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Mapping SS1-3 chemistry teachers' interest, self-efficacy, and literacy in teaching for creativity using simulation

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The purpose of this article was to analyze chemistry teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation teaching of concepts in chemistry to enhance students' creativity skills. A descriptive and exploratory quantitative design was used in the study. The study used 150 serving chemistry teachers from the Calabar education zone public education system. A 29-item questionnaire was employed to gather data from respondents. Independent *t*-test, regression, and a 2-way analysis of variance were used for data analysis. Results obtained indicated high levels of teachers' interest, literacy, self-efficacy, and teamwork in the utilization of simulation strategy in teaching chemistry concepts. Results of a 2-way analysis indicated that teachers' age and years of experience influence teachers' self-efficacy, teamwork, and creativity. It was recommended among others that serving teachers' interest in the use of simulation is encouraged to support their learners' instructional activities in a simulated classroom.

KEYWORDS

creativity, chemistry education, simulation, self-efficacy, literacy, gender

Introduction

In times past, creativity was seen as an exclusive prerogative of talented people who were seen utilizing their skills to produce a novel product. There is no commonly accepted definition of creativity (Getzels, 2017). Creativity in the general sense is often defined as follows: creativity is the creation of a new product, by combining knowledge acquired from various environments, which to a certain degree is measurable and developed, and even though people proclaim it as desirable, most of the time it is not rewarded (Sternberg, 2006).

Theoretically, the concept of creativity is defined as "the interaction among aptitude, process, and the environment by which an individual or group of people produce a perceptual product that is both novel and useful" (Plucker et al., 2004, p. 91). When mental images, inspiration, and novel ideas are used to attain a desired end or aim is termed creativity (Cheng, 2010). In the context of education, teacher creativity refers to the application of innovative techniques, strategies, and styles to enhance learners' educational outcomes (Ghanizadeh and Jahedizadeh, 2016).

In the twenty-first century, creativity is rapidly gaining ground as it is regarded as an important feature of work, thought, and life (Henriksen et al., 2016). The dynamic nature of modern society is witnessing a paradigm shift and therefore teachers must adjust to keep pace with the changing society. Innovation and creativity in the classroom should not be seen as a chance, but also indispensable. The educational system as it is now or tomorrow sees creativity as an inseparable part (Ferrari et al., 2009).

Creative teaching is believed to positively influence the student's academic achievement, performance, and learning outcomes of learners (Richards, 2013; Dikici and Soh, 2015), as well as Cropley (2018), highlighted that students' ability to hone their potential acquired during their school years will help them solve unanticipated problems in the future as a result of creativity. Creativity enhances thinking and problem-solving thereby reducing stress and anxiety. It gives one a sense of purpose which leads to feelings of accomplishment and pride. All advancements known to mankind began with a novel idea, and novel ideas are inspired by imagination and creativity (TeachThought Staff, 2022).

The production of a skillful workforce and human capital in the future is enhanced in students when creativity is nurtured in students. Creativity is very important in the twenty-first century as nations are clamoring for technology and are instituting educational policies to shape their citizens into producers of innovative products as opposed to being the end users of technology (Sidek et al., 2020).

Presently, pedagogues are concentrating on changes in the current education sector and the functions of teachers in the operations of teaching and learning. Instruction strategy has changed at an alarming rate of late and thereby is much altered from previous decades (Segedy et al., 2011). The functions of teachers have greatly changed from a basic instructor to a combination of facilitator, moderator, tutor, and consultant (Bui et al., 2020). New technology and approaches to teaching-learning are transforming twenty-first-century classrooms. Educational institutions from primary schools to colleges are leaping on the Digital trends such as Smart classrooms, Webcast Lectures, Virtual Labs, Virtual Reality, Augmented Learning, blended Learning, Flipped Learning, and a host of others that have taken center stage in the classroom (Vijayalakshmi, 2021).

Simulation has diverse definitions in the literature. The act of mimicking the original process is termed simulation (Yin and McKay, 2018). A simulation involves the use of tools that enhance teaching by employing representation and practice in a repeatable, focused environment (Aldrich, 2004). Such simulation includes role play, games, and computer programs that encourage students to become active participants in the chemistry classroom (Almasri, 2022). The use of role plays, games, and computer programs to motivate students, and make them active participants in the chemistry classroom is termed simulation (Blum, 2017). Fallon (2019) referred to simulation as the representations of real or hypothesized situations using a computer in a dynamic, interactive, environment that provides visualized learning experience. Computer simulation aids in identifying and understanding factors that take charge of the system which can see the hereafter conduct of the system (Goldsim, 2011).

The purpose of the study was to examine the levels of interest, self-efficacy, and literacy of science teachers in the utilization of computer simulation in teaching and learning. Specifically, the study sought to find out;

1. The levels of interest, creativity, teamwork, self-efficacy, and literacy of science teachers' usage of educational simulation for teaching.
2. The inter-correlation among the concepts under investigation.
3. The differences in the scores of individual concepts concerning gender, age, and teaching experience on simulation usage.

Research hypotheses

The following null hypotheses directed this study.

1. Chemistry teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation do not differ significantly.
2. There is no significant difference in the inter-correlations of teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation.
3. The gender of chemistry teachers does not significantly influence their interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation.
4. Teachers' ages do not significantly influence their interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation.
5. Years of teaching experience do not significantly influence teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation.

Background

Creativity

Presently, the cry for twenty-first-century skills, among others, is for creativity skills. Creativity refers to people's ability to solve problems and transform reality. UNESCO (2015) defined creativity to be the ability of people to proffer solutions to a problem they encounter in their day-to-day living.

The process of creating or inventing new ideas is termed creativity. Everyone and everybody can be creative regardless of their field of study (Trnka et al., 2016; Glăveanu, 2018). Nowadays, the study of creativity is becoming the hallmark in scientific endeavors. Glăveanu (2018) cherishes newness, originality, and worth in creative outcomes. Presently, researchers are expressing a keen interest in the interaction between being creative and the psychological state of humans. There is the assertion that a creative mind is a healthy mind and vice versa (Richard, 2010; Conner and Silvia, 2015; Benedek et al., 2019). When creativity is in action, the individual feels happy and thereafter even happier after the creative process; people feel happier and therefore actively involved and relaxed (Silvia et al., 2014; Conner et al., 2017). Sternberg (2012) has argued that creativity can predict college success above and beyond just what students obtain from school examination scores.

In light of the above, teachers are expected to provide positive emotions for learners in the classroom in order to facilitate the efficacy of creativity progression. Educators presently are concentrating on a collection of suggestions which together are termed 21st creativity skills. This group of creativity skills takes into account the totality of a person, the "interior teacher," and the interior lives of teachers, with a focus on novel packs of skills (Piirto, 2011; see **Appendix A**).

Computer simulation

Computer simulations have been greatly applied in various fields such as education, aviation and health sciences (Blum, 2017). Participants are empowered to develop skills without suffering from exorbitant expenses or unbearable consequences. Interestingly, computer simulations contain programs that offer an effective method of keeping an eye on experimental variables, thereby creating an avenue for exploration and hypothesizing (Blake and Scanlon, 2007). There are three types of simulation, namely: Live simulation, virtual simulations, and constructive simulations (Blum, 2017). In this article, life simulation was used because humans (teachers) were involved. Chen and Howard (2010) opined that the use of simulations in the teaching of chemistry produced positive results with time.

Some studies have indicated positive and significant effects in favor of computer simulation (Udo and Etiubon, 2011; Plass et al., 2012; Ezeudu and Okeke, 2013; Sentongo et al., 2013; Kotoka and Kriek, 2014; Okwuduba et al., 2018; Nnadi, 2019; Farkhanda and Muhammad, 2020; Jack et al., 2020; Adah, 2021).

In particular, Okwuduba et al. (2018) investigated the effect of computer simulation on the academic achievement of chemistry students and findings indicated that computer simulation was more effective in enhancing students' achievement in chemistry than the lecture method. A similar study by Farkhanda and Muhammad (2020) showed that students exposed to a chemistry laboratory supplemented with simulations had better academic achievement than those students who worked in the chemistry laboratory without supplementing with simulations at the secondary school level.

Furthermore, results from previous works indicated that simulation was an effective teaching strategy when used in the classroom (Adebayo and Oladele, 2016; Asogwa et al., 2016). Studies also showed that simulation positively affected the achievement and retention of learners (Asogwa et al., 2016; Bello et al., 2016; Chinenye et al., 2019; Ibezim and Asogwa, 2020). Teachers' literacy, interest, and self-determination are pertinent factors in science and mathematics classrooms and especially in chemistry.

Investment theory of creativity

Creativity is mostly a decision someone takes. It has to do with a decision to purchase something low and sell high in the world of ideas (Sternberg and Lubart, 1991). They compared their creative postulates to investors who buy goods at a cheaper rate and intend to sell them at a higher rate to make profits. Creative people, when they get their items, are said to be buying low and when they sell the ideas and they are accepted as selling high. A creative person does not follow the crowd, they stand out. They resist thinking and doing what everyone else is doing. They are not good followers or imitators, they resist thinking and acting like others. They are domain definers as they tend to go off in their own direction, seeking to propose ideas that are both novel and useful in some way. The greatest hindrance to creativity is not peers' influence but comes from the limitations an individual places on themselves as a result of their individual thoughts—people are not born creative or uncreative; creativity is acquired through the development of a set of attitudes toward life that characterize those who are willing to go their own way. If the chemistry teacher is interested in making teaching and learning effective, the teacher can develop creativity in the teaching of chemistry concepts. The right attitudes expected of a chemistry teacher to teach creativity are; the willingness to (a) see challenges in a new way, (b) take reasonable risks, (c) exchange ideas that others might not initially accept, (d) not give up when faced with deterrents, and (e) investigate if personal preconceptions are interfering with their creative process. The aforementioned attitudes can be taught and ingrained in students by using teaching strategies that will make students think for themselves.

Bandura's social cognitive theory of self-efficacy (1977)

Self-efficacy according to Bandura (1977) is associated with an individual's conviction concerning his or her capability to manage and administer an action to attain the desired outcome. It can also be said that self-efficacy is the conviction teachers have concerning their ability to carry out their professional obligation in finishing a task in the particular context of instruction, manner, and positive attitude. Teachers take decisions and actions to implement a lesson based on their convictions. Therefore self-efficacy shows its relevance in deciphering how to enhance performance in creativity. Change and upgrading in discernment, prompt processing of feedback from teaching information and foreseeing unanticipated occurrences and always taking the action to examine their instructional activities require a high level of teacher's self-efficacy (Anderson et al., 2021). An individual with the professional obligation to effectively teach students is called a teacher. It, therefore, implies that when people that have been entrusted with the responsibility of teaching lack confidence, then it is expected that the teaching will not be effective and the classroom will be boring to students. Hence teachers affirm that a high creativity level is used in the classroom regularly to inculcate scientific creativity in learners.

Teachers' self-efficacy can be controlled by such factors as teaching experience, gender, and teachers' age (Jamil et al., 2012). Teachers with high self-efficacy will be more successful in comparison to those who have low self-efficacy and therefore will remain in the teaching profession. This is not unconnected to the fact that teachers with high self-efficacy can manage difficult situations, thereby enhancing students' academic performance (Klassen et al., 2011; Black, 2015; Patterson and Farmer, 2018). Lastly, low teacher self-efficacy can result in teachers' lassitude (Smetackova, 2017). The successful implementation of creativity in education greatly contingents on teachers for effective implementation (Bereczki and Karpati, 2018).

As aforementioned those teachers' feelings of self-efficacy are not static and can change in different teaching tasks and contexts. Therefore this study sought to find out science teachers' self-efficacy, literacy, and interest in simulations and their relevance in teaching and learning situations.

Materials and methods

Design, population, and sampling technique

The study used a census survey design. This design was used because the researcher did not manipulate the independent variables. The research investigated what has happened. All the subjects were used for the research as the population was not too large to be used for the research (Onwiduokit, 2002). The population of this study comprised 150 serving chemistry teachers in public schools of the Calabar education zone. A breakdown of this figure indicated that there are 80 women and 70 men. No sampling technique was done as all the chemistry teachers were used for the study because of the small population size.

In carrying out this research, the recommendations of the ethical commission of the Secondary School Education Board of Cross River State and the ethics guiding educational research were adhered to. Participants were intimated about the aim of the research, they were told that the exercise was purely for research purposes and it was highly confidential and anonymous in terms of data collection and analysis. Independent research assistants were employed in this study.

Participants

The subjects for this research were 150 serving chemistry teachers at Calabar Education Zone public schools, 80 women and 70 men. Eighty-eight of the participants were within the age bracket of 45 and above years old. Experienced teachers who have taught for 21 years and above were 91. All the sampled teachers had a degree in chemistry. The sample comprised all the chemistry teachers in the Calabar Education Zone.

Validity and reliability

To ensure the validity of the instrument, a visit to experts was made. This consultation was for the experts to examine the items in the questionnaire to ascertain their appropriateness, relevance, and coverage of the traits under consideration. Those items that were found unsuitable were deleted, while those found adequate were retained and some were modified or revised.

Reliability of the SIQ scale was carried out using all 28 items of the scale. The essence of this test was to establish the reliability of the instrument. The SIQ was administered to 20 chemistry teachers who were not used for the study but were equivalent to the teachers used in the study. Responses collected from the teachers were coded and analyzed using Cronbach's alpha coefficient. Results obtained as shown in **Table 1** range from 0.76 to 0.85.

TABLE 1 Reliability statistics.

S/N	Variable name	No. of item	Cronbach's alpha coefficient
1	Interest	3	0.82
2	Literacy	5	0.79
3	Self-efficacy	6	0.87
4	Teamwork	4	0.85
5	Creativity	10	0.76

Data collection

Data for this study were collected from the subjects between April 2021 and May 2021, using Simulation Interest Questionnaire Scale (SIQ). SIQ was of two parts; the first part was for concepts of interest, literacy, and self-efficacy. The second part involved creativity. The instrument was constructed by the researcher. The 28 items on the SIQ examined teachers' interest in simulations (Q1, Q2, Q3), literacy (Q4, Q5, Q6, Q7, Q8), self-efficacy (Q9, Q10, Q11, Q12, Q13, Q14) teamwork (Q15, Q16, Q17, Q18), and creativity (Q19, Q20, Q21, Q22, Q23, Q24, Q25, Q26, Q27, Q28). A 4-point Likert scale from strongly agree (SA) = (4), agree (A) = (3), disagree (D) = (2), and strongly disagree (SD) = (1) was used for data collection from the participants in Simulation Interest Questionnaire Scale (SIQ) (**Appendix B**).

Interest contained 3 items, the highest score was 12 and the lowest score was 3, literacy comprised 5 items and the highest score was 20 and the lowest was 5. Self-efficacy had 6 items and had the highest score of 24 and the lowest score of 6. Teamwork with 4 items had the highest score of 16 and lowest score of 4. Creativity, which had 10 items, had the highest of 40 and lowest score of 10.

Data analysis

The data analysis process was done by first coding the result obtained from the participants. Data analysis was done using Statistical Package for the Social Sciences software. A trial test was done using 30 teachers who were not part of the research but were equivalent to the teachers used for the research. This was used for the analysis of reliability using Cronbach's alpha coefficient for each subscale. Teachers' scores were analyzed by using mean and standard deviation, independent *t*-test, and analysis of variance (ANOVA) to check for significant differences among the independent sample groups for teaching experience, age and gender, and dependent variables of interest self-efficacy, teamwork, and creativity.

Results

Reliability of simulation interest questionnaire scale

Reliability of the SIQ scale was carried out using 28 items from the scale. The essence of this test was to establish the reliability of the instrument. Cronbach's alpha coefficient was used for analysis and it had a coefficient ranging from 0.76 to 0.85 which is appropriate because the size of the sample was not large.

Inter-correlation analysis

The inter-correlations among the five variables of the SIQ were determined using Spearman's correlation coefficient. It was used because it is suitable for the analysis of ordinal variables and non-normal distributions. The results of the analysis using Spearman's correlation coefficients indicated that there was a significant positive correlation among the variables ($0.31 < \text{rho} < 0.63$, $p < 0.001$). The results also indicated a high level of correlations between creativity and teamwork (rho = 0.59; $p < 0.001$) and between creativity and Interest ($r = 0.61$; $p < 0.001$). Contrarily, there were lower levels of correlation between 'Self-efficacy and literacy' and the other four variables (see **Table 2**).

These results showed the variables with the highest correlation coefficient when a linear regression model was used. When interest score was used in the linear regression model as the predictor of creativity score, the results showed that teachers' interest in the use of simulation accounted for 52% of the variance in the 'creativity score. It was also reported that the regression model predicted a significant creativity level [$F(148) = 209.36$; $p < 0.001$; $r^2 = 0.52$]. Findings also indicated that when there was an increase by 1 in interest score, there was an increase by 0.60 of creativity solving' score 0.60 ($b1 = 0.60$; $t = 4.59$; $p < 0.001$).

Lastly, when the teamwork score was used as the predictor of the creativity score in the linear regression model, results showed that teamwork practices accounted for 50% of the variance in the creativity score. The regression model predicted a significant creativity level of [$F(148) = 189.90$; $p < 0.001$; $r^2 = 0.50$]. This findings implied that when there is an increase by 1-point in 'Teamwork' score 'creativity' score increases by 0.68 ($b1 = 0.68$; $t = 12.88$; $p < 0.001$).

Chemistry teachers scores on simulation interest questionnaire scale

Descriptive data were used to examine teachers' scores on the scale in each aspect of SIQ. This was shown in **Table 3**. The overall sample had a high level in the five aspects of SIQ. This

TABLE 2 Inter-correlations among the scores of the Simulation Interest Questionnaire Scale (SIQ) dimensions (=150).

	1	2	3	4	5
1. Interest	1				
2. Literacy	0.31**	1			
3. Self-efficacy	0.40**	0.30**	1		
4. Teamwork	0.41**	0.33**	0.32**	1	
5. Creativity	0.61**	0.40**	0.43**	0.63**	1

**$p < 0.01$.

ranged from 2.70 (literacy) to 3.78 (interest) and a total score of 3.08 on a 4-point Likert type scale.

Also, analysis was done to investigate differences in groups in terms of participants' scores on gender, age, and years of teaching experience. Independent-sample *t*-test was used to investigate the gender influence of "Interest," "literacy," "self-efficacy," "teamwork," and "creativity" on the use of simulation. Table 4 indicated that all variables in SIQ had different mean scores. However, when an independent *t*-test was used to check for the influence of gender on all the variables, the results indicated a non-significant difference. This was so as the *p*-value obtained was greater at a 0.05 significant level ($p > 0.05$).

Also, analysis was done to investigate differences in groups in terms of participants' scores concerning gender, age, and years of teaching experience. Independent-sample *t*-test was used to investigate the gender influence of "Interest," "literacy," "self-efficacy," "teamwork," and "creativity" on the use of simulation. Table 4 indicated that all variables in SIQ had different mean scores. However, when an independent *t*-test in Table 5 was used to check for the influence of gender on all the variables, the results indicated a non-significant difference. This was so as the *p*-value obtained was greater at 0.05 significant levels ($p > 0.05$).

The influence of teachers' age on the mean scores of the five variables in the SIQ using the One-way ANOVA and Scheffé test is presented in Table 6. A Scheffé test was used to find out the group responsible for the significant difference. It indicated that, for all variables, there were no significant differences between ages 25–34 and 35–44 groups. Meanwhile, regarding the variables of; 'self-efficacy' and 'teamwork the results of the test showed a significant disparity between the 45 and above group. Results like this imply that this age group 45 and above years old have higher levels of teamwork and self-efficacy in simulation usage than other groups.

Lastly, analysis was done on the influence of the years of teaching experience on the mean scores of the five variables in the SIQ using the One-way ANOVA test. The results were presented in Table 7. Table 7 indicated that the differences in scores on teaching years did not have statistical significance in 2 variables of creativity and literacy ($p > 0.05$) However, teaching years' experience influenced interest, self-efficacy, and teamwork ($p < 0.05$).

The main findings of this study had been described alongside the statistical stools that were used in the collection and analysis of data in the above section. The next phase of the article is the discussion of the findings of research questions and hypotheses.

TABLE 3 Descriptive statistics of teachers' scores on the scale in each aspect of Simulation Interest Questionnaire Scale (SIQ).

Variables	N	Mean	SD
Interest	150	3.78	2.52
Literacy	150	2.70	1.55
Self-efficacy	150	3.04	3.73
Teamwork	150	2.88	1.69
Creativity	150	3.02	5.13
Total	150	3.08	2.92

TABLE 4 Variables in Simulation Interest Questionnaire Scale (SIQ) had different mean scores.

Variables	N	Mean	SD
Interest	150	3.78	2.52
Literacy	150	2.70	1.55
Self-efficacy	150	3.04	3.73
Teamwork	150	2.88	1.69
Creativity	150	3.02	5.13
Total	150	3.08	2.92

Discussion and conclusion

This study investigated the interest, literacy, self-efficacy, teamwork, and creativity of chemistry teachers on the usage of simulation in the teaching of some chemistry concepts

TABLE 5 Results of the independent *t*-test on the variables scores of Simulation Interest Questionnaire Scale (SIQ) grouped by gender ($N = 150$).

Variables	Gender of teachers	N	Mean	Std. deviation	*t*	*p*
Interest in simulation	Female	70	11.01	2.551	1.177	0.241
	Male	80	11.50	2.496		
Literacy in simulation	Female	70	13.47	1.422	−0.209	0.835
	Male	80	13.53	1.684		
Teachers' self- efficacy	Female	70	18.07	3.704	−0.599	0.550
	Male	80	18.44	3.755		
Teamwork	Female	70	11.46	1.603	0.656	0.513
	Male	80	11.28	1.772		.
Teachers' creativity	Female	70	30.23	4.861	1.003	0.317
	Male	80	31.08	5.400		

to enhance creative skills. The research went a step further to analyze teachers' gender, age, and years of teaching experience on their interest, literacy, self-efficacy, teamwork, and creativity of teachers in the use of simulation in teaching chemistry.

1. Chemistry teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation do not differ significantly.
2. There is no significant difference in the inter-correlations of teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation.
3. The gender of chemistry teachers does not significantly influence their interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation.
4. Teachers' ages do not significantly influence their interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation.
5. Years of teaching experience do not significantly influence teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation.

In response to the first research hypothesis—Chemistry teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation do not differ significantly—this study found that all 150 chemistry teachers possess high levels of interest, literacy, self-efficacy, teamwork, and creativity in the use of educational simulation to teach chemistry concepts. It is interesting to note that the scores obtained were higher than 2.70 on a scale that ranges from 1 to 4. This shows that teachers used for this study had a high interest in developing creativity for the use of simulation. The results also reported that literacy and teamwork need to be improved as the score was not higher than 3.00 for both variables.

The high level in the interest score for the study may be connected to the fact that simulation is an aspect of Information

TABLE 6 Summary analysis of the one-way ANOVA test and the results of the Scheffé test on the influence of teachers' age on the five variables of SIQ.

Variables	Teachers' age	N	Mean	SD	*F*	*p*	Scheffé test *p*
Interest	25–34	24	11.04	2.805	1.691		
	35–44	38	11.92	2.352		0.188	
	45 and above	88	11.06	2.498			
Literacy	25–34	24	13.54	1.382	1.260	0.287	
	35–44	38	13.16	1.516			
	45 and above	88	13.64	1.620			
Self-efficacy	25–34	24	16.29	4.144			
	35–44	38	18.47	3.577	4.254	0.016	
	45 and above	88	18.72	3.530			0.017
Teamwork	25–34	24	12.92	1.349	32.687	0.000	0.000

TABLE 7 Results of the one-way ANOVA on the variables scores of SIQ and the results of the Scheffé test grouped by years of teaching experience ($N = 150$).

Variables	Years of teaching experience	N	Mean	SD	*F*	*p*	Scheffé test *p*
Interest	0–10	19	10.47	2.547			
	11–20	40	12.20	2.409	4.236	0.016	
	21- and above	91	11.03	2.483			0.000
Literacy	0–10	19	13.05	1.810			
	11–20	40	13.35	1.369	1.446	0.239	
	21- and above	91	13.66	1.579			
Self-efficacy	0–10	19	21.21	1.084			
	11–20	40	18.65	3.490	9.047	0.000	
	21- and above	91	17.48	3.863			0.000
Teamwork	0–10	19	12.42	2.063			
	11–20	40	11.23	1.561	4.481	0.013	
	21- and above	91	11.20	1.600			0.015
Creativity	0–10	19	30.53	5.327			
	11–20	40	29.70	4.146	1.099	0.336	
	21- and above	91	31.14	5.499			

Technology (ICT). ICT is everybodys companion—everybody uses it. The use of simulation in chemistry teaching reduces the stress teachers go through trying to explain difficult concepts to students. Teachers, therefore, are interested as their job of teaching and learning is made easier with simulation practices. Watching divers simulation exercises would have made the teacher to be equipped with creativity skills for their novel simulation. Findings reported low scores for literacy and teamwork variables may be a result of the concept of simulation being a new teaching strategy. The teamwork score was low as teachers needed to be familiar with the new strategy before working in groups.

The result is in agreement with earlier studies conducted by Wolf et al. (2010) and Mehdinezhad (2012) whose studies reported high scores on teachers' self-efficacy, literacy, self-efficacy, and teamwork. Teachers' attitudes (interest) significantly correlated with their teaching for creativity (So and Hu, 2019; Abdullah et al., 2021). Research conducted by Niu et al. (2017) and Abdullah et al. (2021) on the influence of knowledge on teachers' creative teaching indicated a positive relationship between teachers' knowledge (literacy) and teaching for creativity.

In the same vein, the self-efficacy factor was discovered to be a significant positive effect on creative teaching (Huang et al., 2019; Liu and Wang, 2019; Liu et al., 2020). The steps a teacher takes in the classroom are positively correlated to what they believe in. Teachers who possess high self-efficacy can timely sense when there is a need to vary the teaching and materials to be used. Such a teacher can quickly process teaching information, foretell unforeseen occurrences and constantly take the introductory step to counter in the classroom (Anderson et al., 2021).

The second research hypothesis sought the significant difference among the inter-correlations of teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation. The results of the analysis indicated that there was a significant positive correlation among the variables. The results also indicated a high level of correlations between creativity and teamwork (rho = 0.59; $p < 0.001$) and between creativity and Interest ($r = 0.61$; $p < 0.001$). Contrarily, there were lower levels of correlation between Self-efficacy and literacy and the other four variables.

When interest score was used in the linear regression model as the predictor of creativity score, the results showed that teachers' interest in the use of simulation accounted for 52% of the variance in the creativity score. It was also reported that the regression model predicted a significantly creativity level [$F(148) = 209.36$; $p < 0.001$; $r^2 = 0.52$]. Findings also indicated when there was an increase by 1 in interest score, there is an increase by 0.60 of creativity solving' score 0.60 ($b1 = 0.60$; $t = 4.59$; $p < 0.001$). The results as indicated above may be connected to the fact that when teachers work as a team, exchange of knowledge takes place thereby making them more creative. There was also a high positive correlation between creativity and interest. This result could be attributed to the fact that when one is interested in a concept, the thinking capacity of that person is activated, and that gives rise to creativity.

This finding collaborates with earlier studies that indicated a positive relationship between the interest and creativity of teachers (Chan and Yuen, 2014; Akkanat and Gokdere, 2015; Baka, 2018; Zaina and Matore, 2019; Akyıldız and Çelik, 2020). Creative teachers see creativity as fun and so try new things. They had great interest and motivation for teaching and learning. At all times, individuals are interested to participate in physical and cognitive activities to achieve the intent of their minds (Chan and Yuen, 2014).

Research hypothesis three investigated if there was a significant influence of gender on teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation. Results indicated that for all variables, there existed a mean scores difference between male and female teachers. The findings also showed that male teachers had slightly higher scores than female teachers in interest, literacy, self-efficacy, and creativity. In the finding, female teachers had a slightly higher mean score on the variable of teamwork. Meanwhile, there was no significant difference in their mean scores. This can be attributed to the fact that variables under investigation are not dependent on sexual characteristics and as such male and female teachers can perform equally. Another fact that may be capable of producing such a result is that humans are born equal in intelligence the sex of a person is immaterial. This study agreed with earlier studies by Mahdi and Al-Dera (2013), Odanga et al. (2015), Awodun and Oyeniyi (2018), and Wahyudiati et al. (2020) who discovered a non-significant gender effect in their studies. However, the study of Okonkwo Ifeoma and Samuel (2020) is at variance with this study as the finding indicated that gender had a significant influence on the self-efficacy of teachers. The womens' self-efficacy mean score in the study was higher than the mens'.

However, some studies conducted on the influence of gender on teachers teaching for creativity indicated a significant influence on teachers' teaching for creativity (Alali, 2020; Chang et al., 2021). Their studies showed that male teachers had higher creative teaching mean scores than female teachers. Nevertheless, the findings of the research conducted by Li and Li (2019) and Amzaleg and Masry-Herzallah (2021) indicated that male teachers had lower creative teaching mean scores than their female counterparts.

The fourth null hypothesis stated that "Teachers' ages do not significantly influence their interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation." The fifth stated that "Years of teaching experience do not significantly influence teachers' interest, literacy, self-efficacy, teamwork, and creativity in the use of simulation." Results showed a statistical significance in mean scores on self-efficacy and teamwork. The teachers aged 45 and above had a significant result. This finding implies that the older a person is the more self-confident the person is. This can be because age gives rise to maturation which brings about confidence. With age, people tolerate each other more and can work in a team. Findings also indicated that teaching years influenced their interest, self-efficacy, and teamwork. This result may be because when one does a particular thing for many years it becomes part and parcel of that person and interest increases. In the same vein, doing a particular task for many years makes the job easier and thereby makes the individuals build confidence in themselves. Self-efficacy which has been built as a result of knowledge in the teaching process can make teachers work in a team and not be scared that their inadequacy will be exposed.

The findings from studies conducted by Li and Li (2019) and Liu et al. (2020) agreed with this study as their results showed a significant relationship between teachers' age and teachers' creative teaching. The older the teacher the higher their creativity teaching score and vice versa.

The findings also indicated that interest, self-efficacy, and teamwork were found high among experienced teachers and it further increased with the increase in experience. This finding shows the efficacy of doing a particular task repeatedly. When one does a particular thing for a long time the person becomes a master of that task. Previous studies by Li and Li (2019), NemerAitski and Heinla (2020), and Jin et al. (2021) indicated that the teaching experience of teachers had a significant relationship with teachers' creative teaching. In the study on teachers' years of experience and teaching for creativity by Chung and Chen (2018), results indicated that teachers with 16 years or more years in the teaching field had significantly better marks on creative teaching than those with low experience. Contrary to this finding, in a study conducted by Li and Li (2019), teachers who have not spent more than 3 years in service had the highest creative teaching mean score when compared to teachers with high experience.

Conclusion

This study has analyzed teachers' interest, self-efficacy, age, gender teaching experience, and knowledge as factors influencing the chemistry teachers' creativity in the use of simulation. Chemistry teachers included in this study possess high levels of interest, literacy, self-efficacy, teamwork, and creativity in the use of educational simulation to teach chemistry concepts. A significant difference in self-efficacy was found indicating that teachers above the age of 45 years were more self-confident and they had high team spirit. Interest, self-efficacy, and teamwork were found high among experienced teachers and they further increased with the increase in experience.

Recommendations

This study provides information on the factor influencing the creativity skills of chemistry teachers in the use of simulation. These findings have important implications for policy-makers and educators. Therefore, it is suggested that a larger sample size be used to conduct further research in the future. The core of this is to investigate whether these factors have a direct impact or as moderators or mediators of creative teaching among teachers. This research showed the importance of teaching experience in the creativity of chemistry teachers in the use of simulation. It is therefore recommended that the government and stakeholders in the educational sector motivate the teacher to stay in their teaching profession and avoid brain drain. In conclusion, initiatives in teaching and learning situations were common to all categories of teachers in terms of year of teaching but more pronounced in teachers who have spent decades in the classroom and are above 45 years of age. This group of teachers indicated average interest and self-efficacy in the use of simulation.

Limitations

This study was limited in terms of sample size. The sample size used for this study was 10% of the chemistry teachers in the Calabar education zone, thereby hindering the generalization of the results of this finding. Howbeit, the features of teachers in this sample may be the same as teachers in the population in terms of gender years of teaching experience, and age.

The closed-ended questionnaire which was the instrument used in collecting and analyzing data may not have given respondents leverage to express themselves. Thereby not providing all the details needed to investigate the efficacy of simulation strategy in the classroom. Given the shortcoming, the instrument was validated and reliability was done to partial out this limitation.

As much as this study had a limitation, there is some important information about the chemistry teachers' use of simulation strategy in the classroom. Relevant results indicated that chemistry teachers delight in the use of simulation to aid students' academic achievement. It is imperative to advance the development of the teachers' literacy, interest, self-efficacy, and teamwork spirit in the use of simulation in chemistry instruction. Because of the limitation of this study more studies could be carried out to analyze the use of simulation using a larger sample size and students' academic achievement.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

CN conceived and designed the research and analyzed the data. JU provided materials, analysis tools, and data. RO analyzed the data. BC-U interpreted the data. RN coded the data. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix A

Creativity skills (adapted from Piirto's creativity system).

	Creativity skills of the twenty-first century	Creativity network of Piirto's
	Creative thought	
1.	A variety of ideas and creative strategies are utilized (an example is brainstorming).	– Core attitudes [openness to experience, risk-taking, tolerance for ambiguity I (inspiration, intuition insight, imagination, imagery, incubation)] – General aspects (exercise)
2.	Create new and worthwhile ideas (both incremental and radical concepts)	– Crux attitudes (openness to experience, risk-taking, tolerance for ambiguity, self-discipline, group trust) – Seven I's – General aspects
3	Elaborate, refine, analyze, and evaluate their ideas to improve and maximize creative efforts	– Core attitudes (openness to experience, risk-taking, tolerance for ambiguity. – I's (incubation, intuition) – General aspects
	Work creatively with others	
4	Develop, implement and communicate new ideas to others effectively	– Core attitudes (openness to experience, risk taking, tolerance for ambiguity, group trust) – I's (imagination, imagery, improvisation, general aspects)
5	Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work	– Core attitudes (group trust)
6	Demonstrate originality and inventiveness in work and understand the real-world limits to adopting new ideas	– Core attitudes (tolerance for ambiguity; self-discipline; group trust) – I's (intuition inspiration, incubation) – General aspects (creativity as the process of a life)
7	View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes	– Core attitudes (openness to experience, risk-taking, tolerance for ambiguity, self-discipline) – General aspects (creativity as the process of a life)
	Implement innovations	
8	Act on creative ideas to make a tangible and useful check_and_delete Contribution To The Field in which the innovation will occur	– Core attitudes (tolerance for ambiguity self-discipline; group trust) – I's (intuition inspiration incubation) – General practices (creativity as the process of a life)

Appendix B

Simulation strategy interest questionnaire scale.
Q1 I find it interesting to learn about simulation strategy.
Q2 I like to use a simulation strategy to learn Science.
Q3 I will use a simulation strategy in my classroom teaching.
Q4 I have high literacy on the use of simulation strategy in teaching and learning activities.
Q5 I have high literacy of the plan of simulation strategy.
Q6 I have high literacy to select the most relevant simulation strategy during teaching and learning about students' ages.
Q7 I have high literacy to analyze the pedagogical potentialities of different types of simulation strategies.
Q8 I have high literacy of the different simulation strategies that can be used to teach scientific concepts.
Q9 I am sure that I possess the required skills to use simulation strategy for classroom teaching.
Q10 I am sure that I can involve my students in simulation strategy projects.
Q11 I am sure that I can give a helping hand to students when they have difficulties with simulation strategy.
Q12 I am sure that I can plan and design learning scenarios with a simulation strategy.

Q13 I am sure of teaching Science with a different type of simulation strategy.
Q14 I am sure of evaluating students' outcomes in simulation strategy learning activities.
Q15 I seek the views of others when faced with a task where I need to take a decision.
Q16 I get excited whenever I find myself in a group that is attempting to unravel a problem.
Q17. I like teamwork as it enables me to ask my group mates questions about what does not seem clear to me.
Q18. When I work with others I accomplish my task very fast.
Q19 I can practice originality by creating and generating my ideas for any given situation or task.
Q20 I can practice my sense of curiosity while exploring, researching, and building.
Q21 I can explain my ideas and concepts and interpret new concepts I learn.
Q22 I can analyze, extend, change, and assess my ideas, and ideas from others for possibilities and accuracy.
Q23 I can invite opportunities to explore, reflect, create, and rigorously come up with solutions.
Q24 I can not only find answers but also take my answers and create new questions.
Q25 I can take risks and accept failure as I search for solutions and answers.
Q26 I can practice empathy, understanding, and resolve in my work with others.
Q27 I can use my visualization and imagination to think outside the box while integrating multiple possibilities and answers.
Q28 I can use a design process to answer problems both simple and complex.