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## Scientific Research Hypotheses Understanding of the Pre-Service Science Teachers at Faculty of Education-Amran University, Yemen<sup>(\*)</sup>

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### Abstract

Preparing pre-service science teachers (PSSTs<sup>1</sup>) with the scientific research skills (SRs) is an ultimate aim of PSSTs' preparation programs. Yet, this study aimed to explore PSSTs' understanding level of SRHs (SRHUL). To this end, an action research (AR) was adopted using a pre-post-test design. In doing so, a multiple choice test consists of 15 items was developed and conducted on a random sample consisted of 120 subjects. Results of the study revealed that participants showed insufficient performance on the test of understanding scientific research hypotheses (SRHUT) for both pre and post-test. Besides, results of t-test showed a significant difference between mean scores of pre-test and post-test which was in favor of post-test. Also results of one-way ANOVA revealed a non-significant difference between or within mean scores of compared groups. Based on the study's results, some recommendations were made.

**Key words:** pre-service Science Teachers, Scientific Research Skills, and Scientific Research Hypotheses

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<sup>(1)</sup> For this study, PSSTs can be defined as the 3<sup>rd</sup> academic year-students who studied fundamentals of educational research course (FERC) at faculty of education-Amran university. In Yemeni universities, PSSTs are prepared to become science secondary school teachers after their graduation (Al-hidabi, 2012). They are exposed to different cultural, professional, and academic courses which FERC is one of the compulsory courses.

## فهم فروض البحث العلمية لدى الطلبة معلمي العلوم بكلية التربية-جامعة

عمران

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قسم العلوم التربوية والنفسية

### الملخص

تعد مهارات البحث العلمي هدفا رئيسا في برامج إعداد الطالب معلم العلوم (معلم العلوم قبل الخدمة)، ولهذا فإن هذه الدراسة سعت إلى استكشاف مستوى فهم عينة من الطلبة معلمي العلوم بكلية التربية بجامعة عمران للفروض العلمية وإمكانية صياغتها. ولتحقيق غرض الدراسة تم تكييف أسلوب البحث التفاعلي باستخدام تصميم الاختبار القبلي والبعدي وذلك بتعريض عينة عشوائية تألفت من 120 مشاركا من الطلبة المذكورين لاختبار الفروض العلمية قبل وبعد دراستهم لهذا الموضوع. وقد دلت نتائج الدراسة أن مستوى فهم عينة الدراسة للفروض العلمية كان غير كاف. كما أظهرت الدراسة فروقا ذات دلالة إحصائية بين متوسط درجات أفراد العينة على اختبار الفروض العلمية وفقا لمتغير زمن الاختبار؛ حيث كانت الفروق لصالح الاختبار البعدي، ولم تظهر نتائج تحليل التباين الأحادي بين وداخل المجموعات أية فروق يمكن أن تعزى لمتغير تخصص المشاركين في عينة الدراسة. وبناء على نتائج الدراسة، قدمت جملة من التوصيات يمكن الرجوع إليها في متن تقرير الدراسة.

**الكلمات المفتاحية:** معلمي العلوم قبل الخدمة، مهارات البحث العلمي، فروض البحث العلمية

## Introduction and Background

In the context of 21<sup>st</sup> century, possessing SRSs is considered as a main goal of education, i.e. science education, which leads to rise the SRSs of citizens who could show the scientific aspects of science in their life (Bökeoğlu & Yılmaz, 2005; Irwanto et al., 2017). SRSs can be known as identifying a problem, formulating hypotheses, gathering and analyzing data, interpreting and discussing the results of analyzing data (Fraenkel & Wallen, 2006; Irwanto et al., 2018). Thus, linking such skills should be a paramount in the vision of teacher education (Can & Kaymakci, 2015). Yet, engaging teacher students in research-based learning is a vital issue in PSSTs' preparation program in order to carry out such goal, since research-based learning is a key aid in enabling students to develop a deep understanding of SRSs and empowers them to behave as scientists in acquisition and developing knowledge (National Research Council, 2007; Can & Kaymakci, 2015).

In addition, SRSs (e.g. formulating SRHs) are the most fundamental underpinnings of teachers' education program (National Research Council, 2007; Irwanto et al., 2018). They are a critical issue to involve students in research activities; to enhance their critical thinking and problem-solving capacities which are compulsory competences for new achievements in education and consequently to improve learning-teaching practice. Thus, SRSs should be considered as an essential goal in students learning as well as a pedagogical method used by teachers (National Research Council, 2007; Irwanto et al., 2017). However, merits of the SRSs cannot be obtained by students unless well-qualified teachers who can transfer such skills to their students.

As it is illustrated in figure (1), obtaining SRSs requires several practical phases for doing research that PSSTs should be exposed to. One of these phases is formulating of the hypotheses (Pedaste et al., 2015). So, hypotheses formulating is an indispensable in doing scientific research, since it helps researcher in determining the type of data that will be collected (1); it helps in selecting the instrument/s for collecting data (2); in choosing the suitable means for analyzing data (3); and organizing such search with others searches (4) (Walliman, 2011; Cohen et al. 2017).

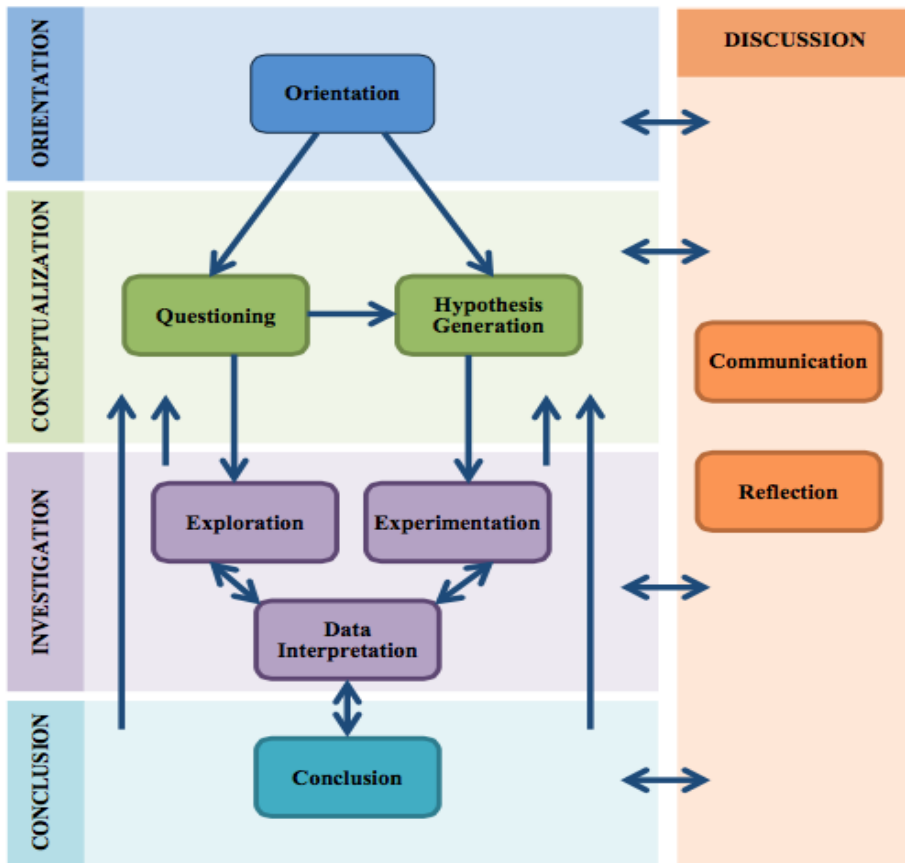


Fig 1. General Phases, Sub- Phases and Their Relations in Doing Scientific Research<sup>2</sup>

SRHs can be defined as tentative statements that explain and describe a solution to a problem which can supposedly occurred as results of testing such statements for accepting or rejecting the expectation solution to the problem (Fraenkel & Wallen, 2006; Walliman, 2011). Also hypothesis is a "statistically measurable/ testable prediction of a relationship between one or more variables and the problem under study" (Degu & Yigzaw, 2006: 23). Formulating hypotheses, therefore, is one of the most significant components of SRSs. The person who could formulate hypotheses in a good and easy way, the person who is able to create a good conceptual knowledge (Aydoğdu, 2015; Kabir, 2016, Mourougan & Sethuraman, 2017).

2. Source: Pedaste et al. (2015: 56)

Thus, teacher students' skill of formulating hypotheses is a key skill for teachers in mastering doing research and teaching SRSs to their students.

Epistemologically, formulating hypotheses belongs to the scientific integrated processes (i.e. hypothesis formulating, identifying variables, controlling variables, experimenting and interpreting data etc.) (Yakar, 2014; Aydođdu , 2015; Paulo & Cruz, 2015). Hypotheses can be formulated in different formulations: as a null or alternative hypotheses. A null hypothesis,  $H_0$ , refutes the differences or relationships between variables, while the alternative one,  $H_1$ , confirms such differences or relationships (Gay et al., 2009:6). In addition,  $H_1$  is examined in two ways: directional and non-directional. While the direction of the variables' difference or relationship is stated in the statement of the directional hypothesis, it is not stated for the non-directional hypothesis (Fraenkel & Wallen, 2006).

With regard to generating and formulating SRHs, there are many sources lead researcher in generating and formulating a good SRHs, as it is illustrated in figure 2.

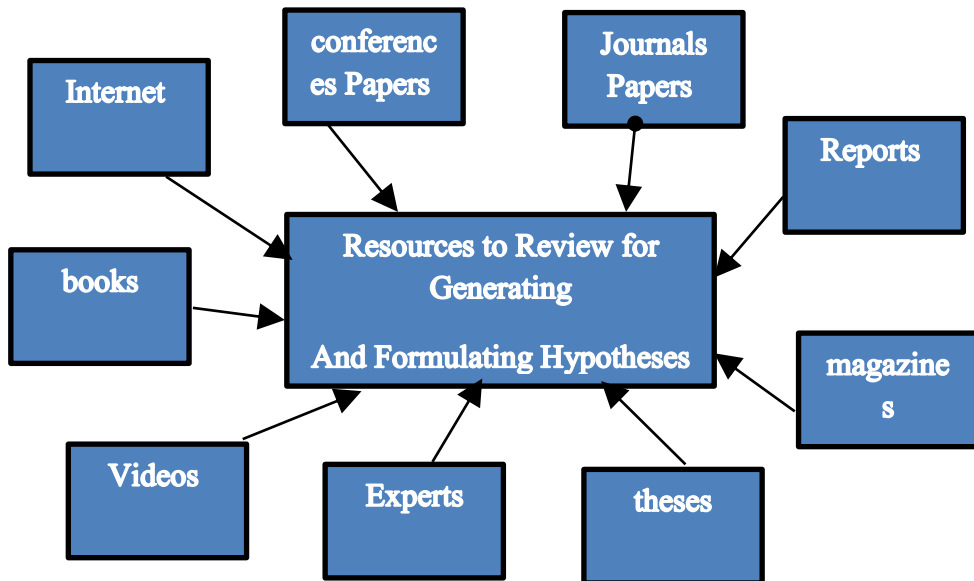


Figure 2 Resources of Generating and Formulating Scientific Hypotheses

A good hypothesis should be (Cohen et al., 2017; Walliman, 2011) in a: clear, practical, and testable formulation (1); way that helps researcher/s to define and determine operationally research's methods, terms, variables, etc. (2); way that helps researcher/s to choose and clear up the suitable search design (3). Yet, acquisition knowledge and skills of SRHs requires well prepared teachers.

In doing so, teachers, mainly science teachers, should be well-prepared via a high quality preparation programs at institutions of teacher's preparation. In Yemen, task of PSSTs preparation for teaching in secondary school is authorized to faculties of education. They (i.e. PSSTs) are exposed to undergraduate programs of the professional preparation (3Ps) in a wide variety of content areas. Thus, PSSTs are expected to be a skillful for SRSs via such 3Ps. Responding to this expectation, 3Ps often offer a standalone FERC (Kleiner et al., 2007). In context of Yemeni 3Ps, every PSST exposes to FERC which supposedly provides them with sufficient knowledge and skills on SRSs particularly the skills of SRHs. Yet, engagement in understanding of SRSs, mainly SRHs, is critical to the PSSTs.

#### **Aim and Problem Statement**

As educators of FERC, the researchers noticed that PSSTs often enter FERC in teacher 3Ps with a lack of the research content knowledge and skills that deal with SRHs. Such lack may result in part from a limited research content background. This insufficiency may slow down PSSTs' activities of planning high-level learning experiences for their students as well as the activities of teaching SRSs during their practicum, and it also lessen teachers' understand inquiry as a valuable method in teaching science for conceptual understanding.

To address this general issue, therefore, FERC was included to the 3Ps that Yemeni PSSTs at the faculty of education in Amran university are exposed to, as a compulsory course of the 3Ps. It is foreseen that if PSSTs have taken such course, they will develop their knowledge, attitudes, and skills of SRSs like formulating hypotheses.

In addition, exploration knowledge and formulating hypotheses skills of PSSTs at faculty of education in Amran University has not obtained much attention. In this regard, this study could contribute to existing literature on SRHs. In addition, results of the recent study could shed light on the existing 3Ps of PSSTs as regard to its focusing on teacher development through scientific research and its focusing on teacher development via inquiry. Moreover, results of this study will help the researchers, as educators,

in improvement their instruction. Thus, this study aimed to explore the PSSTs' SRHUL. Specifically, the study attempted to find out the PSSTs' SRHUL as they progress through studying the CFER. More specific, this study aimed to answer the following questions:

1. What is the PSSTs' SRHUL at faculty of education-Amran university, Yemen?
2. Are there any differences between mean scores of the participants (i.e. sample of PSSTs) on the SRHUT referred to the variable of test period (i.e. pre and post-test)?
3. Are there any differences between mean scores of the participants on the SRHUT referred to the variable of participants' major (i.e. chemistry, biology, and physics)?

### Research Hypotheses

In order to answer the 2<sup>nd</sup> question, the following hypotheses (i.e. null and alternative hypotheses) were set down as following:

1<sup>st</sup> a. Null hypothesis ( $H_0: \mu=0$ ): there are no statistically significant differences between the participants' mean scores on the entire SRHUT and its scales referred to the test period variable.

b. Alternative hypothesis ( $H_1: \mu \neq 0$ ): there are statistically significant differences between the participants' mean scores on the entire SRHUT and its scales referred to the test period variable.

2<sup>nd</sup> a. Null hypothesis ( $H_0: \mu=0$ ): there are no statistically significant differences between and within the participants' mean scores on the entire SRHUT and its scales referred to the major variable (i.e. chemistry, biology, and physics).

b. Alternative hypothesis ( $H_1: \mu \neq 0$ ): there are statistically significant differences between and within the participants' mean scores on the entire SRHUT and its scales referred to the major variable (i.e. chemistry, biology, and physics).

### Literature review

Many studies in the field of science education and science teachers' 3Ps (i.e. PSSTs' 3Ps) revealed that there is a misunderstanding on knowledge and skills of scientific research mainly SRHs. Though an issue of preparation teacher as a researcher has been globally considered and studied by several researchers in diverse educational researches for different purposes (e.g. Kuter, 2013; Özdilek & Bulunuz, 2009; Tuberty et al., 2011; Darus & Saat 2014; Ural, 2016), it was hardly studied in the context of Yemeni PSSTs' 3Ps at faculty of education in Amran-University.

As the relevant literature on exploring of possessing research knowledge and skills, there is also a certain emphasis on the



possessing research knowledge and skills such as knowledge about SRHs and its formulating. Moreover, a considerable amount of research has focused on how to improve such knowledge and skills different subjects, i.e. basic schools, secondary schools, universities, (Özdilek & Bulunuz, 2009; Tuberty et al., 2011; Darus & Saat 2014; Ural, 2016). Some of those studies used descriptive, quasi-experimental design, while others used pre-post-test to carry out their objectives (Tuberty et al., 2011; Darus & Saat 2014; 2005; Ural, 2016).

Özdem (2009) For instance, conducted a study aimed to explore PSSTs' argumentation in the context of inquiry-oriented laboratory work. Data of this study were collected through video- and audio-recording and transcribed during the participants' performance of the laboratory tasks. Argumentation schemes that developed by Walton (1996) was used for analysis data of this study. Results of Özdem's study showed that PSSTs applied varied premises rather than only observations or reliable sources, to ground their claims or to argue for a case or an action.

Another study conducted by Aydoğdu (2015) aimed to investigate the process Skills of Turkish science teachers in terms of some variables. Aydoğdu used science process skills test to collect data. Results of this study revealed that the level of integrated science process skills, which scientific hypothesis formulating belongs to, was under blow the satisfactory level. Also Aydoğdu (2015) conducted a study aimed to examine PSSTs' skills of formulating hypotheses and identifying variables. To collect data, Aydoğdu used a qualitative approach research (i.e. a phenomenological research design). Results of this study showed that participants' skills of formulating hypotheses as well as identifying dependent, independent and control variables accurately were insufficient.

Likewise, a study conducted by (Özdilek & Bulunuz, 2009) aimed to investigate the effectiveness of a guided inquiry method for science teaching on the elementary PSSTs' self-efficacy beliefs. (Özdilek & Bulunuz, 2009) conducted a pre-post-test design on a sample consisted of 101-2<sup>nd</sup> year-PSSTs of the elementary school who enrolled to a science laboratory course using 'Science Teaching Efficacy Belief Instrument' and focus group interviews for collecting data. Results of this study indicated that the level of subjects' efficacy expectations and outcome expectations on post-test scores were higher than the pre-test scores.

Similarly, Ural (2016) aimed to find out the effect of guide inquiry in doing laboratory experiments on attitudes of the 3<sup>rd</sup>-year undergraduate Turkish students in science education towards chemistry laboratory; to find out the guide's effect on their anxiety from chemistry laboratory; and find out the same effect on their academic achievement in chemistry laboratory. To collect data, Ural used a pre-post-test design using Chemistry Laboratory Attitude Scale and Chemistry Laboratory Anxiety Scale as well as Semi-attractorial interview. Results of Ural's study revealed that there was a significant increase in subjects' attitudes towards chemistry laboratory, their academic achievement, and a significant decrease in their anxiety towards chemistry laboratory.

Also a study conducted by Yakar (2014) aimed to find out the effectiveness of scientific process skills on a sample selected from PSSTs of Pamukkale University Primary Science Teacher Education Program for four years. To collect data, Yakar used a survey approach. Results of this study, as regard to the formulating scientific hypothesis, indicated that PSSTs at Pamukkale University in Turkey can describe and identify the appropriate hypotheses, decide and test them as well as they can determine the research variables that deal with the tested hypothesis.

In context of Yemeni related literature review, only one study related to the recent study which conducted by Aziz & Zain (2010). This study aimed to compare included science process skills in the content of Yemeni physics textbooks for the 10<sup>th</sup>-12<sup>th</sup> grades. Although the study revealed strengths in the analyzed textbooks' content, it showed a number of integrated science processes have been neglected such as measuring, predicting and hypothesizing processes.

### **Methodology**

Mixed research Methodology is a common in doing scientific research (Blaxter et al., 2006). Thus, a mixed research approach (i.e. descriptive and quantitative research approach) was used to carry out this study. Descriptive research approach was used to answer the 1<sup>st</sup> question of the study, while pre-test and post-test one-group was used to test its hypotheses. Pre-test and post-test is categorized as an experimental approach, but it is educationally used as a quasi-experimental research approach (Womack, 1997; Walliman, 2011; Ural, 2016).

Due to that this study does not include a true experiment, therefore it does not belong to the experimental studies. Eight terms should be verified for the true experiment: control group/s (1);

experimental group/s (2); random sample (3); equivalence (4); a tool to measure the independent variable effect on the dependent variable (5); intervention to the experimental group/s (6); isolation, control and manipulation of independent variable/s (7) and non-contamination between the control and experimental groups (8) (Cohen et al., 2007). If one of the previous terms is not seen through the experiment then it is not experiment, it can be looked as a quasi-experiment (Cohen et al., 2007). Thus, this study is a quasi-experimental study.

Data of the study were collected using the pre-post-test, one-group design, from a sample consisted of 120-3<sup>rd</sup>-year PSSTs at faculty of education Amran-university in order to test the study's hypotheses. Moreover, this study belongs to AR (i.e. AR is a systematic search's procedures conducted by practitioners, teachers or other individuals, in an educational context to collect data about teaching-learning situation in order to improve and develop teaching and learning in such context) (Creswell, 2012; Ali & Akayuure, 2016; Abelardo et al., 2019). Based on the previous definition of AR, AR can be theoretically taken as an incorporation component of the study's overall process.

In addition, AR is a flexible hence it can be used as a separated approach of research, or as a part of it (Wiersma, 1989; Womack, 1997). Furthermore, this study can be considered as an AR because it reflects the collaboration of the faculty staff (i.e. the authors of the study) in doing research for understanding some issues deal with SRHs that was taught to PSSTs by the authors themselves (Ferrance, 2000).

### Sampling

Participants in this study were 120 PSSTs university 3<sup>rd</sup>-year who studied the FERC at faculty of education-Amran university, Yemen. They were randomly selected from a population consists of 227 PSSTs (i.e. 40 Participants from three departments (i.e. biology, chemistry and physics), as it is illustrated in Table 1.

Table 1 Study's Population and Sample

Population		Chemistry	Biology	Physics	Total	%
		81	74	72	227	100
Sample	Pre-test	40	40	40	120	53
	Post-test	40	40	40	120	

### Instrumentation

A multiple choice test, i.e. SRHUT, was developed by the researchers themselves as an instrument to fulfill this study. Test's

items were developed passed on the related literature as well as analysis of the sub-topics related to SRHs. Besides, the test's items covered two areas: knowledge and formulating of SRHs, see table 2. SRHUT consisted of 15 items, each of them was remarked as 1 for the true answer, or zero for the false one. Consequently, the test's maximum mark was 15 marks, while the minimum one was zero. Test's items were developed in terms of document analysis of the literature, and text of student's course that deals with SRHs and their formulating.

Table 2 Items' Distribution of the SRHUT Among Its Sub-scales

Scale	Items	Total
SRHs' knowledge	1, 2, 3, 4, 5, 6, 9 and 10.	8
SRHs' formulating	7, 8, 11, 12, 13, 14 and 15.	7
		15

For further testing the SRHUT's applicability and comprehensive, validity and reliability were figured out. For validity, it was given to a panel of Experts (i.e. psychologists and educationalists) to figure out its content validity. Experts were asked to evaluate the test's items in terms of the clarity and accuracy of each item. they were also asked to be free in adding, removing, or modifying any of its items. An entirely consensus (100%) among the experts were taken as a criterion to accept the item. As for the reliability of the test, Cronbach alpha was figured out and it found as (0.67) which is an adequate and acceptable coefficient (Taber, 2016).

Subjects, therefore, were exposed to SRHTU as a pre-test before teaching them the topic of SRHs, then they were taught it during the 2<sup>nd</sup> semester of the 2019 academic year. Time for pre-test was 30 minutes, while it was for teaching the topic 2 hours. After teaching the topic, subjects were again exposed to the same test as a post-test. Then, their responses on the test were collected to be analyzed and compared with their responses on the pre-test.

### Procedures

In this study, eight main procedures were implemented: sampling, i.e. choosing the sample of the study from the PSSTs' population (1); reviewing the available literature (2); identifying the sub-topics of SRHs (3); instauration, i.e. development SRHUT (4); teach participants the topic of SRHs (5) collecting data via exposure

participants to the pre-post-test on the SRHUT (6); analyzing data (7); and interpreting data (8).

### **Data Analysis**

Different statistical tools were applied to analyze the data of the recent study. To answer the 1<sup>st</sup> study's question, descriptive statistics (i.e. frequencies, and percentages) were conducted. A variety of statistical tools (e.g. T-test, ANOVA, ANCOVA, MANOVA, MANCOVA, etc.) are used to analyze the data of pre-test and post-test as an AR (Borg, 19887; Charles, 1988; Womack, 1997; Ural, 2016). Thus, independent sample t-test was used to compare the scores' mean of pre-test and post-test in order to test the 1<sup>st</sup> hypothesis of the study as an answer for its 2<sup>nd</sup> question. In addition, one-way ANOVA was used because the analysis of variance deals with the differences between or among sample means. Moreover, test of Tukey-HSD was used to investigate the homogeneity of the study's groups (Pallant, 2005).

### **Results**

Results of this study were set according to the study's questions and tables used to illustrate its results. According to the 1<sup>st</sup> question 'What is the PSSTs' UL of SRHs at faculty of education-Amran university in Yemen'. Participants' percentages of the responses on the pre-test and post-test were figured out before and after teaching topic of SRHs. While the percentage of pre-test for all items of all subjects was found (41.6%), it was for the post-test (50.6%). As it showed by table 3, all items of pre-test except for the 1<sup>st</sup> and 6<sup>th</sup> items were less than 50%. on the other hand, the percentage of each item of the first eight test's items of the post-test was great than 50%, while the percentage of each item of the rest test's items was less than 50%.

Table 3 Participants' Responses Percentages on SRHUT's Items for Both Pre and Post- Test

Item	Test (%)		Scale		Sub-scale
	Pre-test	Post-test	Knowledge	Formulating	
1	51	95	√		Definition of SRH
2	39	54	√		SRH and scientific theory
3	40	88	√		SRH and research problem
4	34	82	√		Sorts of SRHs
5	43	50	√		Standers for a good SRH
6	76	88	√		Sources for the SRH
7	48	87		√	Example for formulating SRH
8	47	93		√	Example for formulating SRH
9	25	38	√		Statistics and SRH
10	14	10	√		Sorts of SRHs' errors
11	12	12		√	Example for formulating SRH
12	3	49		√	Writing directional SRH
13	2	13		√	Writing non-directional SRH
14	3	21		√	Writing null SRH
15	3	20		√	Writing alternative SRH

As it is illustrated in table 3, regarding to the items' percentages of the SRHUT, every item of the test had a less than (50%) except for 2 items (i.e. 1, 51%, and 6, 76%,) which belong to knowledge scale of the test. The 1<sup>st</sup> item dealt with the definition of SRH, while the 6<sup>th</sup> item dealt with the SRH's Sources. On the other hand, 7 out of 15 items (47%) of the test's items (9, 10, 11, 12, 13, 14, and 15) were found less than (50%). All of these items except for (9,

and 10) belong to the scale of formulating hypotheses skills, whereas the rest two items belong to the knowledge scale.

In order to answer the 2<sup>nd</sup> study's question (i.e. Are there any differences between mean scores of the participants on SRHUT referred to the variable of test the period (i.e. pre and post-test)?), a null and alternative hypotheses were set down and tested. As for the null hypothesis (i.e.  $H_0: \mu=0$ ): there are no statistically significant differences between participants' mean scores on the entire SRHUT and its scales referred to the test period. Results of t-test for independent samples revealed (see table 4.) that there are statistically significant differences between participants' mean scores on the entire SRHUT and its scales referred to the test period variable, since the value of 'P' (0.001) was less than the required cut-off (0.05), and all differences, in all comparisons, were in favor of the post-test. Based on the t-test results, therefore, the null hypothesis dealt with the 2<sup>nd</sup> question was rejected and the alternative one was accepted.

Table 4 t-test for Comparison of Pre and Post-test Groups on SRHUs' Mean Scores

Scale	Group	N	Mean	S. D	T	Df	P
SRHUs Knowledge	Pre-test	120	3.24	1.58	-10.45	206.09	0.001
	Post-test		5.05	1.04			
SRHUs Formulating	Pre-test	120	1.12	0.96	-9.12	217.23	0.001
	Post-test		2.54	1.33			
All SRHUT's items	Pre-test	120	4.41	2.03	-12.64	238	0.001
	Post-test		7.60	1.87			

As regard to the 3<sup>rd</sup> question "are there any differences between participants' mean scores on the SRHUT referred to participants' major variable", the 2<sup>nd</sup> null hypothesis "there are no statistically significant differences between and within the participants' mean scores on the entire SRHUT and its scales referred to the major variable (i.e. chemistry, biology, and physics)". In doing so, one-way ANOVA was used to investigate such differences.

Results of one-way ANOVA, as it is illustrated by tables 5, indicated that there are no statistically significant differences between and within the groups participants' mean scores on the entire SRHUT and its scales referred to the major variable, since the value of 'P' for all comparisons between and within groups was greater than the required cut-off (0.05). Consequently, the 2<sup>nd</sup> null hypothesis was accepted, while the alternative one was rejected.

Table 5 one-way ANOVA between and within sample groups the SRHSU

Domain		Sum of Squares	df	Mean Square	F	P
Knowledge Domain	Between	4.41	2	2.20	0.84	0.43
	Within	619.49	237	2.61		
Formulating Domain	Between	6.86	2	3.43	1.90	0.15
	Within	427.04	237	1.80		
All SRHs' Items	Between	1.30	2	0.65	0.10	0.90
	Within	1512.70	237	6.38		

In addition, Tukey's Honestly Significant Different test (HSD) was used to find out the directions of these differences. Similarly, results of HSD pointed to accept the 2<sup>nd</sup> null hypothesis and reject the alternative one (see table 6), since the value of 'P' for all comparisons between and within groups was greater than (0.05).



Table 6 Results of Tukey's Honestly Significant Different test (HSD)

Groups	Scale	Mean Difference	Std. Error	Mean			P
				Chemistry	Biology	Physics	
Chemistry Biology Physics	Knowledge Scale	-0.29	0.26	4.05	4.05	4.34	0.5
Biology Chemistry Physics	Knowledge Scale	-0.29	0.26				0.5
Physics Chemistry Biology	Knowledge Scale	-0.29	0.26				0.5
Chemistry Biology Physics	Formulating Scale	0.175000	0.21	2.05	1.88	1.64	0.69
Biology Chemistry Physics	Formulating Scale	0.175000	0.21				0.69
Physics Chemistry Biology	Formulating Scale	-0.412500	0.21				0.13
Chemistry Biology Physics	All SRHUT's Items	0.18	0.40	6.34	6.03	6.12	0.90
Biology Chemistry Physics	All SRHUT's Items	-0.18	0.40	6.34	6.03	6.12	0.90
Physics Chemistry Biology	All SRHUT's Items	-0.13	0.40	6.34	6.03	6.12	0.95

## Discussion

In general, results of the study revealed that PSSTs' SRHUL on the SRHUT was insufficient, while PSSTs' SRHUL for the post-test was greater than it for the pre-test. This insufficiency may be due to the insufficiency of the knowledge and skills deal with SRHs that PSSTs were exposed to neither via the preparation program's courses nor through their pre-university education (i.e. basic and secondary education). Such interpretation can be deduced from a studies conducted by Aziz and Zain' study (2010) hence they revealed that content of physics textbooks for the 10<sup>th</sup>-12<sup>th</sup> grade was insufficiently included a number of integrated science processes such as hypothesizing process. On the other hand, as regard to the post-test, results showed that most of the test's items which got a percentage over (50%) were belonged to the scale knowledge of SRHUT. That is, maybe, due to the lack of attention on SRHs process particularly

formulating hypotheses within the courses' content of PSSTs' preparation program at faculty of education in Amran university.

Results of this study are in line with the results of the Aydoğdu 's study (2015) and Irwanto et al.' study (2018), but differ from the results of Yakar's study (2014). While the studies of Aydoğdu (2015) and Irwanto et al. (2018) revealed that participants' skills of formulating hypotheses were insufficient, results of Yakar's study (2014) showed that PSSTs could sufficiently describe, identify, formulate SRHs and test them.

With regard to the 2<sup>nd</sup> question's results, results of t-test showed that there are statistically significant differences between mean scores on the entire SRHUT and its scales referred to the variable of test period and the differences, in all comparisons, were in favor of the post-test. In other words, the mean scores on the entire test and its scales (i.e. All SRHUT's items, SRHUs Knowledge, and SRHUs Formulating) for post-test were greater than the mean scores of the same test for the pre-test. Obviously, teaching topic of SRHs to PSSTs gave rise to the improvement of participants' achievement on the SRHUT for the post-test. But this improvement is not sufficient particularly with respect to the results of formulating hypotheses skills. In this context, some studies (e.g. Paul, 2015) reported that not only students have a problem deals with formulating SRHs, but also teachers have the same problem.

### Conclusion

In the context of 21<sup>st</sup> century, possessing SRSs is considered as a main goal of science education. For this reason, the aim of this study was at exploring the PSSTs' SRHUL as well as finding out the differences in their understanding level as they progress through studying CFER. To this end, a validated and reliable instrument (i.e. SRHUT) was developed and conducted to a sample of PSSTs before and after studying the topic of SRHs at faculty of education-Amran university. According to the study's results, participants showed insufficient performance on the SRHUT, as a results of the pre -test and vice versa in terms of the results of the post-test.

Although it was found a significant difference between mean scores of pre-test and post-test, by using t-test, which was in favors of post-test. In addition, there were not significant differences between or within mean scores of compared groups, as results of one-way ANOVA. Results indicated that PSSTs' performance of the post-test on SRHUT was greater than their performance of pre-test because of teaching them the topic of SRHs. Disappearance the significant

differences between or within mean scores of compared groups, as results of ANOVA one-way was due to the homogeneity of the study's sample.

In a few words, one may conclude from the result of this study that PSSTs have insufficient knowledge and skills on the SRHs. Although results reveal that participants' achievement on the SRHUT for the post-test was greater than their achievement on the same test for the pre-test, this achievement still insufficient particularly with respect to the results of formulating hypotheses skills.

Due to the importance of enabling students from acquisition SRSs, SRSs are universally given an important consideration in science education. Thus, in-service and pre-service science teachers should be prepared well in SRSs. To make this possible, yet, science teachers (i.e. PSSTs) should be well prepared in terms of acquisition the SRSs, that (i.e. acquisition SRSs) could not be as a reality unless these teachers are exposed to well preparation on SRSs via the preparation programs in the faculties of education. Therefore, it is recommended that an evaluation studies on the PSSTs' preparation programs based on the inclusion of SRSs within the programs' contents and activities.

In addition, as the recent study was limited by the topic of SRHs as well as PSSTs who enrolled in course of fundamental scientific research at faculty of education-Amran university, its results, therefore, could not be generalized to other population or other topic. Based on this limitation, thus, we recommended that similar studies can be conducted to different populations and different topics of SRSs.

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