



Saudi High School STEM Teachers' Understanding and Practices of Creativity in the Classroom

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Abstract: Creativity is a fundamental skill that needs to be promoted in order to develop individuals' economic and social status. Formal education is an appropriate place to enhance creativity. Therefore, international governments and educational administrators have been paying more attention to creativity in the educational context. In contrast, there are many concerns regarding the lack of students' creative thinking. In particular, the Saudi Ministry of education acknowledged that their educational system struggles with a weak environment that hinders creativity. Thus, the Saudi Ministry of Education aims to enhance creativity as one of its main educational goals of the Saudi 2030 vision. This paper aims to assess Saudi high school STEM teachers' understanding of creativity, as they are a key component for enhancing creativity in the school environment. The study was conducted in Saudi Arabia with nine Saudi high school STEM teachers. The qualitative data collection strategy included semi-structured interviews. The analysis approach was *a priori* coding based on the review of the theoretical foundations for creativity and innovation in European education. The analysis shows that Saudi high school STEM teachers have various definitions of creativity. Participants valued creative students by providing opportunities and establishing positive relationships with them. Teachers claimed they practiced creativity through instructional practices that engage students' participation in the learning process. Participants were not satisfied with their professional development or the technical support provided by the Saudi Ministry of Education. The study results suggest further exploration and recommendations that enrich the research area of creativity in STEM education.

Keywords: *Creativity; Education; Teachers; Saudi Arabia; STEM.*

Introduction

Creativity is a crucial factor that helps drive individuals to succeed in various fields. Several studies suggest that formal education is the ideal place to enhance creative thinking (Shaheen, 2010; Gustina & Sweet, 2014; Daud et al., 2012; Lin, 2011). Therefore, Canadian, Australian, Swedish, and US educational policy statements emphasize the importance of creativity, extended to all areas of educational practice (Gustina & Sweet, 2014; Sharp, 2004).

In line with globalization and research recommendations, education in Saudi Arabia has also experienced reforms intended to achieve a “2030

vision.” The Saudi 2030 vision is a plan that aims to develop the economy and improve the public services sectors, such as education, health, and tourism. The Ministry of Education aims to improve “the educational environment, stimulating innovation and creativity” (Ministry of Education, n.d.).

On the other hand, several barriers are inhibiting the development of creativity and innovation through education in Saudi Arabia. There is dissatisfaction with creativity outcomes (Iqbal, 2011) and Saudi students lack awareness of creativity and innovation (Aichouni et al., 2015). Thus, there is a contradiction between the current attention given to creativity and the actual outcomes of teaching creativity.

The interest in conducting this study was based on a regrettable situation concerning the lack of creativity among Saudi students. One way to improve creative outcomes is to investigate teachers' roles in developing creativity (Gustina & Sweet, 2014). Therefore, this project investigates teachers, in particular, as they are a key component for developing students' creativity. In the Saudi research context, the current project addresses one of the "2030 vision" educational goals of improving creativity outcomes within Saudi education. The significance of this study lies in involving both male and female teachers from different cities and schools in Saudi Arabia, which has not been done before because of socio-cultural constraints on researchers.

More broadly, this study addresses the general lack of research on creativity in STEM classrooms, which have been largely ignored in previous creativity studies. Therefore, this study contributes to enriching creativity research in the STEM context, which addresses the misconception that creativity connects to only the arts (Sharp, 2004). Further, many studies examine creativity by focusing on children or elementary school teachers (Aljughaiman & Mowrer-Reynolds, 2005; Hui & Yuen, 2010). However, this study investigates how Saudi high school STEM teachers define creativity, their attitudes towards creativity, their instructional practices to promote creativity, and professional needs to better develop creativity in their classrooms.

Creativity in this context can be defined as "A product or process that shows a balance of originality and value" (Ferrari et al., 2009), which is similar to Runco and Jaeger's (2012) standard definition of creativity. Throughout this paper, creative teaching can be

defined as "using imaginative approaches to make learning more interesting and effective" (NACCCE, 1999: p. 89), whereas creative learning refers to the students' ability to develop their thinking skills and learn in a creative way instead of merely notional acquisition (Ferrari et al., 2009).

This study conceptualized creativity as a skill for all individuals, which can be developed or blocked. Thus, teachers have the ability to enhance students' potential. Ferrari et al. (2009) suggest that creativity and innovation require eight "enablers," which refer to circumstances that facilitate creativity development such as assessment, culture, teachers, and curriculum. The presence of all eight enablers does not mean that creativity is accomplished, instead, both teachers' and students' active engagement is required to accomplish creativity.

Hence, teachers play an essential role in increasing creativity and innovation in schools. Therefore, this study focuses on investigating one of these eight enablers, that being teachers.

The present study uses Ferrari et al.'s (2009) review of the theoretical foundations for creativity and innovation in the context of education in Europe as a framework. Ferrari et al.'s framework was the most appropriate choice for this study for several reasons. First, it highlights the significant need for developing students' creativity and innovation, especially in the current technological revolution. Second, Ferrari et al. (2009) admit there is a gap between educational policies and creativity and innovation practices in schools, which aligns with the current gap of creativity education in Saudi Arabia. Third, Ferrari et al. (2009) examined different factors that could facilitate

developing creativity in detail, as well as, considering the active engagement of teachers, which is the subject of the study.

The current project investigates one enabler, the “teacher” from the Ferrari et al. (2009) framework. Ferrari et al. provided eight tables (one table for each enabler) that summarize a variety of categories associated with that group. The table of teachers as

enabler was originally composed of six categories. We revised the framework by combining two of Ferrari et al.s’ categories (training on creativity and support from technical personnel) into a single category “Teachers’ needs.” We also excluded one category (time away from curriculum) because it does not reflect the culture of Saudi education. Thus, the modified framework that used in this study includes four categories (Table 1).

Table 1
The Framework for Assessing Teacher Enablers

Enablers (Teachers)...	Description	Research Question
Understand what creativity is.	Define what creativity is, how to foster it, and address myths, implicit theories, and assumptions on creativity.	What definitions do Saudi high school STEM teachers provide for the term “creativity?”
Value creativity in students.	Welcome creativity in students and acknowledge the balance between originality and value.	What attitudes do Saudi high school STEM teachers have towards creativity in their classrooms?
Are creative.	Need to be creative themselves and implement creativity in their practice.	In what ways do Saudi high school STEM teachers demonstrate creativity in the classrooms?
Need -Training on creativity -Support from technical personnel	Need training to acquire new skills, techniques, and methods to be innovative and creative, and support professional development. Need technical support, extra time and supporting materials to foster creativity in their teaching.	What do Saudi high school STEM teachers need as far as resources in order to be able to better foster creativity?

Note. Adapted from “Innovation and Creativity in Education and Training in the EU Member States: Fostering Creativity Learning and Supporting Annotative Teaching,” by (Ferrari et al, 2009)

What is creativity?

There are many definitions of creativity in the literature, which can generally be divided into three categories; individual, intellectual, and social.

First, several scholars defined the term creativity based on the features of creativity or the traits of a creative individual. Creativity is defined as an output that could be an idea or product of a process that has specific features. Guilford (1950) and Torrance (1974) defined creativity as having: “flexibility, fluency, elaboration, tolerance of ambiguity, originality, breadth of interest, sensitivity, curiosity, independence, reflection, action, concentration and persistence, commitment, expression of the total personality, and sense of humor.” However, other scholars emphasized the features of creativity such as originality, imagination, and flexibility. Particularly, Starko (2001) found that originality is one of the most identified characteristics of creativity reported by researchers. Other experts of creativity believe that originality alone is not enough to be creative. Thus, Runco and Jaeger (2012) added usefulness or value as another feature for an idea or product to be creative. Likewise, Ferrari et al.’s (2009) definition of creativity that is used in this study considers both originality and value.

Second, creativity can be defined as generating new ideas that contribute substantially to intellectual discipline (Gardner, 1993; Runco & Sakamoto, 1999). Guilford (1967) has considered that creative thinking is similar to divergent thinking, which is the ability to generate different thoughts or solutions to one question. Thus, creativity is the intellectual ability to

create a product, identify relationships, or explore unexpected solutions.

Third, some scholars focus on the environment and how it enhances creativity or hinders it. The environment could refer to broad constructs such as society and culture or more narrow environments, such as classrooms. Torrance (1963) highlights the importance of providing students with an opportunity to learn and think creatively by comparing learning creatively and learning by authority.

In short, creativity can be defined from a variety of perspectives as above. Hence, Isaksen et al. (2011) acknowledged that there is no one accepted definition for creativity. However, defining creativity and characteristics of creative individuals play an essential role in assisting instructors in recognizing creative students and practicing creativity in classrooms.

How teachers can be creative?

Creative teaching or teaching for creativity? It is clear that teachers play a significant role in developing students' creativity. Consequently, several studies addressed two critical processes to enhance creativity: creative teaching and teaching for creativity. The National Advisory Committee on Creative and Cultural Education NACCCE report (1999) defined creative teaching as “using imaginative approaches to make learning more interesting and effective” (NACCCE, 1999: p. 89). However, teaching for creativity is an approach of teaching that aims to develop learners' creative thinking or behavior (Jeffrey & Craft, 2004). Overall, creative teaching is related to teachers' instructional practice to enhance creativity. On the other hand, teaching for creativity is related to

learners' traits and empowerment (Jeffrey & Craft, 2004). Creative teaching and teaching for creativity are interconnected processes important for nurturing creativity (Lin, 2011). However, creative teaching is broader than teaching for creativity, as creative teaching leads to teaching for creativity (Jeffrey & Craft, 2004).

Instructional practices promote creativity:

Teachers' instructional practice plays a vital role in developing learners' creativity. Harris and Bruins' (2017) confirmed that teachers' effective pedagogical practices in the classroom could positively influence creativity outcomes. Liu and Lin (2014) indicated that autonomous learning, inquiry-based learning, and diverse fun activities are essential elements of creative classrooms, which leads to enhanced learners' ownership of their learning. For instance, cooperative learning and discussion (Fleith, 2000; Khalid et al. 2020), brainstorming, open-ended activities, and unstructured time are effective activities for promoting students' creativity (Fleith, 2000). Active learning strategies that place the learner in the center of the learning process foster students' creativity.

Creativity in Saudi Arabia

Saudi educational system efforts to promote creativity: Four years ago, the Saudi government established the National Transformation Program 2020 which is the first phase of the 2030 vision. Since then, the Saudi Ministry of Education has focused more attention on 21st century skills, in particular, creative thinking. Nurturing creativity in Saudi schools is under the purview of the Public Administration for Gifted Students, which is formally associated with the Ministry of Education. One way the Saudi government is promoting creativity and

innovation is by providing programs to improve the educational environment, such as the national Olympiad for Scientific Creativity and Scientific Enrichment Outside School program. Further, they draw attention to creative students through centers that provide educational and instructional services for gifted students. They also allocate special classes for gifted students within schools to prepare creative generations.

Another significant contribution to enhancing creativity in Saudi Arabia is "Mawhiba," or King Abdulaziz and His Companions Foundation for Giftedness and Creativity. Mawhiba is a national educational foundation in Saudi Arabia established to help cultivate a comprehensive environment of creativity through a partnership with the Ministry of Education. Mawhiba includes various programs such as gifted classes, enrichment programs, and competitions.

Saudi literature related to creativity: Unfortunately, there are few studies that have examined creativity in the Saudi education system. Almutairi (2015) encouraged integrating creativity into the Saudi school system and studied how to enhance creativity based on teachers' perspectives by interviewing seven teachers. She identified three main areas that could impact creativity: curriculum, classroom environment, and teachers' professional development. Almutairi (2015) supported Aljughaiman & Mowrer-Reynolds's (2005) finding that teachers lack an understanding of creativity.

Moreover, Almutairi drew attention to the curriculum content, which is too intense and reduces opportunities for creativity. The classroom environment was not

appropriate for implementing strategies that enhance creativity. Almutairi (2015) recommended paying more attention to integrating creativity into the educational system by providing professional development programs for teachers and continuing curriculum reforms.

Aichouni et al. (2015) examined students' views on creativity and innovation by eliciting students' opinions about university support to enhance creativity, and services offered by the National Olympiad on Scientific Creativity. A questionnaire distributed to Saudi gifted students indicated a clear positive attitude toward creativity and innovation through their tendency to work collaboratively and participate in creative and innovative works. Also, Aichouni et al. (2015) found that the educational environment supports students' creativity and innovation (2015). On the other hand, Aichouni et al. (2015) showed that gifted students do not have adequate creativity and innovation awareness. Significantly, the study asserted a need for training and awareness programs on innovation and creativity (Aichouni et al., 2015).

One year later, Al-Qahtani (2016) aimed to address the mismatch between classroom practices and expected outcomes from students, instructors, and parents. Al-Qahtani (2016) explored Saudi EFL (English Foreign Language) teachers' attitudes and perceptions toward creativity and their extent of promoting creativity in classrooms through a mixed-methods study. Al-Qahtani's research revealed that Saudi EFL teachers do not foster creativity adequately in their teaching practices, have confusing definitions of creativity, and inappropriate teaching practices. He also found a lack

of support for creativity in the curriculum and a lack of teachers' training programs for creativity (2016).

In conclusion, professional program training, students' workshops, and student-centered instruction are recommended to support those initiatives that the Ministry of Education implemented in the last five years to develop education (Al-Qahtani, 2016; Almutairi, 2015; Aljughaiman & Mowrer-Reynolds, 2005; Aichouni et al., 2015).

To the best of our knowledge, there are no Saudi studies that have investigated high school STEM teachers' understanding and instructional practices toward fostering creativity. All three mentioned studies were able to examine only one gender (that of the researcher). All three studies also took place *before* issuing the objectives of the Saudi Vision 2030. However, this study considers both genders and hopes to determine if teachers have since improved their understanding of creativity and how they implement creativity in the STEM classroom compared to these previous studies.

Research Questions

1. What definitions do Saudi high school STEM teachers provide for the term "creativity?"
2. What attitudes do Saudi high school STEM teachers have towards creativity?
3. In what ways do Saudi high school STEM teachers demonstrate creativity in the classrooms?
4. What do Saudi high school STEM teachers need as far as resources in order to be able to better foster creativity?

Methods

Research Design

This study used a qualitative, exploratory research design to address the above research questions. The qualitative approach aims to describe participants' experiences by evaluating the "teacher" as one of the enablers that encourages fostering creativity through investigating the four categories of the modified Ferrari et al. (2009) framework (Table 1). The data analysis consists of four-stage: a priori coding, conducting the interviews, initial coding, and intercoder reliability.

Procedures

Instrument: A total of 26 questions were gathered from previous empirical research literature about creativity in classrooms. The 26 questions were offered to eight graduate students and three science education faculty to sort them into the four modified framework categories. Then, the lead investigator and a Science Education faculty advisor reviewed and modified those questions to fit the main research questions. Eventually, the interview protocol involved 17 questions that had coherence to the four research questions, and reflected the modified Ferrari et al. (2009) framework (Table 1).

Two graduate students who are Arabic native speakers translated and checked the final interview questions from English to Arabic. The lead investigator conducted a pilot study with a Saudi high school STEM teacher to validate the interview questions. The pilot study suggested modifying two questions by clarifying the meaning of some terminology. The final interview script involved four main open-ended questions along with follow up questions that probed for details to gain further insight (Appendix A).

Recruitment: The lead investigator collected data in March and April of 2020. COVID-19 and travel difficulties affected data collection, which led to implementing a convenience sample of participants. Subjects were found through an announcement script posted in various social media programs (Twitter, What's App, and Snapchat), in particular in accounts that involve Saudi STEM teachers. The lead investigator selected the social media apps because of the popularity of those programs more than email in Saudi Arabia. The invitation post was in Arabic. Two Arabic speakers reviewed the invitation post to check the meaning and culture fit. The consent form was sent to 20 teachers who responded to the announcement post. Recruitment and interviews were first come, first serve and continued until the participants did not mention new responses that related to the research questions. The contact language was Arabic because it is the native language of the subjects and the lead researcher.

Participants: Nine teachers agreed to participate in the study. The lead investigator contacted the nine participants to set interview appointments through the social media apps they chose, either FaceTime or Snap Chat. All HSIRB protocols were followed. Table 2 illustrates a list of participants who participated in the study. The participants were high school STEM teachers with STEM path majors in Saudi Arabia. The teaching tenure of participant teachers ranged from three to 22 years. The study sample involved both genders. The participating teachers were from six different regions in Saudi Arabia which is an additional strength, given the variety of the research sample.

Table 2

The Demographics of Study Participants

Participant	Pseudonym	Sex	Subject	Teaching tenure	City
1	Amal	Female	Biology	22 years	Dammam
2	Bayan	Female	Physics	20 years	Dammam
3	Dalal	Female	Biology	22 years	Riyadh
4	Emad	Male	Mathematics	16 years	Riyadh
5	Fahad	Male	Biology	Three years	Hail
6	Hisham	Male	Biology	16 years	Alzulufi
7	Marwan	Male	Mathematics	16 Years	Alahsa
8	Nora	Female	Chemistry	21 years	Sabya
9	Rakan	Male	Physics	Four years	Hail

Data analysis: The analysis approach was *a priori* coding by developing codes before examining the current data. The analysis process involves four stages. The first stage started before collecting data by creating *the a priori* coding scheme (see figure 1). Four main categories were pre-identified (definition(s) of creativity is/are, attitudes toward creativity, teacher creativity, and teachers' needs) based on the modified Ferrari et al.'s model (2009) and research questions. We also expected additional codes under each category based on the definitions of the major concept in the study (creativity) and the literature findings.

The second stage was conducting the interviews, which lasted between 40-60 minutes and were audio recorded through a QuickTime player. The lead investigator transcribed data from audiotapes and also had text notes that were taken during the audio calls to generate codes. The analysis was in Arabic for several reasons. First, Arabic is the native language of the first author and participants. Second, to obtain the appropriate intended meaning in Arabic, maintaining the study's credibility and validity.

The third stage was the initial coding to generate assign codes. The lead investigator read the transcribed data to identify meaningful analytical units through organizing and grouping the responses into codes according to similarities in ideas. The four main code categories (definition(s) of creativity is/are, attitudes toward creativity, teacher creativity, and teachers' needs) were already created based on the modified Ferrari et al.'s (2009) framework and research questions (see figure 2). However, when necessary, we also developed our own codes when we saw consistent patterns of responses that were not predicted which represent the other hierarchy branches. Then, a list that includes all the codes that were developed and used in the research study was refined and revised, searching for relationships in the data. The codes were then summarized and organized into an overall coding scheme (see figure 2).

The fourth stage was intercoder reliability, done with two graduate students who are Arabic speakers and coded 30% sample of transcripts, using the overall

coding scheme. There was an agreement of 90% between the two coders. The intercoder reliability showed only one difference related to whether to include “fostering creativity” under teachers' attitudes or instructional practices. Eventually, the lead investigator arranged the final codes based on the study's research questions and modified Ferrari et al. framework. Lastly, the results were translated into English to report the results.

Results

Overall, data collected from participating teachers showed that Saudi STEM teachers in this study defined creativity as a *set of features*, an *intellectual ability*, and as a *comprehensive term* that includes giftedness and intelligence. Further, participants valued creativity and creative students because of their beliefs about the significant impact of creativity on students' future and the country. Teachers claimed that they implement creative teaching practices. Despite the training programs and basic technological tools are available for Saudi STEM teachers, participants were not satisfied with them. Interviewees highlighted several impediments to teaching creativity that call for improvement.

Research Question 1: What definitions do Saudi high school STEM teachers provide for the term “creativity?” The *a priori* codes for creativity definitions were *individual*, *intellectual*, and *social*. Teachers were able to define creativity based on the creative individual features and intellectual; however, they did not define creativity based on the social perspective. Unexpected emergent codes were creativity as an umbrella concept which involves

intelligence and giftedness. Overall, Saudi high school STEM teachers defined creativity as a set of features of creative individuals or creativity as a way of thinking (intellectual ability). They also unexpectedly associated creativity with giftedness by considering giftedness as an early phase of creativity. Further, teachers addressed intelligence as an associated factor in creativity.

Creativity is a Set of Features: Participants were also able to define creativity as *features* of a creative person or a creative output. Marwan defined creativity as several features of creative students, “*I see the creative student has high self-confidence and willpower. Also, there is something important in the creative student: the ability to realize the relationships among things and think differently, find alternative solutions, leadership, responsibility, flexibility, fluency of ideas, new ideas, and wide imagination.*”

Teachers tended to focus on the originality of the creative ideas or products, more than other traits of creative output. Amal said, “*Usually scholars define creativity as the originality and novelty of unique ideas. Creative students can manifest creativity in a unique and original idea, a product, or a work. They also could offer new insights that many ordinary people could not provide.*”

Nora corroborated Amal’s statement, “*Creativity is going out of the ordinary or seeing the ordinary product extraordinarily. Creativity depends on many principles; the most important principles are originality, fluency, and flexibility. But the originality is the major principle of creativity.*”

Figure 1

The a priori Coding Scheme

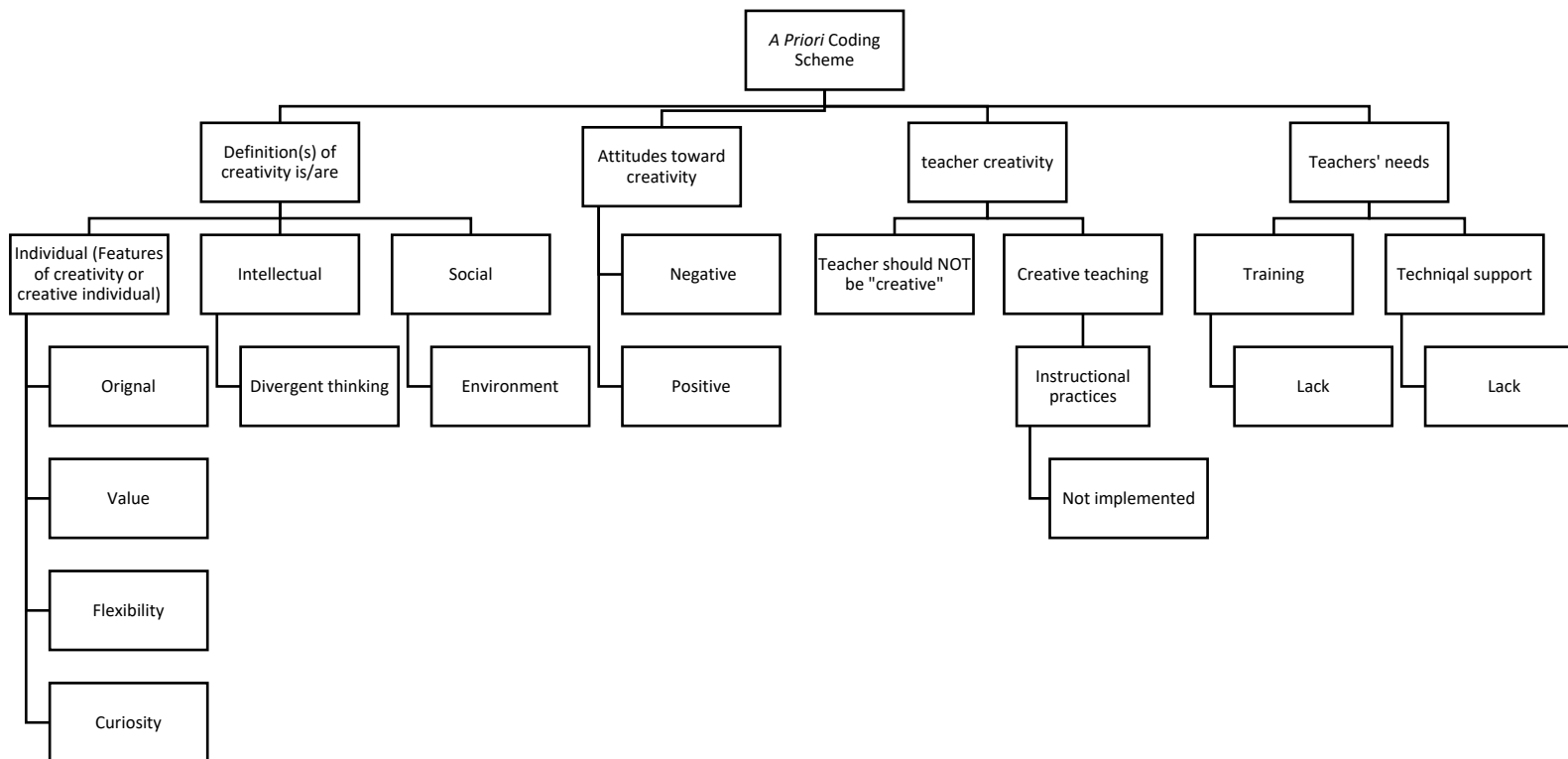
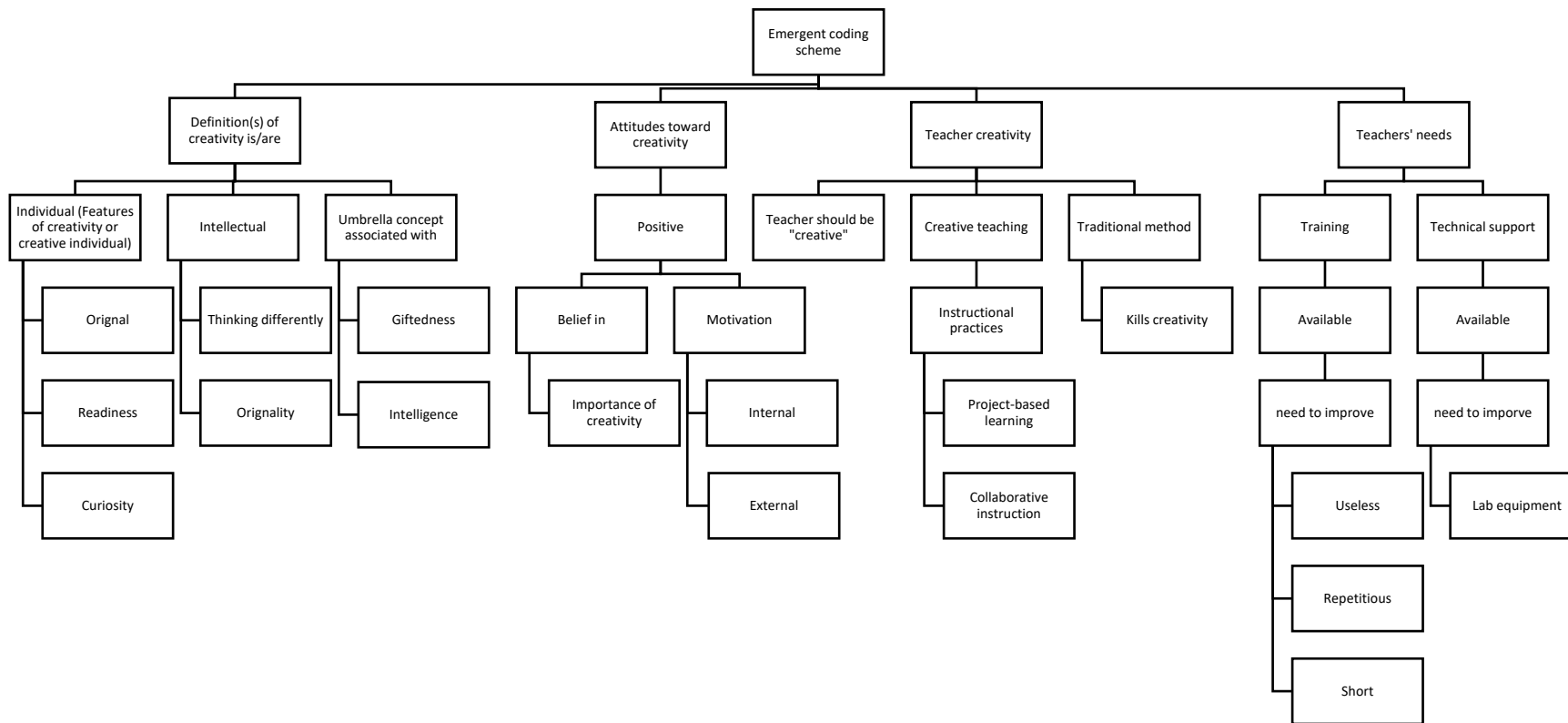


Figure 2
The Final Coding Scheme Including Emergent Codes



However, teachers also indicated curiosity and readiness to learn as important features while discussing definitions of creativity based on creative individuals. Bayan said, *“I noticed that creative students like to learn, and they never stop learning. For example, they have a passion for learning. They keep contacting me when they go home and asking me about something that I did not explain in-depth in the classroom. I think creative students just like you provide them a key and they go to find a door to open it by themselves.”* Like Bayan, Fahad described creative students *“As those who question and have the curiosity to explore the information more than their peers.”* Hisham added the readiness to learn as a feature of creative students. *“Readiness and preparation to receive information from the beginning of the lesson to the end are the most important features of creative students.”* Creative students have a passion and readiness to learn.

Briefly, participants were able to define creativity based on the features of creativity or creative individuals. In particular, participants' responses included a variety of features with emphasis on originality, curiosity, and readiness. On the other hand, they did not suggest usefulness or value as a feature of creative output.

Creativity is an Intellectual Ability: As we expected from the *a priori* codes, teachers defined creativity as an *intellectual ability*. The creative student has the ability to think differently than other students, which is characterized by originality and flexibility and leads to new and extraordinary thoughts. Rakan is a novice teacher. He was the only one who admitted that creativity is a vague term for him *“In general, the idea of creativity is not clear for me.”* but through

discussing creativity during the interview, he could formulate a general definition of creativity, which to him was thinking differently. *“Creativity is a process related to thinking. Creative students think out of the box or think unfamiliarly.”*

Likewise, Marwan and Bayan defined creativity as the ability of creative students to come up with a new method that was unknown to them. Marwan suggested that creativity is the ability to solve problems backward. *“Creativity is the ability to think differently. For example, I can solve the problem from A to Z, but a creative student can solve it from Z to A.”*

Bayan's response was similar to Marwan's, but Bayan clarified that thinking skills relate to creativity. *“Creative students can solve problems differently; in a way, such did not learn before. Creative students can conclude, compare, understand to reach high thinking skills.”* Participants asserted that creativity is the ability to think unusually. Taken together, teachers defined creativity as intellectual ability that is similar to divergent thinking. However, they did not mention divergent thinking explicitly and they ignored the importance of producing large numbers of ideas. Instead, teachers only emphasized the way of thinking and the originality of the production of new ideas.

Creativity is a comprehensive term: Participants also described creativity as a comprehensive umbrella concept that involves several sub-concepts such as giftedness and intelligence, which was not part of our original coding scheme.

Creativity and giftedness: Unexpectedly, teachers linked creativity to giftedness in many of their responses. Hisham compared creativity and

giftedness, “*Creativity is not limited to bright students. Creativity is available for everybody, whether student or not student, inside curriculum or outside the curriculum, inside a classroom or outside the classroom. Creativity is a process of thinking, dealing, and behavior.*” Hisham continued, “*However, giftedness is more related to a specific domain. But creativity is more general and does not relate to one specific domain. Creativity like an umbrella that includes giftedness, excellence, and uniqueness.*”

Participating teachers considered creativity as more comprehensive than giftedness. Nora indicated that “*Creativity is a result of giftedness. The creativity concept implies the highest level of giftedness.*” Like Nora, Fahad described creativity as “*... creativity more comprehensive than giftedness. I think giftedness could be a requirement for creativity.*” Also, Amal stated that “*Giftedness leads to creativity. A creative person could use his giftedness to generate a creative idea.*”

In general, participants described creativity in relation to giftedness. Teachers believed that creativity is available for everyone and developable, while giftedness is an innate ability. In addition, creativity is more comprehensive than giftedness. Finally, giftedness can lead to creativity.

Creativity and Intelligence: Similarly, but with less emphasis, teachers linked creativity to intelligence. Teachers differed in their perspectives on the correlation between creativity and intelligence. Amal said, “*I see high mind ability and creativity in the same circle. We cannot say an intelligent person is creative, but we can say the creative person is intelligent.*”

Amal continued connecting the two concepts “*Creative students could have one of the intelligence kinds (IQ) such as linguistic, logical, or mathematical intelligence based on his field of creativity.*”

Along the same line, Marwan linked creativity to intelligence and extended it to the idea of genius “*Intelligence includes several kinds. I think intelligence is one of the elements of creativity. If the students' creativity is increased, he could be a genius. Hence, genius is an advanced phase of creativity.*” Amal and Marwan believe that there is a relationship between creativity and intelligence.

However, Hisham's perspective is the opposite of Amal and Marwan's idea. Hisham believed that creativity is not related to intelligence. “*Creativity is comprehensive, but it is not related to excellence or high achieving students. Excellence is related to the subject or knowledge; excellence means that students learn through written information in the curricula and getting high grades.*” Hisham indicated that creativity is not limited to intelligent or bright students. Instead, creativity is available for all students.

In general, participants have mixed definitions of creativity that lie in three perspectives; *intellectual ability, features of creative individuals, and comprehensive term.* In particular, teachers emphasized the originality feature. In contrast, teachers missed the feature of value or usefulness of creative products or processes.

Research Question 2: What attitudes do Saudi high school STEM teachers have towards creativity?

The *a priori* codes for teachers' attitudes toward creativity, based on previous literature, were either

“positive” or “negative.” The current study shows that most teachers had positive attitudes toward creativity. Teachers showed their positive attitudes toward creativity through their belief in the importance of creativity and claims of implementing behaviors that value creativity.

First, teachers believed that developing creativity in the classroom is an essential component of the 2030 Saudi vision goals intended to grow the economy of Saudi Arabia. Rakan expressed his perspective on the importance of creativity. *“Creativity is very important because our country is in a significant shift. So, we should have generations who are able to keep up with that significant shift and contribute to the country’s development.”* Emad also addressed the importance of creativity *“Including creativity in the classroom is very important because it influences the student himself and the environment. As well, the circumstances surrounding students should help creative students to develop their creativity.”*

On the other hand, teachers raised some concerns of neglecting creativity. Amal warned of ignoring creativity *“Ignoring creativity may affect the person in a way that could cause depression. In fact, there are many depressed creative students whose creativity was not given appropriate attention or directed to the right path. Hence, their mental health was affected.”*

Emad highlighted the same issue *“Blocking creativity limits students’ abilities, leading to backfire as lying and misbehavior in the surrounded environment. The creative student must have acceptance in the school and between his classmates. So, he can feel comfortable.”* The environment, including teachers and peers, should value students’ creativity.

Second, teachers claimed that they value creativity through internal and external motivation. Bayan states, *“Honestly, I am convinced that the teacher is the foundation because she can change her students. I support my students by providing opportunities and motivating them through praise.... I focus on providing opportunities for my students to show their creativity. For instance, for the class project, I provide them with volunteer opportunities, visiting a place before conducting research about it such as a hospital or school, a fitness club. I emphasize providing opportunities and freedom.”* Similarly, Hisham said, *“I encourage students to be creative. I tell them if they are creative explicitly, which could foster their abilities.”* Likewise, Hisham highlighted providing opportunities, *“I also motivate my students to be creative by giving them the opportunity to work actively with me and their peers through dialogue, asking questions.”* Teachers valued students’ creativity through external motivation, such as praise and awards, which express their positive attitudes toward creativity. Teachers also addressed the importance of internal motivation by providing students a sense of satisfaction, accomplishment, and providing opportunities.

Teachers focused on creating positive relationships with their students, which they believe promotes creativity. Hisham said, *“I need students to be in a good mental situation to learn and to be creative. I see the mental readiness is a very important point following with creating a good relationship with students. If mercy and human relationships are provided, students come into creativity and learning. I see human relations as number one.”*

As well, Dalal pointed out the importance of trust between teachers and students as an essential element to foster creativity, *“The trust between teacher and student opens horizons and breaks barriers, such as fears from the teacher. The student needs to feel the teacher caring about his interests and benefits. Hence, the student will be connected mentally and emotionally with the teacher by providing the best things he has.”* Dalal extended her conversation to the humanistic relationships between teachers and students, *“I am really careful about the humanistic initiatives with students by touching their needs, attendances, absences, and emotions.”* Establishing positive relationships with students is a top priority to enhance creativity.

In short, the interviewed teachers hold a positive attitude toward creativity. They believed that creativity is an important skill that students need to develop. Participant teachers valued creativity through their beliefs in the importance of creativity and claims of students' motivation, such as providing opportunities for students to be creative and forming positive relationships with students.

Research Question 3: In what ways do Saudi high school STEM teachers demonstrate creativity in the classrooms?

We had expected that teachers in this study would suggest that teachers do not need to be creative or that they do not implement creativity at all, with some teachers suggesting they should use creative teaching or instructional practices. Contrary to our expectations, however, emergent codes suggested that teachers believed they need be creative themselves so as not to kill creativity in their students. Thus, the analyzed data showed that teachers demonstrate

creativity in the classrooms through their claims of the importance of being creative teachers and implementing creativity in their instructional practices.

Teachers believed that they play a significant role in developing students' creativity, and creative teachers could positively impact their students. Fahad considered the teacher as a role model for the students, *“It is hard for students to be creative if they did not touch creativity in his teacher. Even if the student is already creative, his creativity will fade away.”* Hisham had a similar idea as Fahad, *“The teachers should use creativity. It should be a part of their personality and work to enhance students' creativity.”* The interviewed teachers believed that even a teacher should be creative, which assists in reflecting creativity onto the students.

Teachers claimed that they express their creativity in their classrooms through instructional practices. Teachers reported that they demonstrated creativity through creative teaching, which significantly contributes to fostering students' creativity. When participants asked about creative teaching, they provided explanations and several examples of creative teaching. Emad defined creative teaching, *“Creative teaching is half of the way to creativity. The teacher is creative if he presents the current lesson differently from the last lessons, which implies variation in instructional strategies and does not make the classroom's atmosphere boring.”* Like Emad, Hisham reported, *“I think creative teaching should use different strategies because students are creative in various fields.”*

Five of nine teachers compared creative teaching with the traditional method, which they view as useless and say kills students' creativity. Bayan said, *“Creative teaching is using information in simple and attractive methods to break the routine and let students conclude. In contrast, the traditional method or initiation kills creativity because I provide the information and ask students to memorize. Hence, I do not let them think.”*

When teachers were asked to provide examples of how they implement creativity in the instructions they used in their classroom, they claimed that they implemented different strategies such as project-based learning, scientific research, flipped classrooms, STEM-based learning, and collaborative instruction. Dalal reported, *“One of the performance tasks I provide my students is creating projects through modeling. Students need to build a model using the provided tools.”*

While Dalal used modeling to implement creativity, Amal sought to apply creativity through imagination skills in her lessons *“I like to implement (evoke) imagination through the (What if...) activity. For example, I asked my student to create an imaginary creature by providing them with pictures of different living creatures. Their role would be to cut the pictures of organs and create new creatures that would be able to adapt to a specific environment and explain why it would be able to do so.”*

Moreover, teachers emphasized using instructional strategies that activate students' roles in the classroom, in particular, engaging their thinking abilities. Hisham indicated, *“I encourage the method that invests students' thinking. I see it as a creative method, such as critical thinking and also problem-solving and all*

of these methods help to foster students' creativity. I do not ignore the mind.”

The participants focused on the instructional practices that not only encourage students to come up with answers for questions, but they encourage them to come up with creative and novel ideas. Emad said, *“I always encourage students not to be content with the last result of a problem, but we need the solution method. For example, I ask them to consider themselves as football players when they solve a problem. Does it count as a goal when the player scores with his foot, knee, or head? Sure, yes. So, I care about the method that you got the solution to the problem.”*

In sum, teachers claimed they implemented creativity in their classrooms through instructional practices that engage students in the learning process, such as project-based learning and collaborative instruction.

Research question 4: What do Saudi high school STEM teachers need as far as resources in order to be able to better foster creativity?

The *a priori* codes for teachers' needs, based on previous literature, were “lack “for both training programs and technical support. However, participating teachers showed that although training programs and technical support were available for them to foster creativity, they tended to discuss the weaknesses of the services provided for them, and they look forward to better developing their needs.

Training Programs: Although Saudi teachers had mandatory training credits that they must gain yearly, they discussed several negatives of the Ministry of Education's training programs. Overall, the Ministry

of Education's training programs did not meet Saudi teachers' needs for several reasons.

First, seven of nine teachers described the training programs as a useless lecture that did not provide them with helpful practices to develop their creativity or students' creativity. Emad said, *"The training programs did not affect teachers significantly. The percentage of the benefits from the training programs for me is only 15-20%."* Like Emad, Hisham said, *"All the provided training programs are traditional and did not present something new for teachers such as active learning and self-confidence. So, I enrolled in training programs at my own expense."*

Second, teachers highlighted that training programs' topics are repetitious and unrelated to the profession. Rakan mentioned, *"Training programs have the same topics every year such as the Herrmann Brain Dominance Instrument (a model to measure brain thinking), problem-solving, decision making, learning in the 21st century, and workplace ethics."*

Third, teachers considered the training programs to be too short a period to learn new practices. Emad discussed how the short time of training programs could prevent benefits *"The training programs are not sufficient; it takes only four hours for four days."*

In short, the interviewed teachers had the opportunity to enroll in training programs provided by the Ministry of Education. However, teachers were not satisfied with the quality of training because they lack instructional practices, are an insufficient length, and have little influence.

Technical Support: As with the training programs, the Ministry of Education provides technical support for teachers, however, with some weaknesses. Bayan said, *"To be honest, the government provides everything for us. Tools, internet, smart board, software, and a digital transformation team who help us when we need programming."* However, Nora expressed her concerns with providing lab tools to conduct experiments. *"Sometimes the lab' materials are not available. So, I have to find alternative materials from the environment."*

Teachers who teach in small towns highlighted that their schools still lack technological tools and resources such as microscopes and projectors. Fahad said, *"Since I am teaching in a small town, the environment does not help me because the school resources are very limited. For example, the microscope is the most important thing in the biology lab. But it is not available in the school. So, I have to bring my own microscope."* Participants believed they need better access to tools that align with activities and experiments in the curriculum.

Further, teachers believed they needed to equip gifted and creative students' classrooms with special tools that foster creativity. Amal indicated, *"In my school, creative and gifted students' classes are identical to these of regular students. Nothing is different."* Nora raised the same issue *"Gifted and creative students' classes need high levels of resources to make their classes different from the rest of the students. For instance, it would be helpful to have a STEM lab that enables us to do specific experiments."* There is insufficient lab equipment, which teachers believe affects the students' creativity.

Discussions

This study aimed to examine Saudi high school STEM teachers as an enabler that assists in developing students' creativity. The underlying assumption at the study's onset was that creativity is generally not an understandable term for the participants of the current study. Further, creativity is not an important concept, nor is it implemented in Saudi teachers' classrooms (Al-Qahtani, 2016; Almutairi, 2015). However, this study does not indicate that to be the case. The analysis of teachers' interviews indicates that participants had various definitions for the term of "creativity", tended to pair creativity to giftedness and intelligence, generally supported creativity, and implemented creative instructional practices. However, the teachers expressed the need to improve training programs and technical support.

Question one: Saudi high school STEM teachers provided three definitions for the term "creativity" that lies in three perspectives; features of creativity or creative individual, intellectual ability, and comprehensive concept includes giftedness and intelligence.

Even though participants in this study did not mention the exact definitions of creativity that we expected, it is not fair to say that they could not define creativity because their views reflected a large part of scholars' definitions of creativity. Some scholars see creativity as an aspect of personality (Guilford, 1950; Torrance, 1974) or intellectual ability (Guilford, 1967). Thus, there is no one definition of creativity (Isaksen et al., 2011). On the other hand, the present study does not support previous research that found that Saudi teachers lack an understanding of what creativity is and the characteristics of creative students (Aljughaiman & Mowrer-Reynolds, 2005; Al-

Qahtani, 2016). This may be because Saudi Arabia has increased their emphasis on creativity in the last few years, which may have improved teachers' understanding of it. This would suggest that efforts by the Saudi government to improve developing creativity in education are working.

For many years, scholars have debated overlapping creativity with other similar constructs. Thus, many theorists have investigated the relationship between intelligence and creativity. According to Sternberg and O'Hara (2000) there are five ways to interpret the relationship between creativity and intelligence: creativity is a form of intelligence, intelligence is a form of creativity, intelligence and creativity have the same meaning, intelligence and creativity are unrelated concepts, and intelligence and creativity have overlapping and common features. Gardner (1993) supported the idea of creativity as a part of intelligence through his popular theory of multiple intelligences. Sternberg and Lubart (1995) suggested that intelligence is a part of creativity in their model, which involves six different factors that should be met to demonstrate creativity.

One common overlap between creativity and intelligence is giftedness. According to the three-ring theory of giftedness by Renzulli (1986), giftedness lies at the intersect between three factors: creativity, intelligence, and task commitment. In a word, creativity, innovation, intelligence, and giftedness have various interrelated perspectives and interpretations.

Similarly, the Saudi STEM teachers in this study appear to link creativity with other terms such as giftedness and intelligence, which is consistent with

(Almutairi, 2015). The Saudi Ministry of Education often pairs creativity and giftedness, particularly in the programs for public management for giftedness. A possible explanation for the overlapping may be to the Saudi Ministry of Education often pairs creativity and giftedness, particularly in the programs for public management for giftedness.

In light of various definitions and theories of creativity presented by teachers in this study, there is a need to rethink creativity in the Saudi education system. In particular, a unified model and definition of creativity aligning to Saudi educational policy, standards, programs, and STEM curriculum, and that clarify relationships between creativity and similar constructs, is necessary.

Question Two: Saudi high school STEM teachers hold positive attitudes toward creativity

Saudi STEM teachers showed positive attitudes toward creativity, though previous research (Aljughaiman & Mowrer-Reynolds, 2005; Al-Qahtani, 2016) had mixed results regarding teachers' attitudes toward creativity. Teachers' concentrating on intrinsic motivation is in line with Torrance (1963), who highlighted the importance of providing opportunities for students that help them think creatively, and avoiding teaching authoritatively, which limits creative thinking. Unexpectedly, the participants in this study mentioned both issues, which make a significant difference in teaching creativity. The fact that teachers in this study realize the importance of intrinsic motivation and teacher encouragement for students' creativity is a positive starting point for Saudi STEM teachers. According to Yuan et al. (2019) these teacher attitudes will help to

engage students in the creative process and lead to growth of creativity.

Question Three: Saudi high school STEM teachers demonstrate creativity in their classrooms by implementing instructional practices that engage students' thinking in the learning process

Consistently with the positive attitudes toward creativity in the previous question, the results of the third question showed that teachers' claims of demonstrating creativity through instructional practices in their classrooms. Unlike Aljughaiman & Mowrer-Reynolds (2005) and Al-Qahtani (2016), teachers in this study claimed that they implemented creativity through instructional practices that foster students' creativity. In line with Almutairi (2015), we also found that Saudi teachers could identify strategies and instructional practices that foster students' creativity. They also admitted the importance of teachers' roles in promoting creativity.

Saudi STEM teachers tended to link creative teaching with traditional teaching as opposite kinds of instruction. Kind and Kind (2007) found that it is typical for teachers to associate "good" creative teaching with project work and cooperative learning, while "bad" traditional teaching involves lecture and individual learning. However, our view supports the idea that "good science teaching" is not fundamentally associated with either creative or traditional teaching (Kind & Kind, 2007). Teachers could implement a "balanced" approach combining both creative and traditional teaching.

Participants also reported that they implemented instructional practices that stimulate students' thinking and participation. This present study is in line with the

systemic review paper of Cremin and Chappell (2019), who found that 22 of the 35 papers on creative pedagogies focused on producing ideas as a key characteristic of creative pedagogical practice. Further, the emphasis on cognitive methods here is consistent with the Ibdāa brochure published by Mawhiba, which indicates brainstorming and problem-solving are models for developing creativity (p.27). Overall, even though the reported creative teaching instructional practices such as project-based learning and collaborative instruction were accepted and on the right track compared to the previous studies that did not implement them at all. However, they missed implementing risk-taking, inquiry-based learning, and minimal evaluation, which is the desired goal in the creative classroom. Further, teachers did not address the creative teaching strategies in the literature, such as provide explicit instruction on how to be creative (Niu et al., 2017), adding an element of surprise, incorporating technology, providing choices (Rinkevich, 2011). Teachers should know how to apply risk-taking in the classroom and even practice it, which helps students develop cognitive playfulness (Harris, 2016). Thus, the reported creative teaching practices within this paper are non-integrated creativity techniques. Teachers need to strengthen their instructional practices.

Question Four: Saudi high school STEM teachers need to have improved training programs and lab equipment to be able to better foster creativity

The Ministry of Education in Saudi Arabia involves a sector called The National Center for Educational Professional Development, which aims to improve the performance of educational practitioners by providing effective professional programs for teachers and educational leadership members. Despite the Ministry

of Education's efforts to improve teachers' performance, participants expressed some resentment toward the Ministry of Education's professional development. The dissatisfaction is consistent with Almutairi (2015) and Al-Qahtani (2016), who found that Saudi teachers were not satisfied with the professional development programs they received. This study supports Aljughaiman and Mowrer-Reynolds (2005), who recommend taking serious steps to provide sufficient professional development and resources for teachers, which leads to creative students. Obviously, the efforts of The National Center for Educational Professional Development through offering training programs for teachers are positive. However, receiving mandatory training programs is not sufficient. Instead, our results indicate a need to pay more attention to the quality of the training programs that the Ministry of Education offers to teachers regardless of the quantity of the yearly mandatory credits. As found in Al-Balushi and Al-Abdali, (2015), this paper expects that implementing appropriate professional development programs and providing sufficient technical support will improve teachers' understanding of creativity and instructional performance.

Conclusion

Previous research has focused on disciplines with the arts and languages (Almutairi, 2015; Al-Qahtani, 2016), investigated only one gender of participants (Almutairi, 2015; Al-Qahtani, 2016), or focused on developing the creativity of younger students, such as elementary level students (Aljughaiman & Mowrer-Reynolds, 2005). Our study focused on high school STEM teachers of both genders in STEM disciplines. The data provided a recent comprehensive view of how creativity is currently understood and practiced by Saudi STEM teachers.

However, the data was self-reported, so we do not know what is actually happening in classrooms. In addition, participants voluntarily participated in a study about creativity and so may be more interested in it than other teachers. Therefore, future research will need to add in classroom observations to see how STEM teachers actually practice and foster creativity in their classrooms. In addition, research must explore other contexts, such as teachers in small towns, novice teachers, students, supervisors, or developers of professional development support creativity such as Mawhiba.

The current study sought to examine Saudi high school STEM teachers as one group that assists in developing creativity. In particular, the study explored four areas: the teachers' definitions of the term "creativity" is, their attitudes toward creativity, how they are creative in their classrooms, and their needs to better foster creativity. Saudi high school STEM teachers defined creativity differently, valued creativity, and claimed practicing creativity through instructional practices that promote engraining students' participants in the learning process. On the other hand, Saudi high school STEM teachers were not satisfied with the Ministry of Education's professional development and technical support.

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Appendix A

Interview Protocol

Research questions	Semi-structured interview questions
1. What do Saudi high school STEM teachers think creativity is and how do they define it?	A. How you can define creativity based on your own knowledge and experience B. How does creativity manifest in your students' work? C. What are the characteristics of creative students? D. How do you develop creativity in your students?
2. What are the attitudes of high school Saudi STEM teachers towards teaching and learning creativity in their classrooms?	A. Do you think teaching creativity is important for your students? Why? B. Do you promote creativity in your class? How? C. Describe what you are doing when you explore a creative student in your classroom
3. To what extent do high school Saudi STEM teachers use creativity in their own teaching and how do they foster creativity in their students?	A. Do you teach creativity in all topics in your classroom? Why? How? B. Do you use instructional practices that support creativity in your class? Please, mention specific strategies C. What teaching practices work best for you in developing creative behaviors in your classes? D. Do you think you are creative? Why?
4. What do high school Saudi STEM teachers view as impediments to teaching creativity in their classes and what do they need as far	A. Describe your experience of training programs that you enrolled in to be more creative

as resources in order to be able to better foster creativity?

- B. Do you think that teachers get adequate preparation to teach for creativity? How
- C. What technological tools and services that you have?
- D. Do you think the technical tools are sufficient for fostering creativity?
- E. What do you think teachers need in order to be able to foster creativity?
- F. What prevent you from fulfilling creative outcomes in your classrooms?
- G. Do you find it difficult to develop creative behaviors in students? Please explain

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