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Commenting on effective laboratory teaching in selected preparatory schools, North Shewa Zone, Ethiopia

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The present study assessed the challenges to implement laboratory teaching in selected Preparatory Schools, North Shewa Zone. The result of this study showed that although laboratories for each subjects were present (100%) in all districts, lack of professional skills (50% in biology, 64.5% in chemistry and 61.5% physics), lack of materials (78.6% in biology, 64.7% in chemistry and 65.4% in physics) and lack of chemicals (75%, in biology, 58.8% in chemistry and 46.2% in physics) were the main challenges to implement effective laboratory teaching. The average numbers of students per laboratory session were 46-55, which was very large size to teach in practical session. Students had interest (strong in all subjects) to learn practically, but 75% of biology and chemistry, and 62.5% of physics laboratory activities were not done. The government look forward that the laboratory activities recommended in the text were not well manipulated and laboratory doing was for the sake of doing. Priority must be given for preparatory school laboratory teaching.

Key words: Biology, chemistry, laboratory teaching, physics, preparatory schools.

INTRODUCTION

For more than 100 years, laboratories have been employed for teaching and learning in natural science disciplines (Hofstein and Lunetta, 2004; Lim and Chai, 2008). Laboratory experiences have been found to

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promote problem-solving abilities (Kola, 2013), intellectual development (Renner and Fix, 1979), scientific thinking (Mudulia, 2012), and practical skills (Ogunniyi and Rollnick, 2015).

In American Association for the Development of Science (1993), the National Research Council (2006) defined a core set of seven science learning goals for students and was supported by Trowbridge et al. (2000). Hence, laboratory work should achieve: ‘‘enhancing mastery of subject matter, developing scientific reasoning, understanding the complexity and ambiguity of empirical work, developing practical skills, understanding the nature of science, cultivating interest in science and interest in learning science, and developing teamwork abilities’’ (Idiaghe, 2004; Dare, 2005 Tesfamariam et al., 2014).

Policymakers, scientists, educators, and parents agree that high school graduates must have a working knowledge of science and technology to participate fully in the workplace, understand everyday decisions on matters ranging from health issues to energy resources, and participate as informed citizens in the civic realm (Eilks and Byers, 2010). Science laboratory experiences for middle school and high school students are a fundamental, unique, and critical component for twenty-first century science education (Mudulia, 2012; Thornburg, 2009).

Recently, Ethiopian ministry of education publicized that many of the students who enroll in preparatory and university level must be for natural science fields (Khan and Zafar, 2011)”. Natural science fields like biology, chemistry, physics, mathematics and engineering fields are the main focus. So, the ministry of education directed the 70:30 strategies in natural and social science fields in the university level, respectively (Mamo, 2017).

Natural science fields are supposed to produce those graduates who are excellent in technology if and only if the teaching learning process is encouraged by practical laboratory teaching. Without laboratory teaching there is no quality education in science fields, particularly in biology, chemistry and physics.

In these regards, the current study was used to see the challenges in implementing practical laboratory teaching in selected districts of North Shewa Zone. Challenges were aligned with the possible solutions of laboratory teaching in the area stated earlier. The objective of the present study is to know the challenges to implement laboratory practice in natural science teaching in selected North Shewa Zone Preparatory Schools.

MATERIALS AND METHODS

Description of the study area

The research was conducted at North Shewa Zone districts including Shewarobit, Tarmaber, D/Berhan, Moret ena Jiru, Efrata ena Gidim, and Menz Keya. These districts have preparatory schools for the study to be conducted. The study sites were located in the range of 0 to 185 km from the North Shewa Zone town Debre Berhan in all directions. North Shewa Zone is located in 130 km North of Addis Ababa.

Data collection

The data were collected from biology, chemistry and physics teachers; lab assistants, students and school administrators. Questionnaire and observation were the main data collection tools. From the 6 districts under this study, many questionnaires were collected. The questionnaires were simple, direct and achieved the research objectives. Mixed questionnaire type was applied, that is, closed and open ended questionnaires, of which “yes or no” and “multiple choices” of closed questionnaire were used in most of the cases and few other questions were open ended.

Sample and sampling techniques

In each study site, all teachers (Biology, Chemistry and Physics), school principal, lab assistants and volunteer students from each level (grade 11 and 12), respectively were selected randomly from all districts. Hence, a total of 8 (all male) laboratory technicians, 8 school principals (all male), 28 biology teachers (20 male and 8 female), 17 chemistry students (12 male and 5 female) and 26physics teachers (24 male and 2 female), respectively filled the questionnaire appropriately. Moreover, 104 biology students (55 male and 49 female), 78 chemistry students (41 male and 37 female) and 112 physics (61 male and 51 female) students filled out the questionnaire. In total, 60.1% who were participated to fill out the questionnaire were male and the rest (39.9%) were females. The respondents age ranges from 18 to 40 and the average age of male and female respondents were 26 and 18, respectively.

Data analysis

Data collected from questionnaire was filled in the excel sheet. Then using an Excel, data were manipulated in the form of figures and tables.

RESULTS AND DISCUSSION

Most of the respondents (students, school principals and lab technicians) accounted that in each district there was only one laboratory room per subject. For example, only one laboratory room was present for biology in Moret and Jiru preparatory school.

Similarly, chemistry and physics subjects were restricted with one laboratory room per preparatory school (Table 1). Although practical laboratory teaching supports the theoretical class room learning (Table 2), all laboratory activities listed in the laboratory manual are not done due to a lot of reasons (Table 3) that is, lack of well skilled man power, lack of materials and chemicals. Moreover, large class sizes were used when teaching practical session (Figure 1). Bayessa (2014) also reported that absence of laboratory chemicals, rooms, apparatuses, technicians and well organized laboratory manuals negatively affected the effective implementation of science education and students’ academic achievement.

Table 1. Number of laboratory rooms in selected preparatory schools of North Shewa Zone.

Subject	Response	1 Room		2 Rooms		3 Rooms		Other	
		Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
Biology	Students	96	92.3	7	6.7	0	0	1	1
	School principals	8	100	0	0	0	0	0	0
	Lab technicians	8	100	0	0	0	0	0	0
Chemistry	Students	63	80.8	10	12.8	0	0	5	8.1
	School principals	8	100	0	0	0	0	0	0
	Lab technicians	8	100	0	0	0	0	0	0
Physics	Students	99	88.4	6	5.3	4	3.6	3	2.7
	School principals	8	100	0	0	0	0	0	0
	Lab technicians	8	100	0	0	0	0	0	0

Table 2. Students' response in teaching methods in laboratory teaching in selected preparatory schools of North Shewa Zone.

Questions	Subject	Yes		No		Other	
		Number	Percentage	Number	Percentage	Number	Percentage
Practical work support theoretical teaching	Biology	95	91.3	8	7.7	1	1
	Chemistry	70	89.7	6	7.7	2	2.6
	Physics	101	90.2	11	9.8	0	0
There is integration between laboratory work and theoretical teaching	Biology	93	89.4	10	9.6	1	1
	Chemistry	69	88.5	4	5.1	5	6.4
	Physics	103	90.2	11	9.8	0	0
There is group work in lab teaching	Biology	92	88.5	12	11.5	0	0
	Chemistry	61	78.2	11	14.1	6	7.7
	Physics	91	81.3	21	18.8	0	0
Lab technicians and teachers support in laboratory session	Biology	95	91.3	8	7.7	1	1
	Chemistry	73	93.6	2	2.6	3	3.8
	Physics	104	92.9	8	7.1	0	0
Lab teaching enhances students' performance	Biology	95	91.3	8	7.7	1	1
	Chemistry	72	92.3	5	6.4	1	1.3
	Physics	103	92	9	8	0	0
All lab activities in the text are done	Biology	53	51	49	47.1	2	1.9
	Chemistry	29	37.2	46	59	3	3.8
	Physics	46	41.1	66	58.9	0	0
There is time of working laboratory teaching outside the school compound	Biology	61	58.7	43	41.3	0	0
	Chemistry	32	41	43	55.1	3	3.8
	Physics	42	37.5	70	62.5	0	0

Students, teachers and laboratory technicians were confident that students have interest in practical laboratory teaching. This is in correspondence with all natural science, that is, biology, chemistry and physics laboratory sessions. In general, students have interest in natural science laboratory learning (Figure 2). However, students perform practical laboratory session very rarely that is, once per month in most of the cases (Figure 3). In

Table 3. Teachers' response in teaching methods in laboratory teaching in selected preparatory schools of North Shewa Zone.

Question	Subject	Yes		No		Not determined	
		Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
Teaching all lab activities	Biology	14	50	14	50	0	0
	Chemistry	9	52.9	8	47.1	0	0
	Physics	14	53.8	12	46.2	0	0
Lab teaching support students	Biology	27	96.4	1	3.6	0	0
	Chemistry	17	100	0	0	0	0
	Physics	26	100	0	0	0	0
Practical teaching improves students' performance	Biology	28	100	0	0	0	0
	Chemistry	17	100	0	0	0	0
	Physics	25	96.2	1	3.8	0	0
Are you skillful to teach practically?	Biology	13	46.4	14	50	1	3.6
	Chemistry	5	29.4	11	64.7	1	5.9
	Physics	10	38.5	16	61.5	0	0
Do you have lab assistant?	Biology	25	89.3	3	10.7	0	0
	Chemistry	10	58.8	7	41.2	0	0
	Physics	13	50	13	50	0	0
Is there job description for lab assistants?	Biology	20	71.4	5	17.9	3	10.7
	Chemistry	16	94.1	0	0	1	5.9
	Physics	11	42.3	3	11.5	12	46.5
Did you take lab training before?	Biology	11	39.3	17	60.7	0	0
	Chemistry	12	70.6	5	29.4	0	0
	Physics	7	26.9	19	73.1	0	0

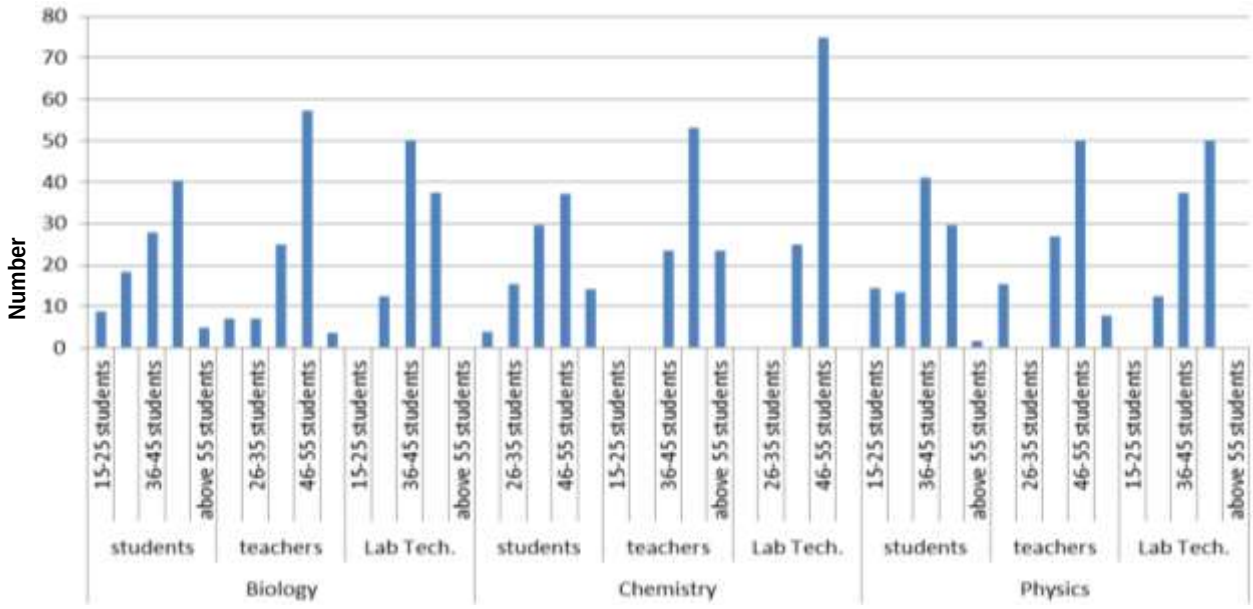

Figure 1. Number of students/laboratory session in selected preparatory schools.

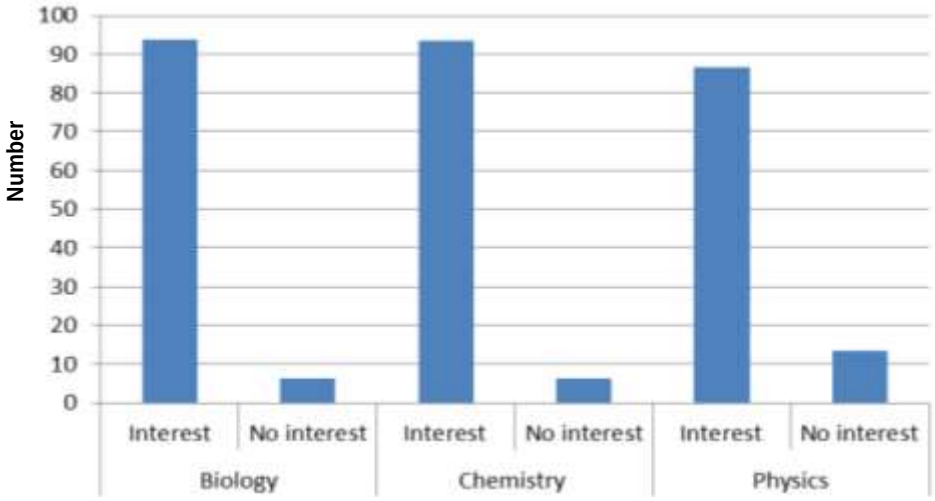

Figure 2. Students interest towards laboratory learning in selected preparatory schools

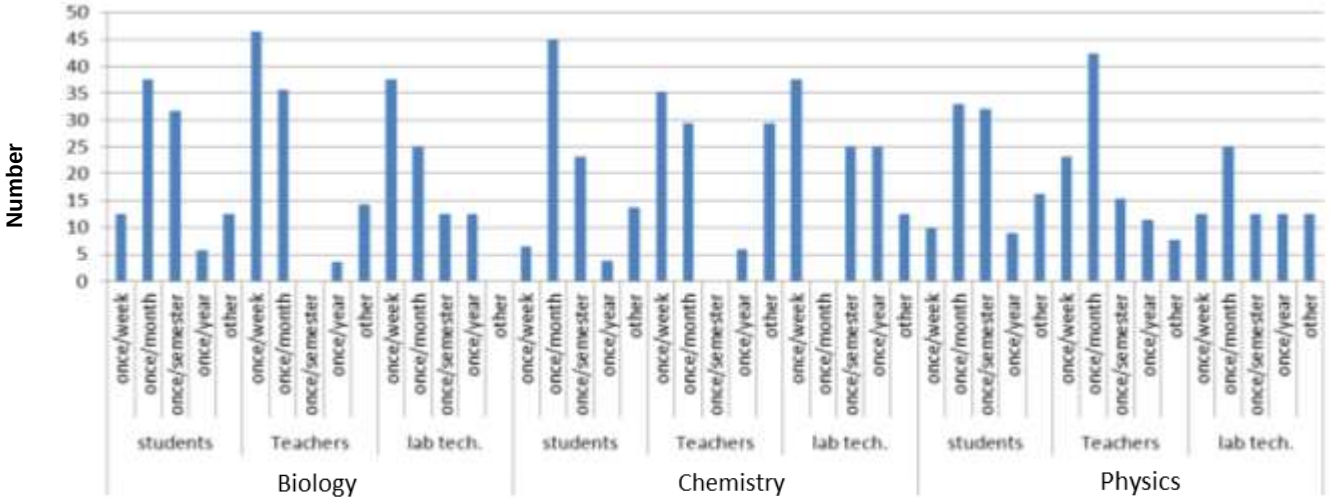

Figure 3. Number of times lab work is doing in selected preparatory schools.

other studies, teaching micro-scale chemistry as a new and efficient method can be a practical solution in the practical education of natural sciences (Ardestani and Badrian, 2014).

In biology and physics laboratories, most of the respondents reported that laboratory technicians assist students sometimes in practical laboratory session; however, laboratory technicians always assist students in chemistry laboratory session (Figure 4). However, laboratory technicians did not attend any laboratory training before (Figure 5). Muleta and Seid (2016) reported that teachers do not use practical activities in teaching science, and thus students do less than 5% of the practical activities on their text books.

Most teachers in the study area respond that all lab materials and chemicals were not available to teach the practical session. Still most of them told that there were materials and chemicals without use and stayed for a long period of time. In addition to lack of materials and chemicals, the materials were not installed properly and chemicals were not used based on the procedures. This was due to lack of well specialized professionals (Table4). Furthermore, the scarcity of materials and chemicals are the main problems of practical teaching in selected preparatory schools (Table 5).

Absence of laboratory chemicals, rooms, apparatuses, technicians and well organized laboratory manuals negatively affected the effective implementation of

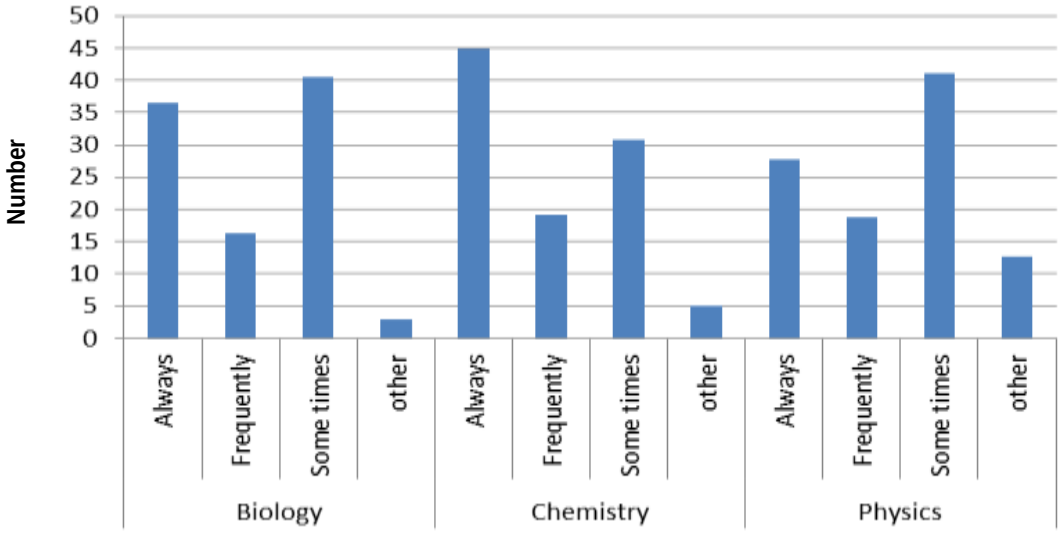

Figure 4. Number of times lab technicians/teachers assist students in practical work.

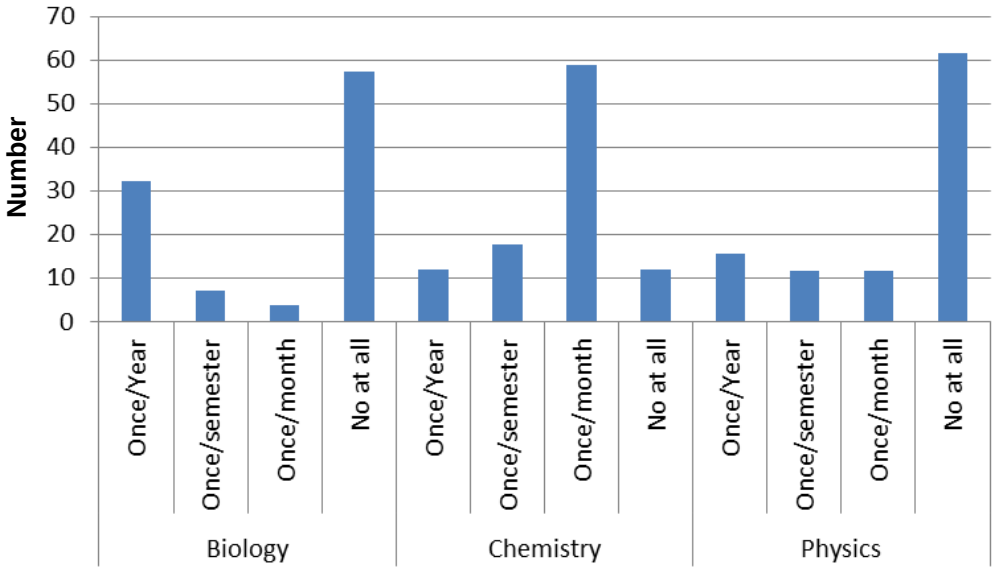

Figure 5. Lab assistants and teachers response on participation of laboratory training before.

science education and students' academic achievement as well (Hunde and Tegegne, 2010; Beyessa, 2014; Caramés et al., 2014; Negassa, 2014).

Conclusion

Laboratory work should achieve mastery of subject matter, developing scientific reasoning, understanding the complexity and ambiguity of empirical work, developing practical skills, understanding the nature of science, cultivating interest in science and interest in learning science and developing teamwork abilities. Well skilled and trained man power, laboratory materials and chemicals in adequate amount enhance the quality of education. This is because practical work develops problem solving skills and a deeper understanding of the concepts and principles in natural science fields. When students do subjects on hands, they understand it and enjoy the learning process since it relates what they have learnt to their real life situations.

The challenges of the modern world require individuals who can apply their theoretical knowledge to solve practical real life problems such as environmental and

Table 4. Teachers' response in laboratory chemicals and materials availability in selected preparatory schools of North Shewa Zone.

Question	Subject	Yes		No		Not determined	
		Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
All lab materials are available	Biology	6	21.4	22	78.6	0	0
	Chemistry	6	35.2	11	64.7	0	0
	Physics	9	34.6	17	65.4	0	0
All lab chemicals are available	Biology	7	25	21	75	0	0
	Chemistry	7	41.2	10	58.8	0	0
	Physics	14	53.8	12	46.2	0	0
Is there lab chemical without use	Biology	16	57.1	12	42.9	0	0
	Chemistry	8	47.1	9	52.9	1	5.9
	Physics	17	65.4	9	34.6	0	0
Is there lab material without use	Biology	12	42.9	15	53.6	0	0
	Chemistry	4	23.5	8	47.1	5	29.4
	Physics	16	61.5	10	38.5	0	0

Table 5. Responses on lab materials and chemicals donation.

Questions	Response	Subject	Government		Non-governmental bodies		Both		Others	
			Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
From where you get lab materials	Teachers	Biology	10	35.7	1	3.6	15	53.6	2	7.1
	Lab Tech.	Biology	2	25	0	0	6	75	0	0
	Teachers	Chemistry	9	53	0	0	3	17.6	5	29.4
	Lab Tech.	Chemistry	4	50	0	0	3	37.5	0	0
	Teachers	Physics	13	50	0	0	12	46.2	1	3.8
	Lab Tech.	Physics	7	87.5	0	0	1	12.5	0	0
From where you get lab chemicals	Teachers	Biology	12	42.9	0	0	14	50	4	18.8
	Lab Tech.	Biology	3	37.5	0	0	5	62.5	0	0
	Teachers	Chemistry	13	76.5	0	0	1	5.9	3	17.6
	Lab Tech.	Chemistry	2	25	6	75	0	0	0	0
	Teachers	Physics	13	50	0	0	12	46.2	1	3.8
	Lab Tech.	Physics	7	87.5	0	0	1	12.5	0	0

economic challenges. Hence, practical work prepares students for adult life since it fosters the theory they have learned. However, laboratory facilities (materials and chemicals) and professional were insufficient to do well with quality education in the case of the present study. A lot of challenges were raised by students, teachers, laboratory technicians and school principal on the topic of laboratory teaching. Authors appreciate the start, but challenges must be look forwarded for all the government officials and stakeholders. University teacher would like to design curriculum (at Bachelor level) of laboratory teaching for Biology, Chemistry and Physics students who will be laboratory technician in preparatory schools.

Researchers are aware that graduating well skilled man power, that is, laboratory technician should be given priority to develop awareness, skill and knowledge on school students. Thus, the study share is to train students in laboratory technician field of study and open the market for the needy schools all over the country. The materials and chemicals scarcity must put under consideration all stakeholders including researchers of the present study. This study fits with the country policy that science and technology is the main tool for development.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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