate…from social science.
C1B: EE concepts Which EE themes have you learnt about?	**C1, L4**: Water pollution, diseases, littering. **C2, L6**: Pollution, littering, **C3, L2**: We learnt about reuse, recycling, pollution, ecosystems, land and atmosphere, and diseases.
C1C Ecological content and processes The following concepts were asked about to explore ecological processes: Atmosphere, pollution, erosion, climate change, ecosystem,	**C1, L5**: Climate change is the heating of weather. **C2, L3**: Climate change is this thing that they call a blanket, that protects us from the sun**.** **C3**, **L5:** Ecosystem is where other things depend on each other, like humans depend on animals, animals depend on plants depend on sun and water.

The responses of C1, L1 and C2, L3 on C1A showed that they learnt EE content in some of their subjects, but their knowledge and understanding were limited. C3, L1 showed embedded EE knowledge and understanding and knew how to apply the knowledge. On C1B, C1:L4 and C1:L6 showed knowledge of EE content but the knowledge was foundational and limited, as guided by the Grade 7 CAPS curriculum. C3, L2 portrayed extended knowledge of a variety of EE concepts, in line with the prescripts of CAPS curriculum. The C1 and C2 further portrayed unorganised and fractured knowledge of ecological processes, which means the learners were limited in terms of fully understanding the importance of ecological processes in their lives. C3:L5 responses showed in-depth knowledge and understanding as well as organised ideas on ecological processes, which are fundamental for the development of environmental literacy (Hollweg et al. 2013).

Table 12.

Theme 2: Attitude

Interview questions	Responses
C2A: Appreciation How important is the natural environment?	**C1, L4**: It is important, it gives us food. **C2, L3**: Our parents plant vegetables and food that we eat. **C3, L4**: It is important, it gives us food, provides animals with shelter, water, the air we breathe, it gives us life.
C2B: Perception How do you take care of the natural environment? Do you love taking care of the environment?	**C1, L3**: We pick up litter, it is a punishment when we come late. I don't like it, because people mock us. **C2, L4**: We pick up litter and burn it. **C3, L1 & 5**: We pick up litter, water the garden and trees, make compost. We love taking care of our environment.

C1, L4 and C2, L2 showed some sense of appreciation for and awareness of, the importance of the natural environment but their perception of picking up litter revealed their negative attitude towards good practices of care and protection which are necessary for inculcating action skills. C3, L1 & 5 showed an extended sense of appreciation and awareness of the importance of the natural environment. They engaged in activities that provided care and

protection for nature. A positive attitude can foster willingness to commit to take responsibility, by taking actions and caring for, and protecting the environment (Veisi et al. 2018).

Table 13.

Theme 3: Skills

Interview questions	Responses
C3A: Identifying environmental problems Which environmental problems have you identified in your surrounding?	**C1, L6**: Papers in the school yard. **C2, L2**: Cows eating plastics and pampers. **C3, L4**: Burning of waste causing air pollution, cutting of trees for firewood.
C3B: Taking responsibility. Who is responsible for those problems	**C1, L3**: Us **C2, L5**: People who have cows and those who litter in the streets. **C3, L2**: The government and us.
C3B: Suggesting environmental problems How would you solve identified problem?	**C1,L3**: Stop littering start planting trees **C2, L2**: People should not throw plastics and papers in the street. **C3, L1**: Government should provide dustbins, recycling, reusing waste, planting more trees.

The participating learners' responses showed that they were able to identify environmental problems in their surroundings, as well as sources of the problems and to provide solution. The ablity to identify environmental problems, evaluate and analyse those problems, and offer solutions, are what makes for an environmentally literate person (Hollweg et al. 2011). The C3 participants showed broader grasp on how to solve environmental problems than C1 and C2 participants.

Table 14.

Theme 4: Sustainable Behaviour

Interview questions	Responses
C4A: Sustainability lifestyle and practices How are you involved in school gardens and managing the ground?	**C1, L4**: There is no garden. Mr Maila is taking care of the grounds. **C2, L3**: We were watering the garden when we come late. The garden is dead now **C3, L1**: We water the garden, make compost.
How do you assist in managing water?	**C1, L2**: We use buckets to drink water, some learners drink from the tap. **C2, L5**: We do not wash our plates at the tap. **C3, L2**: We use a kettle when irrigating plants.
How do you assist in saving electricity?	**C1,L1**: By cooking with fuelwood **C2, L6**: We are not responsible for electricity. The school is, they bought solar. **C3, L1 &6**: We switch off lights, appliances when not in use.
In which EE projects do you participate?	**C1, L1**: We do not have projects. **C2, 3 & 5**: We do technology projects, **C3, 1, 2 & 6**: We make compost; make clothes with waste materials for competitions.

The C1 and C2 learner participant's responses showed limited sustainability related practices to guide and improve their behaviour. The C3 paricipants' responses showed that those learners were fully engaged in the necessary sustainability activities to guide their practices and lifestyle towards sustainable behavioural change.

Summary of Findings

The findings were presented in line with the three working levels of environmental literacy; the nominal, functional and operational levels (Roth, 1992). The nominal level requires a person to have rudimentary knowledge of natural systems, of how humans interact with them, environmental awareness and sensitivity with increased respect for nature. The functional level requires a broader knowledge and increased understanding of human and environmental interactions; greater awareness of, and concern for, negative human interactions; more developed skills to analyse, evaluate, and communicate feelings about environmental problems; and greater willingness to take actions to solve those problems. At the operational level, individuals demonstrate a strong and ongoing sense of investment in, and responsibility for, preventing and remediating behaviour, and routinely take actions that work to sustain and enhance healthy environments (Roth, 1992).

The findings placed both the C1 and C2 teachers and learners on the nominal level of environmental literacy. The observations revealed limited integrative teaching and learning approaches and few of the sustainable practices necessary to promote behavioural change. The findings of document analysis revealed the absence of a school environmental policy to guide environmental practices and shape lifestyles. The interviews revealed that, in both cases, the participants' EE content knowledge and ecological processes were rudimentary, which reflected their limited foundational competencies for developing environmental literacy (Ever, 2012). The participating teachers were also found to have limited pedagogical knowledge to teach integrated EE content, to effectively develop the environmental literacy of their learners. The findings revealed that the participating teacher lacked the performance of accomplishment component of Self-Efficacy.

The performance of accomplishment is the cornerstone for the development of teacher's expertise in the field of EE content, and in terms of the skills based competencies required to implement the integrated EE curriculum for the development of learners' environmental literacy (Bandura, 1977). The participants showed some sense of appreciation for the natural environment, but lacked persuasion, confidence, motivation, and support, to engage in actions aimed at providing care for, and protection to the environmental aspects, which are imperative for developing a positive towards sustainable practices and lifestyles. The participants also lacked vicarious experience, and the social persuasion component of self-efficacy. Sustainable behaviour change must be encouraged and motivated through support and incentives for engaging in sustainable practices.

As regards to C3, the findings placed both the teachers and the learners on an operational level of environmental literacy which can facilitate the development of skills based competencies and the expected behavioural change. The observations findings suggested that all participants had knowledge about, and an understanding of the importance of conservation and the sustainable use of resources. Although there was no environmental school policy, the garden project was guided by Green Garden policy (DEA, 2018). The participants were found to have in-depth EE content knowledge, its concepts and understanding of ecological processes. The findings matched that of the performance accomplishment component of self-efficacy. The teacher was an expert in the field of EE, portraying knowledge and skills based competencies which could help to develop learners' environmental literacy. These participants were also found to be appreciative of the natural environment, and were persuaded to engage in activities that provided care and protection of the environment. The participants were further found to have acceptable levels of skills based competencies, and engage in more sustainable programmes and projects, all of which are necessary to support the development of environmental literacy, and bring about behavioural change. They showed acceptable levels of vicarious experience, and social persuasion components of self-efficacy that encouraged them to engage in sustainable practices. Notably, the absence or existence of environmental literacy is often reflected by observable behaviour (Roth, 1992).

Conclusions

It is apparent from the findings reported on here, that the desired goal of EE to develop environmental literacy in schools has not reached the accepted level of promoting behavioural change across the board. The finding shows that challenges in developing environmental literacy do not solely emanate from teachers and schools, but from a lack of, and inconstant systems and policies aimed at guiding the implementation of EE, and a lack of teachers' development and support. The lack of environmental literacy competencies also affected the development of a self-efficacy belief which is vital for developing confidence and motivating individuals to work towards sustainable behavioural change (Almashard, 2017). Thus to improve environmental literacy in schools, policy systems guiding EE implementation should be clear in terms of guiding the content, and support should be given to practices which are necessary for developing environmental literacy and promoting sustainable behaviour in schools. The EE content curriculum, and

the teachers who teach EE content, are fundamental in developing environmental literacy and resource sustainability in schools (Songqwaru 2012; Kidman & Casinader 2018). Ongoing professional development and support that provides guidance on best practices, are enablers for developing environmental literacy and resource sustainability in schools (Ever, 2012).

Recommendations

Environmental literacy in schools can be improved by aligning the EE content curriculum with teachers' professional development, and strengthening teachers' ongoing development and support to build their expertise in terms of EE content. To that end, it is important to mandate the inclusion of frameworks and policies that guide sustainable lifestyles and practices, to encourage the development of sustainable behaviour in schools.

Limitations of Study

Due to time constrains, the study was conducted with Grade 7 teachers and learners in the Senior Phase, who provided in-depth information in answering the questions in the interview schedule. The study could have been conducted in the entire Senior Phase to provide a full report on the progress being made in developing environmental literacy within a phase. The study was conducted in rural primary schools. If urban and semi urban primary schools had been included, it would have provided a fuller picture of the effective development of environmental literacy across primary schools in South Africa

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Research Article

Using of sigil software in math education: e-module development and effects on self-regulated learning skills

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Self regulated learning skills

Abstract

In the delivery of content, it is important to have multimedia elements so that the learning material delivery can be well received by students. One of these elements is the e-module. This study aims to create an e-module based on Sigil software on enumeration principles, as well as to examine the effects on self-regulated learning (SRL) using the e-module. In this study, action research techniques were used. Some of the researchers are both practitioners and researchers in the research. This e-module development focuses on the development design phases of Alessi & Trollip (2001), which consist of three stages, namely: the planning stage, the design stage, and the development stage. Product tests were performed at the production stage to assess the feasibility of the e-module. The validation test performed was an alpha test and a beta test. The alpha test was carried out by seven content experts and two media experts. The beta test was carried out through a beta-1 test involving 30 students and a beta-2 test involving 27 students of Vocational High School, Lembang, Indonesia for the 2020/2021 academic year. Data were collected through interview guidelines, questionnaires for material experts and media experts, students who responded to questionnaires, and questions' tests. Data analysis techniques for assessing the viability of e-modules used descriptive data analysis, Cochran Q Test for three or more paired samples As a result of the study, an increase has been observed in students' ability to design e-modules for mathematics lessons. At the same time, it supported the development of student's cognitive and affective factors related to the mathematics course. It has been determined that e-module design is a very effective instructional design in the development of students' self-regulated learning skills. In future research, the effects of e-module design stages on students can be examined in detail. In addition, it can be examined in detail which self-regulated learning skills are developed and to what extent.

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Introduction

Under the circumstances of the Covid-19 pandemic that most countries in the world, are facing the necessity of the governments that are forced to transform schooling practices from face-to-face communication to home online-learning based. Since the transformation from schools' face-to-face learning to home online-learning environment is essential, therefore new challenges arise, i.e. the willingness of students and teachers in the implementation of changes. So far, students are accustomed to face-to-face learning with direct instructions and text-taught materials.

New independence still needs to be established. There are also few online learning materials that students can access. Research results of (Aljassar & Altammar, 2020) express the difficulty of teachers and students, in government schools of Kuwait, in synthesizing and retaining textbook knowledge when it is not supported by online learning materials. Research findings from (Supianti & Yaniawati, 2017) shows that pupils: do not have the

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initiative to learn by themselves, they wait for instructions or assignments from the teacher in learning; they are not used to diagnosing learning needs, students learn the material provided by the teacher, not what they need; students' learning goals/targets are still limited to obtaining satisfactory grades, not the abilities they should have developed; they are unable to monitor, regulate, and control learning, and seemingly to learn what is needed for the moment; there are still students who give up when they are faced with difficulties, and some even avoid it; and students rarely evaluate the learning process and results.

Self-regulated Learning & Technology Using in Math Education

Self-regulated learning (SRL) is essential for students since SRL is a determining factor in SRL (Wahyuni, 2010); (Cheng, 2011); (Murray, 2013); (Sundayana, 2018); (Bungsu, 2020). Zimmerman (1990) suggests that SRL is a mechanism that takes place due to the influence of goal-oriented thoughts, feelings, strategies, and behaviors.

Woolfolk points out that knowledge, motivation, and self-discipline are the factors that influence SRL. Woolfolk points out that the factors that influence SRL are a few knowledge, motivation, and self-discipline (Alhaddad, 2014). The freedom of learning emphasizes the value of personal accountability for learning practices. In the learning process, students with SRL can build learning goals, try to monitor, regulate, and control cognition, motivation, and behavior, to control predetermined goals.

In today's mathematics learning, the development of technology-based mathematics teaching materials that are innovative, creative, effective, efficient, and contextual, following the conditions, needs, skills, features, and socio-cultural fields, demanded schools and students. Initiative and enthusiasm for educating students using mobile learning are higher, and mobile learning is more appropriate for students who are afar and having ethnic differences (Chandran, 2010).

Mobile learning is described as the ability of mobile devices to learn anywhere and at any time (Johnson & Williams, 2020). The presence of e-modules is very useful for the consistency of the learning process, which cannot be achieved in face-to-face learning as it is today. One aspect of pedagogical competence is the capacity of teachers to develop and use media and learning resources (Peraturan, 2005). According to Dawley (Albalawi, 2017), a new pedagogy is required to effectively incorporate cellular learning into the learning environment. Sincuba & John (2017) argues that to generate positive attitudes among students towards mathematics, educators and researchers, consideration should be given to exploring alternative teaching and learning methods so that students can improve conceptual awareness and understanding and positive attitudes towards mathematics. Mobile Learning Technology-Based Instruction is a technologically advanced approach in this context (Sincuba & John, 2017).

Present conditions and technological advancements have enabled teachers to create e-modules. According to (Yaniawati et al. 2019) and (Hammad et al. 2020), mathematics is a science that underlies the growth of modern technology in Indonesia and Kuwait. Increasing technical advancements in all life factors have opened up opportunities to meet the needs for information technology facilities that will develop student mathematical skills (Yaniawati et al. 2020). In partnership with We Are Social, Hootsuite releases the development of internet users around the world, including Indonesia. In Indonesia, with a total population of 272.1 million, the Internet users reached 175.4 million in 2020, a rise of 17 percent from 2019. Meanwhile, the number of smartphones connected reached 338.2 million units, almost twice the number of Internet users. This means that many Indonesians have more than one smartphone at hand. It is hoped, therefore, that the e-module would be used by students. The application of ICT in mathematics at the secondary school level in West Java shows 99 % of mathematics teachers at secondary schools in West Java have used ICT in mathematics. The ICT forms, which are mostly performed by instructors, use interactive CD media, animations, and power points, as well as assigning students to search for content from the Internet. Meanwhile, online learning is the least type of ICT in use. Half of the teachers researched social media and used math tools. Other types of ICT that have been carried out include learning with android apps, statistical materials with Microsoft Excel, computer-based tests, and the use of blogs as learning media (Supianti & Yaniawati, 2017). Moreover, in Kuwait, the year 2020 encompassed a population of approximately 5 million people. Almost 90% of this population are internet users. The total number of students and teachers in schools and universities has reached 973,000. A majority of these students and teachers are utilizing advanced technology tools and e-learning platforms to progress in their learning at home during the pandemic.

Most junior high schools in Bandung, Indonesia, already have computer laboratories and internet connectivity; some schools also have their e-learning sites and local WiFi access (edubox) so students do not need a quota to access e-learning teaching materials. Teachers' and students' skills in the use of technology are also good (Supianti & Yaniawati, 2017). In one of our neighboring countries, Malaysia 80.14 % of the population are Internet users, which ranks third in the world after China in terms of e-learning growth rates at a growth rate of 41%. The implementation

of e-learning in many Malaysian universities, such as the Faculty of Education of Universiti Sains Malaysia (USM), in the learning phase, has been effective, and the e-learning facilities used in these institutions are good and adequate. Most lecturers use a range of mathematical applications such as Geogebra, Cabry, Maple, and other learning software.

Based on the data mentioned above, this study conducted research and development of e-modules assessed by Sigil software to improve SRL. Febro et al. (2020) reported that utilizing the e-learning module in the development of skills among participants was significant. Apsari, (2018) notes that research and development is a method or measure to produce a new product or to enhance an existing product that can be justified. Mathematics research and development needs to be undertaken as an enhancement to make it easier for students to understand mathematics. With ICT, students can control their learning progress without interference from others, can also browse learning materials as often as they need, and can repeat exercises to understand the content (Lin et al. 2017).

Problem of Study

The main problem of the study is;

- Does e-module design affect students' self-regulation skills in mathematics teaching?

The sub-problems of the research are as follows:

- What actions should be taken for students to master e-module design with Sigil software?;
- What kind of pedagogical path should students follow in which stages in e-module design with Sigil software?
- How is the quality of students' e-module designs in terms of expert evaluation?

Method

Research Model

This study uses a research and development (R & D) model of Alessi & Trollip (2001), which consists of three stages, namely: the planning stage, the design stage, and the development stage. Product tests were performed at the production stage to assess the feasibility of the e-module. R & D is a research method used to produce a particular product, and test the effectiveness of the product. It is the process or steps to develop new products or improve existing products (Sugiyono, 2016).

Participants

The beta test activity was carried out in two stages consisting of beta test 1 to 30 students of class XII and beta test 2 was carried out to 27 students of class XI poultry.

Table 1.

Structures of Participants

		Beta Test 1		Beta Test 2	
		F	%	F	%
Gender	Female	24	80	22	81
	Male	6	20	5	19
Grade		XII		XI	

Lembang State Animal Husbandry Vocational School was established on October 13, 1980, with National School Principal Number (NPSN) 20267759, School Statistics Number (NSS) 322022301304. Lembang Animal Husbandry Vocational School achieved accreditation A with Expert Competencies owned are Ruminant Livestock Agribusiness, Poultry Livestock Agribusiness, and Veterinary Nursing. Information can be accessed at www.snakma.com and email admin@snakma.com.

Figure 1.
School Building

Figure 2.
Computer Laboratory

Data Collection Tools

Data were collected through the following instruments: validation sheet of teaching materials, used to measure the quality of teaching materials (e-module sigil); Questionnaire, used to measure learning independence; interviews, used to measure self-regulated learning and strengthen the data in the questionnaire.

Self-regulated Learning Scale

Self-regulated Learning Scale to developed by teachers and validated by some experts. The development of this instrument went through two times expert reviews and two trials. The instrument was carried out by nine experts involving seven material expert validators and two media expert validators. The material questionnaire consisted of 20 question items about the content of mathematic and 27 questionnaires about media of information technology. The review results from seven material experts gave an assessment of 4.19 and input in terms of editorial/language revisions. Meanwhile, the results of a review from two media experts assessed 3.97, and input in terms of animation should be opened directly from the application. Furthermore, the instrument was tested in the first stage on 30 students and resulted in the reliability of Cronbach Alpha r = 0.646 then the second stage was tested on 27 students and resulted in r = 0.684.

Semi Structural Interview Form

Interview forms were conducted with nine questions to six students (three superior and three low), who used e-modules assisted by sigil software. One of the questions is: Have you studied mathematics using e-modules, did it make you understand and understand more about the material of counting rules?

T: Have you studied mathematics using e-modules, did it make you understand and understand more about the material of counting rules?

S: The e-module helped me in understanding the material on the rules of enumeration and it was more interesting because there was a video

Student response questionnaires, and interview sheets. Quantitative data were obtained from questionnaires and qualitative data were obtained from answers or recommendations from content experts, media experts, and students, as well as from interviews.

Data Analysis

Data analysis techniques for assessing the viability of e-modules used descriptive data analysis, Cochran Q Test for three or more paired samples (Riyadi et al. 2017).

Procedure

The development model uses the steps of Alessi and Trollip (2001). It is very suitable for developing digital modules (e-modules) since this development model describes multimedia components such as text, pictures, animation, and video. The production phase of Alessi and Trollip consists of three stages in product development, namely planning, design, and development. The development stage scheme can be seen in the following Figure 3:

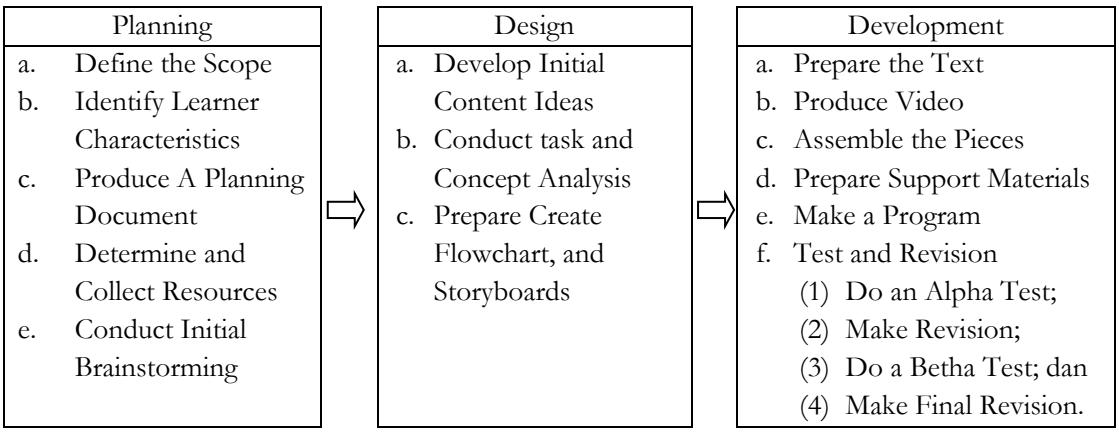

Figure 3.
The Steps for Alessi and Trollip's Development Model (2001)

At the **planning** stage, the activities carried out are (1) determining the objectives and material, namely the rules of enumeration; (2) identify the characteristics of e-module users, namely mathematics teachers and students of Vocational High School, Lembang, Indonesia; (3) make the initial product design; (4) collect relevant data or sources in making the e-module; and (5) gathering ideas in product development, by holding a Focus Group Discussion. At the **design** stage, the authors carried out the following activities: (1) designing the initial content of the e-module display assisted by Sigil software; (2) analyzing assignments and concepts, namely determining the order of the material and organizing the material so that it is easy for students to understand; (3) create flowcharts and storyboards. At the **development** stage, the following activities will be carried out: (1) preparing the text of the enumeration rules; (2) prepare learning videos related to enumeration principles; (3) combining text, images, and videos; (4) preparing other supporting materials; (6) create an e-module following the designed storyboard and supported by prepared text, images, and videos; and (7) testing and revising the e-module.

Thus, when tested and revised, a product is of high quality. The evaluation phases of the product are the alpha test and beta test. The alpha test (validation) is done by seven content experts and two media experts. The validity test is structured to provide relevant, meaningful, reliable, and useful information in concluding the researchers (Effendi, Zulkardi, Putri, & Yaniawati, 2018). The e-module product has been updated based on input from content experts and media experts (Moore, 2012). If the analysis findings have been accepted by the content expert and by the media expert, a beta test will be carried out. The beta test is split into two phases: beta-1 and beta-2. The beta-1 test consists of up to 30 students who have already been given enumeration materials, while the beta-2 test consists of 27 students of Vocational High School, Lembang, Indonesia. The purpose of the beta-2 test was to determine the student's response to the e-modules assisted by Sigil software on the material used in the listing rules. In addition, the student response questionnaire findings have been collected and analyzed.

Results

Using Sigil Software

Figure 4 shows the initial Sigil software that is an open-source editor software for epub. Epub (electronic publication) is a digital format, which is a standardized format introduced by the International Digital Publishing Forum (IDPF) in 2011. The open eBook replacement program that acts as an open book format is epub which can be accessed from HTML, XHTML, XML, CSS files that act as a single file with an epub extension. The epub format is today's most common digital book format. This is because different features can be used to alter the appearance of an ebook on the epub such as the availability of commands used to insert video and audio files, in addition to images and text, to further improve the presentation of the book. In addition, epub is also friendly and supports many devices, such as Android computers (using Ideal reader, FBReader0, iOS (ireader), computers (accessed on Google Chrome, Firefox plugins), Blackberry Playbook, SonyReader, and various other devices (Maharani et al. 2015).

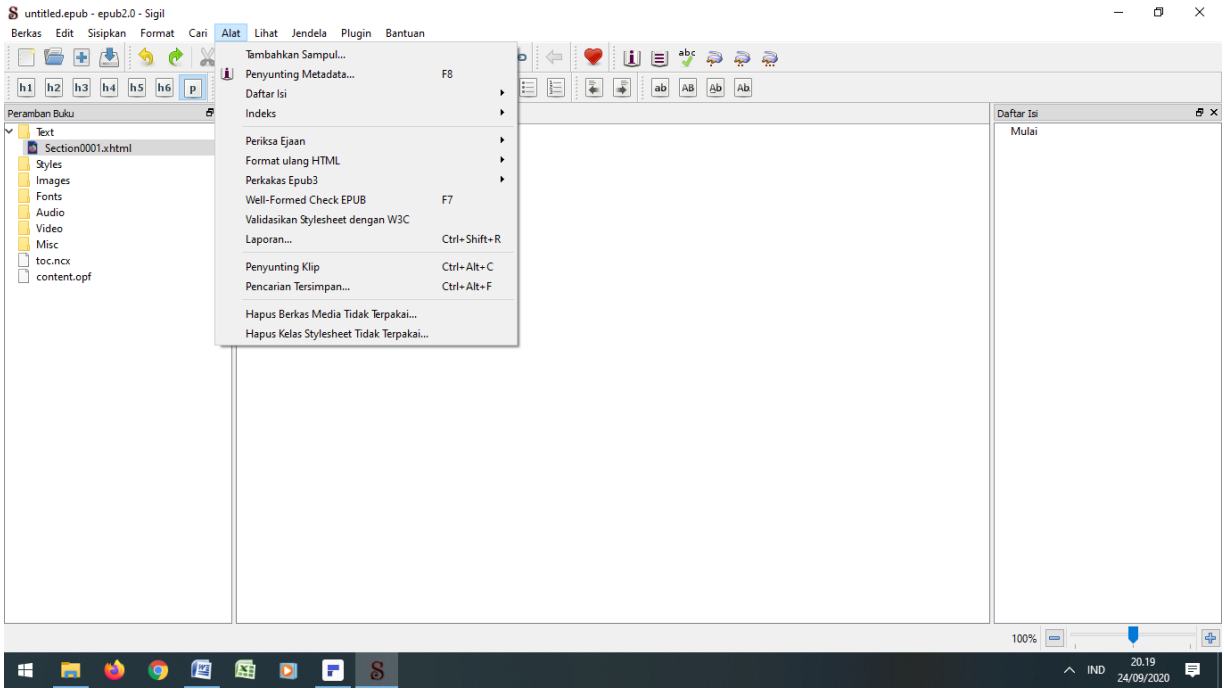

Figure 4.
Initial Display of Sigil software

The material that has been described and stored in a doc format can be extended using epub. To run and develop the epub, first compile the teaching material into a word. Then save the material that was created with the HTML extension, by selecting File>Save as>Web Page, filtered. However, before that, the editing was carried out in such a way that the material produced did not change when it was converted to Sigil using epub. After editing the material to be rendered in the next word, enter the Sigil HTML tab. The first step that needs to be done is to open the HTML file that has been rendered to Sigil using File>Open, then select the HTML file.

Counting rules are the rules used to calculate all the possibilities that may occur in a case. There are a variety of techniques for counting rules, such as counting techniques, factorial notation, permutation, and combination. The difference between permutations and combinations in the solution of verbal problems is that verbal problems are solved by permutation if the order of the elements is reversed with different values or if the elements in the problem have a status. In the meantime, verbal questions are resolved in combination if the order of the reversed elements is the same or if the element in question has no status.

The SRL is a combination of academic skills and self-control that makes learning easier, making students more motivated. Independence emphasizes student learning experiences that are full of accountability for student progress in learning. The attitude of freedom can be seen by the ability to overcome behavioral problems. With behavioral improvement, students often have an increase in thought, assuming that learning must be independent without relying on the help of others. SRL is a recursive (repetitive) cognitive activity cycle that involves practices to evaluate tasks, choose, adopt or define strategic approaches to achieving the objectives of the task, and track the outcomes and strategies that have been implemented. SRL is not individual learning, but learning that involves a student's independence from learning (Astuti, 2016).

Bartholomew (Mulyono et al. 2018) specified that SRL is the ability of students to assess themselves and ask questions so that they know. Learning for independence blends an understanding of what is also not understood with an understanding of learning to gain knowledge. The most important student attitude is SRL in mathematics. Independence in studying mathematics does not mean that students learn to distinguish themselves from other students. As Mu'tadin reported in (Hasibuan et al. 2018), an independent study is not an effort to alienate students from study partners. Students can ask questions, discuss or ask for explanations from others. SRL will be generated from the SRL process. The key feature of SRL is that the growth of students' learning skills does not rely on factors such as instructors, peers, classes, and others. Haris Mudjiman (Astuti, 2016) argued that the implementation of an independent learning process is one solution to the issue of quality education. SRL is an active learning practice that is motivated by a desire to master a skill and is based on the experience or skills that you already have. SRL offers opportunities for students to digest more learning materials with less material from the teacher.

Development of e-modules Assisted by Sigil Software

Based on the researcher's study, it is understood that the Vocational High School, Lembang, Indonesia, still uses textbooks and PDF modules that students will feel bored with learning. The unavailability of IT-based learning media makes learning dull and monotonous. It is therefore important to create updated digital teaching materials to make them more appealing by integrating videos in the form of e-modules assisted by Sigil software to make the learning process more engaging and to enhance student's critical thinking and SRL skills. This is in line with the view (Aljassar & Altammar, 2020) regarding the problem of SRL, media that can increase SRL in the millennial era is computer and internet-based media, which is often called digital media.

Development of e-modules assisted by Sigil software on enumeration rules material carried out using the Alessi and Trollip model phases, i. e. planning, design, development (Peraturan, 2005). The final product to be produced is an e-module with an epub file. This development model starts at the planning stage. According to (Sari, 2016), the planning process involves tasks such as student needs analysis, curriculum analysis (KI-KD), designing and developing media, preparing questions and answers, determining the suitability of materials for curriculum needs, and collecting e-module fonts, images, and videos.

After the planning has been completed, the next step is the design stage. The product being developed is an e-module with the assist of Sigil software for enumeration rules, which are adapted based on basic competencies. At this stage, the preparation of e-module products is carried out with the aid of Sigil software and validation tools. The process for the development of the e-module assisted by Sigil software consists of opening, content, and closing. The opening part is covered by the e-module teaching materials. The content section consists of a table of contents, concept maps, basic skills, learning goals, history, contextual problems, material, summary, practical questions, post-test. And there is a reference in the closing section.

The next stage is development. This is the stage of making an e-module assisted by Sigil software and the alpha test stage. According to Elyas and Yudianto, in (Murray, 2013) short steps to make the Sigil application are: (1) install the Sigil application, (2) prepare files that will be used as digital books, (3) run the Sigil application, (4) save work results in the form of an epub, (5) opening files with a reader application.

The finished product is subjected to an alpha test by educational experts and practitioners consisting of lecturers and teachers. In the meantime, media experts are made up of digital simulation teachers and productive teachers. Validation aims to obtain feedback, suggestions, and criticism to enhance the e-module assisted by the Sigil software being developed. After the validation has been completed, the teaching material is then revised by expert feedback on the validation questionnaire. From the results of the evaluation of content experts and media experts, the e-module assisted by Sigil software was given a decent category. As a result, the researchers concluded that the e-module assisted by the Sigil software on the developed material of the enumeration rules met the valid criteria so that the e-module could be tested.

After the product has been declared feasible by the experts, the next step is a blind test. Based on the results of the beta-1 test, the e-module assisted by Sigil software has obtained a feasible category, so that the e-module product assisted by Sigil software on the enumeration rules material has been declared suitable for use following the expert review. In the second beta test, two forms of data collection were carried out, namely the collection of students' response questionnaires for e-module items assisted by Sigil software on enumeration rules material and data collection of test results. Based on the results of the student response questionnaire, it was concluded that the e-module assisted by Sigil software could be used. In the meantime, based on the size of the effect, it can be concluded that the use of the e-module assisted by Sigil software is effective in improving students' critical thinking skills.

Based on previous research by several researchers, such as (Alperi, 2015) and (Wirasasmita & Uska, 2017), the novelty of this study lies in the development of e-module teaching materials assisted by Sigil software on enumeration rules. Previously some used Sigil software teaching materials but in other materials. No one has yet developed the material for the enumeration rules. Then some have developed teaching materials on the principles of enumeration, but they are still in pdf format.

According to (Alperi, 2015) Sigil's digital books have advantages compared to other digital books, including being able to contain video content, images, and sound/ songs so that learning becomes more interesting and students become more active. The advantages of the product in the development of Sigil-assisted e-module teaching materials are: (a) Sigil-assisted e-module teaching materials are easy to apply because they can be opened on smartphones and laptops/ PCs, (b) Sigil-assisted e-module teaching materials software can be accessed offline so that it will not be a problem for students in using e-module assisted by Sigil software when running out of internet data packages, (c) e-module teaching materials assisted by Sigil software are easy to understand and operate, (d) e-

module teaching materials assisted by Sigil software can insert a video that can be opened so that students do not feel bored in learning the material.

Amalia and Kustijono (2017) that the product weaknesses are: (a) the e-module product assisted with Sigil software requires an epub reader application so it must first download the epub reader application, (b) the e-module product assisted with Sigil software developed in this study is only limited to material enumeration rules, (c) the Sigil-assisted e-module product cannot be directly inserted with animation. The animation form must be converted into an MP4 format, (d) e-module products assisted by Sigil software cannot be directly inserted into the mathematical formula text in the form of Microsoft Equation. Text in the Microsoft equation must first be converted into JPG form.

In Clark and Mayer (Yogiyatno & Sofyan, 2013), it is argued that the best research approach to assess the efficacy of learning is to compare the test performance of students learning with the learning characteristic studied with the test performance of students learning without the learning characteristics studied. One of the teaching materials that help develop psychomotor skills is e-modules (Wulandari, 2013).

This research and development led to the creation of an e-module product with the aid of Sigil software, enumeration rules. The e-module was shown to be feasible by experts and field trials were conducted to assess its efficacy in the opinion of the students. E-module assisted by Sigil enumeration rules meets the development phases of Alessi & Trollip, including the planning, design, and development phases. The following shows a variety of e-module displays assisted by the Sigil program on the enumeration rules.

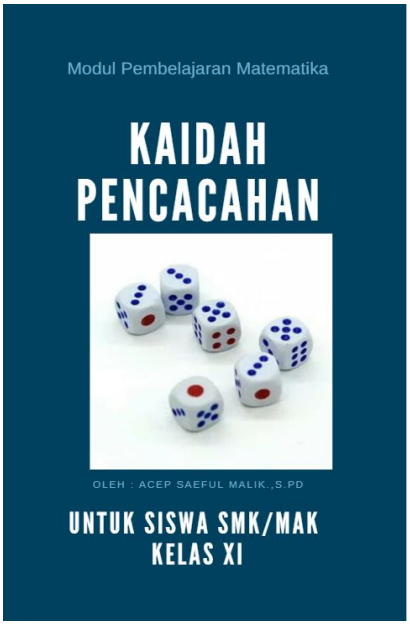

Figure 5.
Cover View

Figure 6.
Material Display

Figure 5, is shown the front cover page of the e-module product with the help of the Sigil software in the enumeration rules material is the title page and user identification. The cover page "Mathematics Learning Module Enumeration Rules for SMK/ MAK students", shows an example of the inclusion of certain dice that are frequently used in the Learning Enumeration Rules to draw students' attention.

In Figure 6, the image content on the material is developed in the form of a jpg file to produce an accurate image form. The use of color in the quality of the picture is clear and easy to read. Text and photos are displayed close together on a single page. The picture presentation is intended to provide an example of the material presented.

Figure 7.
Display Material Contains Video

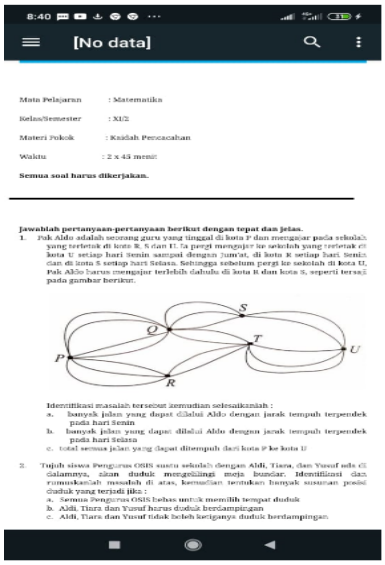

Figure 8.
Evaluation Material Display

Figure 7, is shown an e-module assisted by Sigil software on the enumeration of rules of the material equipped with a video explaining the material and discussing the questions. The video content presented here is a description in the form of a short animation of the subject. The next video includes lessons on the sub-chapters found in the e-module assisted by Sigil software, namely counting, permutation, and combination techniques. Thus, every video can be played at the end of each segment of the content. The resulting video is fitted with a button for play, pause, stop, volume, and full-screen. Students can easily pause, play the video as they wish on video supported by the Sigil software MP4 which is obtained from YouTube.

In Figure 8, the evaluation material on the e-module assisted by Sigil software on enumeration rules material is presented in the form of multiple-choice questions and description questions. At the end of each section, ten evaluation questions are given, consisting of three evaluation materials. For the final evaluation (posttest), six items are presented in the description.

Evaluation of e-Module Desing by Experts

The product validation test based on the Alessi and Trollip (2001) development model was carried out in two stages of activity, namely the alpha test and the beta test. The alpha test was carried out by seven material experts and two media experts, and the beta test consisted of two stages, namely the beta-1 test carried out by 30 class XII students and the beta-2 test was carried out by 27 class XI students of SMKN Livestock Lembang. The next step was to carry out the validation test phase by two content experts and media experts to assess the feasibility of the product and make revisions if there are suggestions from the two experts. After the e-module with Sigil software was finished, the experts reviewed the quality of the e-module with Sigil software. There is a comment column in the feasibility questionnaire filled out by the experts to get suggestions for a review process of the e-module with Sigil software on enumeration rules material.

Based on the results of the evaluation by seven material experts on the four aspects, an average score of 4.19 was achieved, which was qualitatively categorized as Feasible ($3.4 < x < 4.2$). Results of the examination by seven material experts on the four dimensions of the material validity assessment are summarized in Table 1 below.

Table 1.
Result of Material Expert Assessment

Aspect	Material Expert							Average Score	Category
	I	II	III	IV	V	VI	VII		
Theory	4.44	4.11	4.33	4.33	4.22	4.56	4.78	4.40	Very worth it
Question	4.83	4.33	4.00	4.00	4.33	4.17	4.00	4.24	Very worth it
Language	4.00	4.00	4.00	4.00	4.50	4.00	4.00	4.07	Well worth it
Implementation	4.00	4.00	4.00	4.00	4.00	4.33	4.00	4.04	Well worth it
Average Total Score								4.19	Well worth it
Category								Well worth it	

Results of the two media experts' evaluation of these three factors showed an average overall score of 3.97, qualitatively classified as eligible (3.4 < x < 4.2). Therefore it can be assumed that the e-module product assisted by the Sigil program on the enumeration rules material, is appropriate for use in compliance with the proposed revisions. Findings of the evaluation of the three dimensions of validation by two media experts are summarized in Table 2.

Table 2.
Result of the Media Expert's Assessment

Aspect	Media Expert		Average Score	Category
	I	II		
Display	4,40	3,93	4,17	Well worth it
Use	4,33	3,67	4,00	Well worth it
Utilization	3,50	4,00	3,75	Well worth it
Average Total Score			3,97	Well worth it
Category			Well worth it	

Results from the beta-1 test assessment carried out by 30 students on the three aspects concluded that the e-module assisted by Sigil software on enumeration rules material is suitable for use for the beta-2 test following the suggestions and input. The average overall score in this beta 1 test was 3.77 which was qualitatively categorized as "feasible" (3,4 < x < 4,2). The following Table 3 presents the beta-1 test of the three aspects of the assessment.

Table 3.
Result of Beta-1 Test Assessment

Aspect	Average Score
Software	3,73
Learning Design	3,74
Visual Communication	3,85
Average total score	3,77
Category	Well worth it

Results of the beta-2 test assessment which consisted of three aspects overall can be concluded that the e-module assisted by Sigil software on the enumeration rules material showed an overall average score of 3.57. Qualitatively, it is included in the feasible category (3,4 < x <4,2). The following Table 4 presents the results of the assessment of the three aspects by the beta-2 test.

Table 4.
Result of Beta-2 Test Assessment

Aspect	Average Score
Software	3,54
Learning Design	3,46
Visual Communication	3,72
Average total score	3,57
Category	Well worth it

Effect Size of the e-Module Assisted by Sigil Software

An effectiveness test was carried out by giving pretest and posttest to determine the level of effectiveness of the e-modules assisted by Sigil software product that was developed to analyze students' mathematical critical thinking skills, namely by looking at the difference in scores before and after using the e-module assisted by Sigil software. The pretest and posttest activities are carried out after the beta-2 test. Calculation of results of the effectiveness test was carried out using the effect size.

The test instrument was carried out on all students of the Vocational High School, Lembang, Indonesia. Complete data from the pretest and posttest results can be seen in Table 5. From the post-test results data, more than 80% of students have reached the minimum mastery criteria. Mathematics learning using e-module assisted by Sigil software by giving 6 essay questions. The questions have gone through the material expert validation process. The number of questions was based on considerations of the supervisor, material experts, and teachers of the

Vocational High School, Lembang, Indonesia. Based on results of data analysis calculated using the effect size formula. Results of the overall effect size assessment can be seen in Table 5.

Table 5.
Result of Effect Size Assessment

Group	Pretest Mean	Posttest Mean	Posttest Standard Deviation	Effect Size	Criteria
Experimental Group	21,98	75,68	12,28	4,37	High

Based on Table 5, the value of the effect size is 4.37, including the high criteria. This illustrates that the use of e-modules assisted by Sigil software on enumeration rules material has a very significant effect on the mathematics learning process. In addition, the use of e-modules assisted by Sigil software is more effective and can improve students' critical thinking skills. The pretest and posttest questions used consisted of six items representing six-question indicators.

Effects on Student Regulated Learning (SRL) Skills

The SRL data was collected from a questionnaire using the Likert scale. The questionnaire consisted of 30 statements, of which 15 were positive questions and 15 negative questions, and were answered by 27 students of the Vocational High School, Lembang, Indonesia. After completion, the data from the results of the questionnaire were collected and the data were analyzed to understand the student's learning independence through the use of the e-module assisted by Sigil software on the enumeration rules material. Based on the results, the total average student response rate was 40.79 %. This means that almost half of the students are independent in learning mathematics.

Discussion

The development of the e-module with Sigil software helps to generate digital reading rules that are packaged with the Sigil software, as the e-module has text, imaging, and video content. In addition, the e-modules assisted by Sigil software product contains components including cover page, table of contents, concept charts, basic skills, learning objectives, history, contextual problems, documents, summaries, questionnaires, blogs, debate, and a website reference, Filtered (*HTM; *HTML, etc.) that is then saved in the form of a web page.

Furthermore, all content becomes one file in the form of text, images, and videos to become an epub file. This epub file can be opened on a laptop/ PC by using the help of the Readium application on Google Chrome. To open an epub file on a smartphone, a person uses an epub reader application or Readily which can be downloaded via Google Playstore on a smartphone. As Al Fakih stated (Al Fakih, Morei, & Salehi M, 2020) that learning via cellphone has become one of the most popular learning tools used by the younger generation, which is the result of using these devices in education. The use of e-modules assisted by Sigil software on enumeration rules material is feasible and has a significant effect on the mathematics learning process.

The SRL of students using e-modules assisted by Sigil software is successful in improving SRL, as can be seen from the attitudes of students who demonstrate self-confidence in the learning process. Yamada et al. (2017) said that SRL is an important educational theory and concept in education, globally. Students learn on their own whether or not they have teachers. As result students are encouraged to pursue exercises to read and review materials from a range of outlets before and after learning activities, such as textbooks, e-modules, and the Internet.

As a result, many emerging technologies can provide more knowledge upon entering the technological age. Technology is evolving as time continues to develop (Pratama, Ulfa, & Kuswandi, 2018). Concerning technology that is increasingly sophisticated and easy to access at affordable prices, modules that are usually presented in printed form using electronic technology using computer modules can now be presented in digital form and called e-modules.

The development of the media is currently undergoing a transition in the time from the initial use of print media to digital media. This has an impact on the world of education, particularly in the presentation of learning media. The presentation of learning media allowed the use of interactive media, not restricted only to print media. An example of this presentation is an e-book. An e-book or e-book is an electronic edition of a printed book that involves an electronic computer and special software for opening the book.

The existence of innovation in the development of teaching materials in learning is driven by the development of e-book technology. According to (Kassabolat et al. 2020), that the use of teaching materials prepared following the principles of learning technology, is important for individuals to design an effective and interactive learning environment. Therefore, the teaching materials can be transformed into electronic presentations, one of which is e-

modules. Electronic modules can be defined as learning tools designed electronically, containing interesting and systematic material to achieve an expected competency (Awaluddin & Wanarti, 2016).

Thus, technology will help increase students' confidence in learning. This is in line with Attwell's study (Albalawi, 2017) that, cellular learning helps students build self-esteem and self-confidence with technology. In the research result of Wong and Wong (2019) that technology can increase students' interest in learning and related to mathematics performance. The electronic module adapts the characteristics, format, and parts of the print module in general. The objectives of the e-module are as follows: (1) students can learn independently with or without teacher guidance; (2) the teacher's role is not too dominant in learning activities, (3) accommodating various levels and speeds of student learning, (4) students can measure their level of mastery of the material that has been studied. Based on the above conclusion, it can be defined that the e-module is a learning medium whose effectiveness would be the same as face-to-face learning. The e-module may be said to be a tutorial activity on the part of a writer that is delivered in writing, and thus e-module should be written as a teaching subject or something that communicates learning and put forward in the module that has been written.

Conclusion

Based on the results of the development and discussion of e-module development assisted by sigil software, the authors can draw the following conclusions: E-modules are effective in generating student learning independence, as can be seen from the attitude of students who show confidence in the learning process. Students learn on their own whether there is a teacher or there is no teacher. Students are motivated to engage in activities to prepare and study material before and after learning activities from various sources, namely textbooks, e-modules, and the internet; development of E-modules assisted by sigil software on enumeration materials produced in a digital form packaged using sigil software. The resulting e-module product is equipped with text, image, and video content. In addition, e-module products assisted by sigil software consist of components which include, table of contents, concept maps, basic competencies, learning objectives, history, contextual problems, materials, summaries, questions, posttests, discussions, and references in files. MS word is then saved in the form of a Web Page, Filtered (*.htm;*html) which is then converted using sigil software. Furthermore, all the content into one file in the form of text, images, and videos into an epub file. This epub file can be opened on a laptop/PC by using the Readium application on Google Chrome. Meanwhile, to open epub files on a smartphone using the epub reader application or easily which can be downloaded via google play store on a smartphone. The use of e-modules assisted by sigil software on enumeration materials that are suitable for use and have a significant effect on the mathematics learning process; the resulting product is effective for use in improving critical thinking skills, as evidenced by the material expert's right of 4.19, the media expert's assessment of 3.97.

Recommendations

Based on the results of the study and the conclusions obtained, the following suggestions can be submitted: (1) This e-module needs to be developed again on other materials because in this study only material for enumeration rules was developed, (2) The use of e-module products assisted by sigil software, the teacher should re-explain the material or practice questions contained in it, (3) The teacher first explains about the product and its use with the aim that it is easier for students to understand the material presented in the e-module product assisted by sigil software, (4) Because there is still a lack of prior knowledge of students and this has an impact on the test and learning process, for further researchers to conduct a more in-depth preliminary study of these mathematical problems.

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Appendix 1.

Interview Question

1. What do you think about math?
2. What do you think about how to teach teachers in the classroom (teacher lectures)?
3. In your opinion, what is fun math learning like?
4. What do you think about realistic learning related to everyday life?
5. Have you studied mathematics using e-modules, did it make you understand and understand more about the material of counting rules?
6. According to your experience, is it possible to solve math problems after using the e-module assisted by sigil?
7. Are you trying to find alternative methods of solving problems?
8. Do you have the interest and curiosity to get solved math problems?
9. Are there any suggestions and criticisms regarding the mathematics learning that I did during the research?

Questioner

1. Clarity of the formulation of learning objectives
2. Relevance of goals with KI, KD
3. The suitability of the material with the purpose
4. Material update
5. Material depth
6. The systematic, coherent, clear logic flow
7. Clarity of question formulation
8. Completeness of questions
9. The truth of the question concept
10. Providing feedback on the evaluation results
11. Consistency of evaluation with learning objectives
12. Communicative on language
13. Accuracy in the use of terms
14. Giving the motivation to learn
15. Student activities

Material Expert Validation Questions

A. Hint

This validation questionnaire is filled out by material experts who master their fields
This validation questionnaire is intended to obtain information from you as a material expert regarding the quality of the product of teaching materials for mathematics subjects that are being developed.
Answers are given in the column of the rating scale that has been provided, with the rating scale:
5 = Very good
4 = Fine
3 = Enough
2 = Not Good
1 = Very Poor
Please put a tick (√) in the column of the rating scale that corresponds to your opinion
Please provide comments and suggestions in the space provided.
No Assessment Question
1 2 3 4 5
Material Aspect
1 Learning objectives are formulated
2 The material delivered is by KI, KD
3 The material delivered is by the learning objectives
4 The material delivered is actual
5 Materials delivered in complete media

6 The material is delivered clearly
7 Materials are delivered systematically
8 The material presented is packaged in an attractive way
9 The material presented is easy to understand
Aspects of Questions
10 Questions are formulated
11 Questions in complete media media
12 Questions according to theory and concepts
13 Answer keys according to the question
14 There is feedback on the evaluation results
15 Evaluation is consistent with learning objectives
Language Aspect
16 The language used is communicative
17 The terms and questions used are appropriate and appropriate
Implementation Aspect
18 The material can be understood by students
19 The material presented attracts students' attention
20 Students are more active in doing learning activities

B. Comments and Suggestions
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C. Conclusion
This medium is stated *)
1. Worth trying out
2. Worth testing with revisions according to suggestions
3. Not worth trying out
*) Choose one by circling the appropriate conclusion

Bandung, ...
Material Expert

(_____)

Media Expert Validation Questions
A. Hint
This validation questionnaire is filled out by media experts who are experts in their fields
This validation questionnaire is intended to obtain information from you as a media expert regarding the quality of the product of teaching materials for mathematics subjects that are being developed.
Answers are given in the column of the rating scale that has been provided, with the rating scale:
5 = Very good
4 = Fine
3 = Enough

2 = Not Good
1 = Very Poor
Please provide comments and suggestions in the space provided.
Display Aspect
1 Clarity of the title of teaching materials
2 The legibility of sentence structure makes it easier for students to learn
3 Appropriate use of color proportion
4 Accuracy of background color selection
5 Compatibility of font selection
6 Appropriateness of font size selection
7 Clarity of the display of supporting images of the material
8 Clarity of display animation supporting material
9 Clarity of video display supporting material
10 Interesting pictures in the content of teaching materials
11 The attractiveness of animation in the content of teaching materials
12 Interesting videos in the content of teaching materials
13 The beauty of the cover
14 The suitability of the cover design with the material
15 Customization of the main menu button display (bookmark display, print, and logout)
Aspects of Use
16 Ease of use of the product
17 Precise use of buttons and navigation
18 Ease of accessing the product menu (back to the desired page)
19 Ease of interacting with the product
20 Ease of access out of the product
21 Completeness of module identity
Utilization Aspect
22 Compatibility of teaching material components with module systematics (cover, concept map, basic competence, learning objectives, history, contextual problems, materials, quiz summary, post-test, references)
23 The suitability of the language used communicative
24 contemporary material
25 Has a visual appeal that includes colors, images, illustrations, font shapes, and sizes (bold, italics, underlines)
26 The accuracy of giving feedback on student input
27 Possibility of students doing self-assessment

B. Comments and Suggestions
....
....
C. Conclusion
This medium is stated *)
1. Worth trying out
2. Worth testing with revisions according to suggestions
3. Not worth trying out
*) Choose one by circling the appropriate conclusion

Bandung, ...
Media Expert
(_____)

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Research Article

Investigating and analyzing the situation of the talented students of shahid beheshti university of medical sciences: a qualitative study

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Abstract

In this era, investing in human resources, especially the talented, is specifically important because they have high potential, creativity and initiative to advance science.so the present study was conducted to investigate the situation of the talented students at Shahid Beheshti University of Medical Sciences. The present study is a qualitative research of content analysis type with a conventional approach. Participants included talented students who were selected by targeted sampling method in2019. Data collection was performed using in-depth and semi-structured individual interviews. From the findings of this study, four main themes were obtained,which include poor educational situation, research problems, inappropriate welfare services and weakness in performing cultural affairs. The results of the present study showed that the problems of the talented students in the fields of education, research and welfare are more than before. Therefore, it is suggested that the authorities and planners pay more attention to meet the needs of this group of students.

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Introduction

In this era, investing in human resources, especially the talented, is specifically important because they have high potential, creativity and initiative to advance science (Nikneshan et al. 2010 & Maker, 1982). A highly talented person is a person with a potential of elitism, however, has not yet reached that condition and requires a process of guidance and empowerment to gain expertise and ultimately influence the environment (Renzulli, 2000). In fact, human resources with the potential of elitism have capabilities beyond the general level of capabilities and mainly have major potential capabilities (Nazemi et al. 2012) that can move towards elitism in appropriate conditions.

According to the results of the study other., talent management can lead to individual and organizational excellence as the highest level of performance in universities (Nazaripour et al. 2017). Therefore, curricula and the environment of universities should be such that they do not hinder the growth and flourishing of their talents and creativity (Nikneshan et al. 2010 & Maker, 1982). Identifying the talented in the education system based on correct and scientific criteria can be the first step in developing an appropriate policy plan. On the other hand, the needs, interests and

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problems of these people must be carefully identified. So that specialists can develop an appropriate plan for their flourishing and ability in scientific and academic fields so that talented people can express their utmost abilities (Cantu,1998).

Most people who have worked in the field of the talented do not consider ability alone enough for success in creative programs, but consider other factors such as motivation, lack of problems, and intellectual preoccupations and appropriate planning of educational institutions as highly effective (Csikszentmihalyi, 1996). According to the report of the Commission of the Talented Education of America, a highly talented person is a person who, because of his prominent abilities, has high performance capabilities and as a result needs different educational and service programs to be able to appropriately serve the society. Therefore, programs related to the talented in universities must identify all the talented and abilities of individuals and try empowering them, which requires comprehensive planning. In the study by Nasrabadi & Nowruzi (2006), conducted to investigate the level of satisfaction of elite students of the University of Isfahan with educational components, there was a gap between the current situation and the desired. In the study by Nikneshan et al. (2010). in Isfahan also, the talented students were dissatisfied with educational situation.

Statement of the Problem

Also, according to the searches done, most of the studies conducted in our country, Iran, were quantitative and slightly focused on investigating the level of satisfaction, problems and obstacles of talented students. Given the importance, role and specific position of the talented in various fields, especially science production, elite management is essential so that today it has become a very important and key issue in the field of human resources (Ghaffari et al. 2017). On the other hand, in order to identify and eliminate other problems and obstacles of talents in all fields of science and research, education and culture to facilitate the path in universities and prevent the escape of talents (brain drain), create a suitable for, which is a prerequisite for the 2025 horizon in the Iran, therefore, it is necessary to identify and investigate the current situation of students to help overcome obstacles.

The Research Significance

According to the appropriate nature of the current qualitative study in comparison with quantitative studies in explaining the situation of this group of special students (talents) can be useful in reducing the existing problems and challenges. It can also help colleges, faculty, and policymakers plan and improve the quality of service for gifted students.

The Research Terms

Talent: a set of including skills, knowledge and ability to grow and develop that comes to talent through systematic and gradual training (Tannenbaum, 2000).

Concept analysis: Concept analysis is a precise and formal process that uses it to try to identify, clarify and define an abstract concept and distinguish it from similar concepts (Morse et al. 1996).

Literature Review

A review of the literature shows that almost all gifted students suffer from a variety of problems. In Cheraghi et al (2019) study, the results showed that poor teaching methods and lack of educational resources were the most important educational problems. Poor management and lack of research budget were the most important research problems. For students, improving the teaching situation and organizing human resource management are the most important priorities for retaining elite forces. In another study by Mohammadi et al. (2014), The findings indicate that 17.7% of students agree that the facilities regulations of talented students are clear and without any defects, and 39% disagreed. About the implementation of the current related regulations, 43.1% disagree and 11% are in favor of implementing regulations by the university. The majority of students believe that the approved regulations do not apply.54.1% also believe that the experts and supervisors do not have enough information about related regulations. 57.2% believe that it is necessary to change some options of the current regulation. The results of current study that are consistent with the results of domestic and International studies, emphasize the importance of paying special attention to the expectations and demands of gifted
and talented students.

The Research Objectives and Questions

This study aims to Investigating and Analyzing the Situation of educational, research, welfare and cultural services of talented students.

The research questions are as follows:

Preliminary questions:

According to which section of the Talents Regulations were you selected as a Talent Student?

Main questions:

- How do you evaluate the quality of education during your studies?
- Explain about your research activity during your studies?
- What do you think about the research activities offered by the university?
- In your opinion, what is it like to provide welfare service facilities to talented students?
- Explain about your cultural status (participation in religious ceremonies, political participation and membership in institutions and associations, etc.)?
- What are your expectations as a talent student?

Final questions:

- What suggestions do you have for improving the quality of services provided to talented students?
- Do you think there is another issue that should have been raised?

Methods

Research Model

This study is a qualitative research of content analysis type with a conventional approach that was conducted in 2019 in order to investigate and analyze the situation of the talented students of Shahid Beheshti University of Medical Sciences.

Population & Sample of the Study

Participants included undergraduate, graduate, Doctor of Medicine and Ph.D students who were selected using a targeted sampling method. The interviews were conducted in a deep and semi-structured manner with 16 students individually and continued until data saturation. It was approved by the University Ethics Committee (IR.SBMU.RETECH.REC.1397.1057). After obtaining permission from the authorities, and informing by the researcher, through invitations containing an explanation of the purpose of the study and a request to participate in the research, the students who wished to participate in the study were asked to determine a time for the interview. Also, coding was used to keep the name of the participants confidential.

Data Collection Procedure

The interviews started with an open question and then other questions were asked based on the interviews guide and the participants' answers, so that the general question of the research included "How is the situation of the talented students of Shahid Beheshti University of Medical Sciences?" The focus of the interview was on the quality of services provided to the talented students. Also, if necessary, in continue exploratory questions such as "Can you explain more" or "When you say ..., what do you mean?" were asked. At the end of the interview, the participant was asked to state if there was any talk left. Each interview lasted from 25-30 minutes. Interviews were recorded with the permission of the participants and then were transcribed on paper word by word. Field notes were also used. In order to determine data credibility, continuous examination of the data, data analysis simultaneous with collecting them, member check, examining data analysis process by several qualitative research researchers and continuous and long-term conflict with data were used.

Data Analysis

Content analysis was based on Graneheim & Lundman model. In this model, after specifying the unit of analysis in the field, semantic units are extracted from the field which after reduction, compression and summarization, the compressed semantic units are identified based on which they are coded and then the codes are assigned. In the simultaneous and continuous comparison of codes and their similarities and differences, sub-theme and themes and finally the main themes are created (9).

Results and Discussion

The mean age of the participants was 30 years. From the data analysis of the present study, four main themes were obtained, each of which included a number of sub-themes as shown in Table 1. The main themes obtained included poor educational situation, research problems, poor welfare services, and weakness in performing cultural affairs, which are discussed in more detail below.

Theme 1: Poor Educational Situation

A) Undesirable teaching method

Most of the students were dissatisfied with the inexperience of some professors and the lack of mastery of some professors to present the lesson content.

In this regard, one student stated that "Our professors have a high academic level but the power to convey the concepts is not well" (Code 4) and another student stated that "some professors do not have sufficient mastery and experience in the lesson content" (Code 1)

B) Insufficient educational resources

Another statement from the participants was the lack of professors to teach the lessons.

One of the students says, "The number of professors of our department is low for teaching, and I think if there are more, the quality of teaching will be better" (Code 3)

C) Insufficient educational facilities

Students complained about the lack of Internet access in some classes and the low speed of the Internet, the lack of reference books related to the field of study in the library.

"We don't have internet in our classes and we can't search online, which can affect our learning" says one student.

And another student acknowledged what previous students said as "In the library of our faculty which is newly opened, our reference books are either not available or, if they are, they don't allowed us to bring them home" (Code 3).

D) Inappropriate educational planning

According to the students, there was not enough time for teaching the full lesson content, as well as the compulsion to attend the university full time, the weakness in team learning and the high volume of content in some educational courses during one semester led to disorder in their learning.

In this regard one student says, "Because of the large volume of lesson content, much is not taught, and we have question and ambiguity" (Code 6).

And another student stated, "The condition of the college pavilion is not good, and when we were there all the time, we practically had a lot of wasted time, and we could go into the field to make better use of this time" (Code 7).

Theme 2: Research Problems

A) Insufficient resources and budget

The students complained about the insufficient budget.

One student said, "Low budget is given and late and it takes about a year for the prize of articles to be awarded" (Code 9), and another student said, "Difficult conditions are put to get a prize for an article, so many students can't get the prize" (Code 11)

B) Insufficient spiritual support

The students expressed dissatisfaction with the lack of cooperation between some research centers and hospitals to provide data and allocate limited and equal time for various research projects by the Student Research Committee.

So that one student stated, "I had to quit a lot of questions and research projects because the centers and hospitals didn't provide me with data, or they had a lot of selfishness about their own data" (Code 7).

C) Weakness in the performance of professors with students in playing a research role

Most of the students stated that the professors had weakness in encouraging and attracting students in order to conduct research and the necessary cooperation in the research projects of interest to the students, and the research projects are imposed on the students by them.

A student says, "Professors do not play a significant role in encouraging students to carry out research projects" (Code 5).

Another student said, "Teachers impose their subjects on students to do research projects, and most of them refuse to cooperate in our projects" (Code 8).

Theme 3: Insufficient Welfare Services

A) Weakness in equipment/facilities

Students pointed out some problems in this field as the lack of photocopiers in some faculties, the insufficiency of special loans to talented students, and the lack of self-service and markets in faculties.

One student stated that "They could afford to lend money to talented students which they didn't" (Code 2), and another student said, "In our faculty, self-service and market, or even a photocopier is not yet provided and it's not attended to" (Code 10).

B) Weakness in the dormitory

The students were dissatisfied with the crowds and the lack of facilities in the dormitory and the inappropriate space of the study hall in the dormitories.

In this regard, a student stated that "dormitories are both crowded and not a good place to study, especially during exams" (Code 2)

Theme 4: Weakness in Cultural Affairs

A) Weakness in cultural planning

The students stated that the informing in the faculties regarding cultural affairs is weak.

A student said, "In our faculty, we are not given any news of cultural affairs at all, only occasionally they attach some news as poster on the wall" (Code 6).

B) Decreased individual motivation

The students stated some factors of the low motivation of the people for not participating in cultural affairs as, not allocating appropriate points in the regulations, insufficient time to participate in cultural affairs and low profitability for future careers.

So that in this regard a student said, "Our classes and lessons are too much, so we don't have time to go to that at all" (Code 2)

Another student stated, "At Ph.D., we should be more active in medicine, so I didn't go into cultural issues much" (Code 7).

Another student stated, "Since no specific point for participation in cultural affairs is not assigned by cultural regulations, and it's not that effective on our future career, so we didn't go towards it anymore"

According to the students, their most important problems and concerns included four main themes: poor educational situation, research problems, poor welfare services, and weakness in doing cultural affairs. By investigating the comments of the talented students on the "poor educational situation" theme, the researchers concluded that the lack of skills in teaching methods was one of the main problems for students and in this regard, holding workshops and teaching courses to promote educational systems is known essential which was consistent with the results of Sander's study (Sander et al. 2000 & Mc-Neel, 2004). There was also the problem of "insufficient mastery of some professors and their inexperience in teaching" so that like Pichter et al. (2010) study, one of the factors of academic achievement was the experience and expertise of the teacher, educational counseling and support and participatory learning. In the discussion of inappropriate educational planning, students also pointed out the importance of Team Based Learning, because this method leads to enhanced efficiency of students' learning, which is consistent with the study by Cheraghi et al. (2019).

The results of the investigation of students' opinions on research problems showed that the majority of the students, in addition to being new or unfamiliar with research methods and its steps, faced various obstacles, such as insufficient resources and budget, which are repeatedly mentioned in similar studies, inadequate spiritual support including the lack of cooperation between research centers and hospitals to provide them with data, allocating limited and equal time for a variety of research projects, and a lack of research facilities such as laboratories. Therefore, in this regard, the establishment of collaborative networks between professors and students, the dynamism of university research units, especially the Student Research Committee to support talented students and holding educational workshops is very important which is consistent with several studies (Zohor et al. 2003, Haynes et al. 1998 & Hamilton, 1986)

Regarding the problem of inappropriate welfare services, according to the students, there was a weakness in equipment/facilities and weakness in dormitory, which is consistent with the results of the study by Mohammadi et al. (2014). In order to improve and upgrade the welfare services to the students, holding special field trips for the talented, paying special loans during the study to the talented, paying the price of some recreational and educational classes by the university to the talented students, providing suitable spaces such as study halls and some other facilities are recommended in dormitories and also encouraging students in any way in the program of the talented can be very effective.

Other problems reported by the students included weakness in cultural affairs with themes of weakness in cultural affair planning and decreased individual motivation, so that the study by Avarideh & Elmi (2010) was consistent with the results of the present study. According to students' opinions, the factors influencing their poor performance to perform these tasks were things such as poor informing, insufficient time to participate in cultural affairs, lack of appropriate allocation of points in regulations to students and low profitability for future careers. Strengthening a sense of solidarity and social belonging among students, as well as creating cultural and social contexts by university officials, is also proposed as a solution and increasing participation. According to the problems and issues expressed, in the opinion of the talented students, things such as forming expert groups of the talented for informing and counselling students regarding the development of research projects, scientific productions or solving other educational and welfare problems by managers and university officials and, ultimately, more researches on the examination of providing new solutions to support and guide the talented in Iran are also recommended.

Conclusion and Recommendations

The results of this study showed the problems of the talented students in the fields of education, research and welfare more than before. Therefore, it is suggested that the authorities and planners take more care in order to meet the needs of this group of students.

Limitations of Study

One of the limitations of the current study is that it has been done only among talented students of Shahid Beheshti University of Medical Sciences. Therefore, it is recommended to do similar studies in other medical universities in cities and countries.

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Appendix 1.
Content Analysis

Table 1.
Themes and sub Themes of present study

Theme	Sub-theme
Poor educational situation	Undesirable teaching method
	Insufficient educational resources
	Insufficient educational facilities
	Inappropriate educational planning
Research Problems	Insufficient resources and budget
	Insufficient spiritual support
	Weakness in the performance of professors with students in playing a research role
Insufficient welfare services	Weakness in equipment/facilities
	Weakness in the dormitory
Weakness in cultural affairs	Weakness in cultural planning
	Decreased individual motivation

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Research Article

Analysis of students' mathematical communication ability in solving mathematical problems

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Abstract

The aim in study was to analyze the characteristics and levels of mathematical communication of students in solving mathematical problems. This study used a qualitative descriptive study with 6 of prospective teacher, 3 students from STIKIP Bangkalan and 3 prospective teacher students from STIKIP Al Hikmah Surabaya, Indonesia. Research data collection techniques through documentation of teaching preparation assignments, and video recordings during learning to obtain verbal mathematical communication. The comparison method is still used to analyze the data through the stages of data condensation, data display, conclusion drawing, and verification. The results show that the characteristics of mathematical communication consist of accurate, complete, smooth, and systematic. Each subject has different characteristics. The prospective teacher students with high-level communication can explain accurately, completely, fluently, and systematically facts, concepts, procedures, operations, and principles. For prospective teacher students with intermediate levels of mathematical communication can explain accurately, fluently, and systematically facts, concepts, procedures, operations, and mathematical principles. Whereas for low-level prospective teacher students, they can explain mathematics accurately.

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Introduction

Humans are social creatures that cannot possibly live naturally individual (Bartz, 2018). This consequence causes humans to be able interact and communicate with others, so that aspects of communication skills are very important for humans. Students are the nation's successor who must be provided with something that will be useful in their life, especially in socializing. One aspect that needs to be taught to students is how they are able to express their thoughts both in writing and in speech, so that later they are able to interact with the community.

Content standards for primary and secondary education units for mathematics subjects (Fuadi, Johar, & Munzir, 2016) states that one of the objectives of learning mathematics is that students have the ability to communicate ideas with symbols, tables, diagrams, or other media to clarify the situation or problem. For that, teachers need to have good communication skills so that they can be transmitted to students.

According to Farrell (2009), teacher communication in the classroom is used to develop relevant knowledge for students, ask questions and answer questions with students, and tell meaningful experiences in the classroom. In class and learning mathematics the knowledge developed is mathematical ideas and ideas. These mathematical ideas and knowledge can be in the form of facts, concepts, principles, and skills (Gagne & Dick, 1983). This is in line with the results of a study which states that 86% of teachers agree, the communication process during the teaching and learning

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process of mathematics occurs when the teacher explains mathematical concepts, and student and teacher questions and answers (Rahman & Lee, 2014).

According to Poladian & Zheng (2016) some mathematical communication skills that must be mastered are explaining concepts, running procedures smoothly, using strategies, and making arguments. Included in mathematical communication skills, namely the ability to explain the meaning of symbols, diagrams, graphs, and other variations (Morgan, Craig, Schuette & Wagner, 2014). Communication in mathematics learning is unique because it uses many mathematical symbols (Caniglia, Borgerding, & Meadows, 2017). Based on several opinions that have been described, it is concluded that a teacher's mathematical communication skills are needed to explain mathematical facts, concepts, operations, and principles, ask questions, answer questions, and guide discussions in the classroom.

The quality of a teacher's mathematical communication will affect the quality of teaching and learning mathematics (Kurniawan, Yuwono, Irawan, & Susanto, 2018). Good mathematics communication can improve student achievement, understanding of concepts, and reduce student anxiety (Lomibao, Luna, & Namoco, 2016). Teachers who have excellent communication skills, can explain math material well, are easy to understand by students. In addition, the quality of teacher communication can help students convey their ideas to others, encourage students to construct mathematical ideas, and solve math problems. Good mathematical communication has the characteristics of being accurate, precise, and systematic (Harianja, Hernadi, & Indah, 2020), accurate, clear, precise, and correct (Vale & Barbosa, 2017). The accuracy could be described by considering the accuracy of mathematical notation and terminology, the correct concept explanation, the procedure with clear and logical algebra manipulation, the calculation process, and also rigorous final result (Zahri, Budayasa, & Lukito, 2019). From some of these descriptions it is concluded that the teacher's mathematical communication that is accurate, precise, correct, and systematic not only helps students understand the material, but can also improve students' ability to solve problems, construct mathematical ideas, and create conducive learning in the mathematics classroom.

The goal of increasing the level of teacher mathematical communication skills is to raise the level of teacher communication skills to a high level (Kar, 2016). Cristobal & Lasaten (2018) stated that there is a relationship between the level of oral communication and student academic achievement. In practice, mathematical communication carried out by a teacher in learning includes oral and written communication. In line with (Tok, 2010), that during teaching practice, prospective teacher students must plan, also communicate when explaining material, giving questions, and answering student questions. Meanwhile, teaching practice is the pinnacle of education for prospective teachers (Tok, 2010). For this reason, the development of teacher communication skills includes written and oral communication in order to prepare teaching preparation and explain material during learning.

To improve teachers' mathematical communication skills, it is necessary to precede the process of mapping the level of teacher communication skills as a reference for developing training programs. If the teacher's mathematical communication skills improve, it is believed that it will improve the quality of learning mathematics, and in general it will improve the quality of education. Several researchers have started the research process for mathematical communication separation, namely the level of written communication with student subjects (Lim & Pugalee, 2004), the level of oral communication as part of the ability to solve problems with student subjects (Hirschfeld-Cotton, 2008), and (Sample & Sample, 2009) with student research subjects to describe the level of communication in relation to the ability to solve problems both orally and in writing. Through mathematical communication in solving mathematics problems, prospective teacher students can develop positive attitudes in learning, acquire and integrate knowledge, expand and perfect knowledge, use knowledge meaningfully, and develop productive thinking habits. The level of mathematical communication and the ability to solve mathematical problems is very important to the success of learning mathematics.

Method

The model of research is a qualitative descriptive study. Research using this method aims to describe the conditions that occur during the research. This research was written to analyze and describe the mathematical communication skills of prospective teachers in solving math problems.

The subjects of this study were students who are prospective mathematics teachers at STKIP PGRI Bangkalan and STKIP Al Hikmah Surabaya, Indonesia. The difference in campus culture is not a consideration in determining the subject of this study. Two research subjects at each high, medium, and low level of mathematical communication were selected based on the snowball method with the criteria for ranking scores of mathematics and Indonesian language subjects.

The task of oral communication in this research is the task to teach in grade 7 of junior high school with one variable linear equation and inequality material. The subject explains the material of linear equations and inequalities

of one variable, within a span of 2 × 35 minutes. Meanwhile, written communication tasks are teaching preparation documents in the form of lesson plans, ppt, and notes on the blackboard during learning. To obtain oral mathematical communication data, a video recording is carried out during the learning process from the beginning to the end of the lesson. Then the data was triangulated.

The data processing technique uses a modified level and the characteristics of the mathematical communication level, which are as follows:

Table 1.
Levels and Characteristics of Valid and Reliable Mathematical Communication Levels

Communication Level	Characteristics	Description
High	Accuracy	Express mathematical facts, concepts, procedures, operations and principles accurately
	Completeness	Complete mathematical facts, concepts, procedures, operations and principles
	Smoothness	Express mathematical facts, concepts, procedures, operations and principles fluently, without stuttering, with no long pauses
	Systematic	Express mathematical facts, concepts, procedures, operations and principles systematically
	Accuracy	Express mathematical facts, concepts, procedures, operations and principles accurately
Intermediate	Incompleteness	Disclose mathematical facts, concepts, procedures, operations, and principles incompletely
	Smoothness	Express mathematical facts, concepts, procedures, operations and principles fluently, without stuttering, with no long pauses
	Systematic	Express mathematical facts, concepts, procedures, operations and principles systematically
	Accuracy	Express mathematical facts, concepts, procedures, operations and principles accurately
Low	Incompleteness	Disclose mathematical facts, concepts, procedures, operations, and principles incompletely
	Non-fluency	Disclosing mathematical facts, concepts, procedures, operations, and principles smoothly, there is a long delay
	Unsystematic	Disclose mathematical facts, concepts, procedures, operations, and principles in an unsystematic way

Results

The results of this study are written and oral mathematical communication that will be analyzed to describe the characteristics and levels of mathematical communication of prospective teacher students in solving mathematical problems. Figure 1 is the written answer of prospective teacher students as research subjects with a high level of mathematical communication in solving linear inequality problems of one variable. The subject of this study solves this linear inequality problem on the blackboard in the first semester class of junior high school during learning.

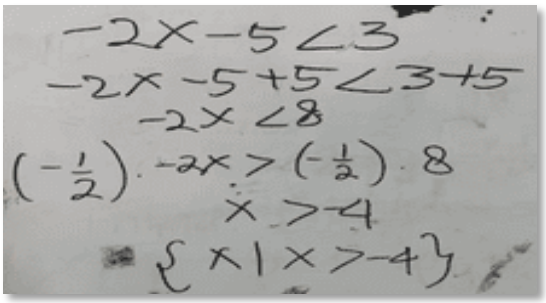

Figure 1.
One-variable Linear Inequality Solution

Data in figure 1 shows, that a high-level subject can write mathematical facts, the number notation -2, 5, 3, 8, $\frac{1}{2}$, and 4 , the x variable, the addition symbol +, the subtraction simbol -, the inequality notation >, and the set symbol { ... } accurately. The linear inequality -2x-5<3 is written accurately. In the second line, the subject adds both sides of the inequality by 5, which is the inverse of -5, then simplifies it to -2x<8. In the fourth line, both sides of the inequality are multiplied by - $\frac{1}{2}$, and reverse the sign of the inequality because it is multiplying by a negative number. The solution to this inequality is written completely { x | x > -4 }. These are some procedures, and principles in mathematical operations that are expressed accurately, completely, and systematically.

Data analysis of video recordings of high-level subjects can also explain solving linear inequalities problems verbally fluently and clearly. Subjects can express facts, and mathematical concepts clearly, and completely, explain operations, and procedures systematically and smoothly without pauses. Likewise for the second high level subject consistently expresses and writes the solution of linear inequalities accurately, completely, fluently and systematically.

The results of this data analysis have shown that high-level research subjects can explain facts, concepts, operations, procedures, and mathematical principles accurately, completely, fluently, and systematically.

The second level research subject is intermediate level mathematical communication, which must solve of $2n + 5 > 16$, n natural numbers. Figure 2 is the written answer of prospective teacher students in solving linear inequality problems of one variable.

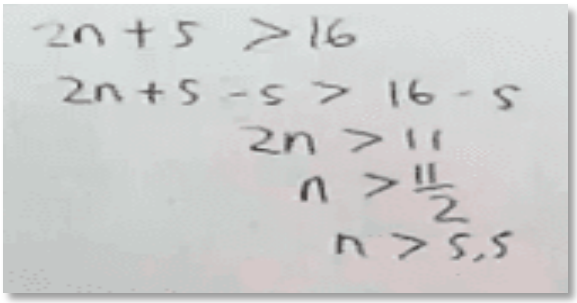

Figure 2.
One-variable Linear Inequality Solution

The subject has written accurate operations and procedures, reducing the right and left sides by 5, and divided both sides by 2. In the fourth line, the right-hand side of the inequality is divided by 2, while on the left-hand side it is not written completely. If the process is completed then the fourth line will be in the form of $\frac{2n}{2} > \frac{11}{2}$. After simplifying, we get the form $n > \frac{11}{2}$. The solution to this mathematical problem is also incomplete because at the end, the solution set in the form { n|n >5.5, n natural number} is not presented. Mathematical problem solving has been written and explained accurately, fluently, and systematically by intermediate level subjects, but the answers are not complete. Analysis of video recordings showed that the subject's oral communication was fluent, but did not explain the set of completions. Based on this analysis, it is concluded that the research subject at the intermediate level has the characteristics of accurate, fluent, systematic, and incomplete mathematical communication.

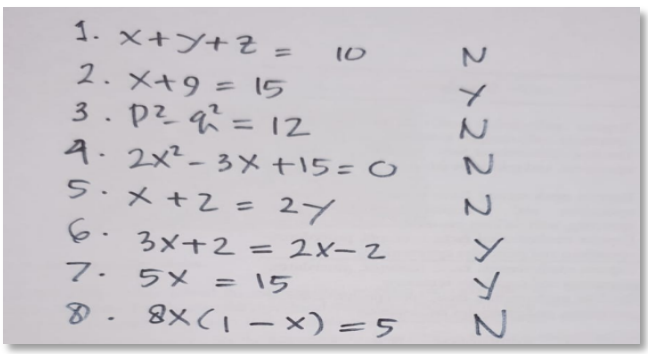

Figure 3.
Examples and non-examples of one-variable linear equations

In Figure 3, subjects with low levels have accurately determined examples and non-examples of linear equations of one variable, with yes or no answers without giving a complete explanation. The answers are written randomly and not systematically because they do not sort from the simplest to the most complex. For example, the answers can be sorted as follows $5x = 15, x + 9 = 15, 3x + 2 = 2x - 2, x + 2 = 2y, x + y + z = 10, p^2 - q^2 = 12, 2x^2 -$

$3x + 15 = 0,\ 8x\ (1 - x) = 5$. Subjects solve mathematical problems smoothly so that all questions can be solved according to the time that has been set. Solving mathematical problems is not complete because the answers are only yes and no, without a clear explanation. So, the research subjects of low-level mathematical communication only have accurate characteristics, and do not meet fluency, completeness, and systematicity

Based on this analysis, the results of this study shows that the mathematical communication characteristics of prospective teacher students consist of accurate, complete, fluent, and systematic. Each subject with different levels has different characteristics, high-level subjects have four characteristics of mathematical communication, medium-level have three characteristics, while low-level subjects meet only one characteristic.

Discussion and Conclusion

The novelty of the results of this study, there are two, namely the characteristics of mathematical communication produced is a combination of oral and written mathematical communication characteristics. Second, the mathematical communication level of prospective teacher students is determined to be the main objective of research, and is developed based on the combined characteristics of oral and written communication. This is different from (Mujiasih, Waluya, Kartono, & Mariani, 2018) who examined the development of geometric reasons for prospective teacher students in terms of their communication skills. (Junsay, 2016) examined the effect of student teacher student reflective learning on communication skills. Meanwhile, (Wenglinsky, 2000) examined the relationship between teacher communication skills and student achievement.

The characteristics of the mathematical communication level of the results of this study are a combination of oral and written characteristics, each of which has 3 characteristics. There are many pairs of combined oral and written communication characteristics for each level of communication. This becomes a sea of knowledge to be studied gradually, more completely and deeply. Based on a study in the field of psychology, the researcher originated from the theory of Bee (2012) which states that effective communication is very important for teachers in the learning process, classroom management, and classroom interactions. Farrell (2009) states that communication in the classroom is used by teachers to develop and increase relevant knowledge, to ask and answer student questions, and to explain various good experiences that can be conveyed in class.

Meanwhile Lomibao et al. (2016) stated that oral and written communication in the field of mathematics can help students understand deeper. In line with this opinion Sample (2009) states that oral communication and tls can help understanding and the process of regrouping mathematical concepts. (ElSheikh & Najdi, 2013) stated that communication is an essential thing in mathematics education. From some of these theories, it is concluded that communication is very important in learning mathematics. Communication in mathematics learning can enhance a deeper understanding of the concept.

In mathematical communication, there are communication characteristics as stated by Lim and Pugalee (2004), namely clear, detailed, precise, correct, and the use of appropriate algorithms or procedures. In line with (Lim & Pugalee, 2004) the characteristics of mathematical communication are accurate, clear, and correct (Hirschfeld-Cotton, 2008). Meanwhile (Sample & Sample, 2009) states that the characteristics of communication consist of effective, correct, systematic, and smooth. This is in line with the opinion of (Wilson, 2009) which states that the characteristics of mathematical communication consist of being accurate, clear, clear, true, and complete. From these opinions, it can be concluded that effective mathematical communication has the characteristics of being accurate, complete, smooth, and systematic.

From the results above, the characteristics of high-level mathematical communication consist of accuracy, completeness, fluency, and systematic. Mathematical facts, terminology, concepts, examples of concepts, procedures, operations and mathematical principles can be expressed accurately, completely, fluently, and systematically by subjects with a high level of mathematical communication. The characteristics of high-level mathematical communication are composed of high-level oral mathematical communication characteristics, namely accuracy, completeness, and fluency with high-level written mathematical communication characteristics, namely accuracy, completeness and systematization. The characteristics of accuracy and completeness appear as characteristics of oral and written communication, fluency characteristics only appear in oral communication, while systematic appears in the characteristics of written communication only.

Meanwhile, the characteristics of medium level mathematical communication consist of accuracy, fluency, and systematization. Subjects with moderate level mathematical communication can express mathematical ideas and knowledge accurately, fluently, and systematically. Medium level mathematical communication characteristics are formed from medium level oral mathematical communication characteristics, namely accuracy and fluency, with

medium level writing characteristics, namely accuracy and systematization. The characteristics of accuracy appear consistently in oral and written communication, fluency in oral communication, systematic in written communication, while completeness is not found in both.

Furthermore, low-level mathematical communication has only one characteristic, namely accuracy, both orally and in writing. Subjects with low-level mathematical communication can express mathematical ideas, concepts and knowledge accurately both orally and in writing

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