Full Length Research

Perception of secondary school science and mathematics teachers on Professional development participation in Zamfara State, Nigeria

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ABSTRACT: The study adopted a descriptive survey design to examine the perception of secondary school science and mathematics teachers on professional development in Zamfara State, Nigeria. The population of the study consisted of all Science and Mathematics teachers in public secondary schools in Zamfara State. A sample of 217 respondents were drawn through purposive and simple random sampling techniques. Data were collected using a structured questionnaire. Four research questions and two null hypotheses guided the study. Analysis of data was done using descriptive statistics and z-test. The study revealed that science and mathematics teachers in Zamfara State have low level of awareness on the various types of professional development programmes and have not been participating in the programmes. They ascribed these to the lack of incentives, lack of employer support, too expensive/unaffordable and poor publicity. They also identified content knowledge and pedagogy of teaching as the two major areas they needed professional development. The two groups of teachers have no significant difference on the areas they needed professional development as well as on the barriers impeding their participation. The study recommended among others that, government should regularly sponsor teachers to attend professional development programmes and that teachers should explore and take advantage of numerous free professional development opportunities.

Keywords: Perception, professional development, secondary school, science and mathematics teachers.

INTRODUCTION

Education is the foundation of human development. Consequently, national development has continued to be tied to educational development. Countries of the world today are increasingly involved in aggressive competition to surpass each other using education sector as a driver. Also, technological breakthrough of any society and innovations for national development are hinged on science and science education of which science and mathematics teachers are the critical actors. Science subjects at senior secondary school level comprises Physics, Chemistry, Biology and Mathematics (Isma'il *et al.*, 2019). The roles of science and mathematics teachers at the secondary school level are multifarious. Part of

which is that, they serve as an essential link between the scientifically oriented citizens of the present and the future (Luft and Hewson, 2014).

Policy documents from several countries articulate the need for science teachers to receive sufficient professional development opportunities in order to enhance and improve their instructional knowledge and practices (Luft and Hewson, 2014). The advantage of the training of teachers has been entrenched in Nigeria's National Policy on Education (NPE). The Federal Republic of Nigeria (FRN, 2013) made specific policy provision for teacher education in paragraph 56(b) of the NPE which stipulates that, "In recognition of the pivotal role of quality education

at all levels, teacher education shall continue to be given major emphasis in all educational planning and development". It further states that "in-service training shall be an integral part of continuing teacher education… Promotion opportunities shall continue to be created for unhindered professional growth at all levels". The policy also made it mandatory for all school proprietors to provide in-service education for teachers. Also, Jekayinfa (2005) emphasized that the training and production of manpower needed for the attainment of national educational objectives should be framed on the quality and quantity of teachers. Luft and Hewson (2014) reported that, given additional learning opportunities, science teachers will successfully prepare their students for the 21st century. Therefore, a quality teacher needs to be redefined from being the source of knowledge to an individual who teaches students how to think creatively and critically (Adeosun, 2014).

Secondary school is the base for preparing future scientists, technologists and mathematicians. To lay solid foundation at this level, adequate attention must be given to what goes on there. Science teachers at secondary level must possess good knowledge, skills to guide inquiries and have profound understanding of the disciplines they teach. Knowledge about the process of learning is continually developing, requiring that teachers remain informed (Dass and Yager, 2009). Thus, as science content increases and changes, so do the need to keep teachers' understanding in pace. This undoubtedly indicates the need to prepare and capitalize a lot of resources for professional development of science and mathematics teachers.

Professional development is concerned with the provision of learning, development and training opportunities for employees in an organization in order to improve their organizational performance (Khalid, 2007). Staff development programmes include in-service training, attendance of seminar, workshops, conferences and short courses within and outside the institution. It also include sabbatical leave (Tiberondwa, 2000). According to Awodjii *et al.* (2020), teachers' professional development are lifelong learning programmes organized for the development of teachers' dynamism, effectiveness, competencies (skills, knowledge, and attitudes), and motivation in a systematic and planned way to improve their performance. Jekayinfa (2005) described professional development as all forms of in-service, continuing education and training, whether formal or informal, whether teacher initiated or system initiated and whether accredited or otherwise.

The main aim of professional development is to impact teachers' knowledge, skills, and beliefs, making their practice become more useful to their students. Dadds (2014) articulated that, Teachers' Professional Development and Continuous Professional Development are interchangeable terms that claim to meet the needs of teachers as learners in a changing society. The current science education reform movement emphasizes the importance of professional development as a means of improving student science achievement (Supovitz and Turner, 2000). According to Nwarie and Nwakudu (2019), it is necessary to organize professional development programmes for the teachers and every hindrance impeding its provision and teachers' participation must be eliminated. This is due to the strategic position of secondary education and the enormous responsibilities placed on the teachers teaching at this level.

Research has shown that, teachers' quality is an important factor in determining gains in student achievement (Organization for Economic Co-operation and Development [OECD], 2005; Dass and Yager, 2009). Participation in professional development has been found to change science and mathematics teachers' attitudes towards reform, their preparation to use reform-based practices, and their use of inquiry-based teaching practices. A study by Hill and Ball (2004) reveled that participation in a professional development programme focused on mathematics content improved teachers' performance on measures of mathematical knowledge for teaching. Also, Collopy (2003) found that teachers demonstrated marked changes in instructional philosophy and practices in using mathematics curriculum materials. It became abundantly clear, according to Dass and Yager (2009), that the desired reforms in science teaching and learning could not be accomplished without significant professional development of in-service science (and mathematics) teachers.

Statement of the Problem

Despite the important position occupied by secondary education in Nigeria, the sector is still suffering many problems in many parts of the country and Zamfara State in particular. The report of Zamfara State Secondary Education Assessment Committee [ZSSEAC] (2014) revealed numerous challenges facing secondary education in the State and raised alarm that the performance of secondary school students in the State in external examinations is generally abysmal. The report attributed the poor performance of students to lack of qualified teachers, poor teachers' welfare and dearth of science and mathematics teachers in the state, leading to some arts and social science teachers being made to teach science related subjects. More so, the distribution of teachers by subject area indicates that 66% of the teachers are in Arts and Humanities related areas, while 34% are in the Science-based subjects (ZSSEAC, 2014).

Again, ZSSEAC (2014) revealed that, the bulk of the teachers in the State are NCE holders (64.79%) of which the majority of them lack knowledge of the subject matter of what they teach. This contradicts FRN (2013) which

stipulates that, NCE holders are to teach at Basic Education not at Senior Secondary School level as in the case of Zamfara State. These situations mentioned above presented critical situations for the need of robust professional development for science and mathematics teachers in the state so as to improve their efficiency in order to boost students' academic achievement. As improving students' outcomes depends on improving the quality of teachers (Dass and Yager, 2009), it is therefore imperative to investigate the views of teachers concerning their training and retraining for better efficiency and maximum output. Hence, this study surveyed the perception of science and mathematics teachers in secondary schools in Zamfara State on their professional development.

Objectives of the Study

The specific objectives of the study were to;

1. determine the level of awareness of science and mathematics teachers on the types of professional development programmes in Zamfara State.
2. find out the extent to which science and mathematics teachers participate in the types of professional development programmes in Zamfara State.
3. identify the areas of professional development needed by science and mathematics teachers in Zamfara State.
4. identify the perceived barriers to participation in professional development by science and mathematics teachers in Zamfara State.

Research Questions

The following research questions were formulated to guide the study:

1. What is the level of awareness of science and mathematics teachers on the types of professional development programmes in Zamfara State?
2. To what extent do science and mathematics teachers participate in the types of professional development programmes in Zamfara State?
3. What are the areas of professional development needed by science and mathematics teachers in Zamfara State?
4. What are the perceived barriers to participation in professional development by science and mathematics teachers in Zamfara State?

Hypotheses

The following null hypotheses were tested at a 0.05 significant level.

Ho$_1$: There is no significant difference between the mean rating of science and mathematics teachers in the areas of professional development need in Zamfara State.
Ho$_2$: There is no significant difference between the mean rating of science and mathematics teachers on the barriers to participation in professional development in Zamfara State.

METHODOLOGY

A descriptive survey research design was adopted for the study. In this type of design, researchers administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviors, or characteristics of the population (Creswell, 2003). The target population for this study comprised 339 Science (Biology, Chemistry, and Physics) and 195 Mathematics teachers in public secondary schools in Zamfara State. The sample size of 217 (164 science and 53 mathematics teachers) was arrived at using Research Advisors (2006) sampling model. Purposive and simple random sampling techniques were employed in the selection of the participants. OECD (2018) Teaching and Learning International Survey (TALIS) instrument was adapted for data collection in this study. The adapted instrument was a twenty-seven-item structured questionnaire having section A for demographic data and section B on a 4-point scale of Strongly Agree/High Awareness (SA/HA) - 4 points; Agree/Moderate Awareness (A/MA) - 3 points; Disagree/Low Awareness (D/LA) - 2 points and Strongly Disagree/No Awareness (SD/NA) - 1 point. The instrument was properly validated and the reliability coefficient of the instrument was determined using Cronbach's Alpha technique and yielded 0.75. The instrument was administered personally by the researchers and collected on the same day of administration. All the copies were correctly filled and returned. The research questions were answered using frequency counts, percentage responses, mean, standard deviation, and ranking while the z-test was used to test the hypotheses at a 0.05 level of significance. Items with a mean above 2.50 indicated that the respondents agreed/have a high awareness of the item on the questionnaire while a mean below 2.50 indicated respondents' disagreement/low awareness.

RESULTS

Research Question 1: What is the level of awareness of science and mathematics teachers on the types of professional development programmes?

Table 1 shows that the mean responses on the items revealed that, science and mathematics teachers used for the study were aware of workshops, conferences, seminars, supervision, distant learning, and study leave

Table 1. Mean responses of science and mathematics teachers' level of awareness on the types of professional development programmes.

S/N	Types of professional development programmes	Science Teachers $\bar{X}_1$	Mathematics Teachers $\bar{X}_2$	Mean set $\frac{\bar{X}_1 + \bar{X}_2}{2}$	Remarks
1.	Workshop	3.01	3.51	3.31	HA
2.	Conference	2.94	2.55	2.71	HA
3.	Seminar	3.01	2.81	2.91	HA
4.	Mentoring/Coaching	1.22	2.01	1.62	LA
5.	Online courses	1.44	2.11	1.78	LA
6.	Supervision	3.21	3.17	3.19	HA
7.	Teacher collaborations	1.88	1.09	1.49	LA
8.	Short full time courses	1.01	1.52	1.27	LA
9.	Vacation courses	2.25	1.89	2.07	LA
10.	Radio-TV courses	1.54	2.04	1.79	LA
11.	Distant learning	3.02	3.04	3.03	HA
12.	Study leave with pay	3.72	3.6	3.66	HA
13.	Study leave without pay	2.11	2.22	2.17	LA
14.	Full sponsorship study leave	1.89	2.38	2.14	LA
	Grand mean	2.31	2.42	2.37	LA

Keys: HA = High awareness, LA = Low awareness.

with pay as types of professional development programmes to a high extent because they had mean scores greater than 2.50 mean benchmark. However, the level of awareness of the two groups in the other types of professional development programmes was low. Therefore, having a grand mean of 2.37 indicated that the level of awareness of science and mathematics teachers on the types of professional development programmes was low in Zamfara State.

Research Question 2: To what extent do science and mathematics teachers participate in the types of professional development programmes in Zamfara State?

The question of whether science and mathematics teachers have been benefiting from the listed types of professional development programmes in Zamfara State was assessed by asking the teachers to tick as many programmes they have once participated. Table 2 shows that only 'Study leave with pay' got a little above 20% positive response (i.e. 21% for both science and mathematics teachers). Item 5, 7, 8, 10, 13, and 14 have 0% responses from the two groups except item 7 where mathematics teachers had 2%. The responses for the remaining items were from 1% to 10%. This result implies that, the extent of science and mathematics teachers' participation in the types of professional development programmes in Zamfara State is very low.

Research Question 3: What are the areas of professional development needed by science and mathematics teachers in Zamfara State?

Table 3 shows that items that have a mean rating that is above the benchmark of 2.50 for science teachers are 2, 3, 4, 5, 6, 7, 9, 10, 12, 15, and 16 while that of mathematics teachers are 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13 and 15. The three areas of greatest professional development needed by science teachers are 'Content knowledge of my subjects' ($\bar{X}$=3.98), 'Pedagogy in teaching my subject' ($\bar{X}$=3.97) and 'Application of academic research findings in the classroom' ($\bar{X}$=3.91) while that of Mathematics teachers are 'Content knowledge of my subjects' ($\bar{X}$=3.92), 'Pedagogy in teaching my subject' ($\bar{X}$=3.90) and 'Selection and use of relevant instructional materials' ($\bar{X}$=3.81). Hence, 'Content knowledge of my subjects' and 'Pedagogy in teaching my subject' are ranked 1st and 2nd by the two groups. Conversely, 'Application of academic research findings in the classroom' and 'Selection and use of relevant instructional materials' were ranked 3rd by science and mathematics teachers respectively. The least area (ranked 16th) that science teachers need professional development is 'Student counseling' while that of mathematics teachers is 'Interdisciplinary teaching/integration of concepts. The grand mean of 3.13 and 3.06 for science and mathematics teachers respectively show unanimous agreement by the two groups that they need professional development.

Table 2. Percentages of extent of science and mathematics teachers' participation in the types of professional development programmes.

S/N	Types of professional development programmes	Science teachers (n=164)		Mathematics teachers (n=53)	
		f	%	f	%
1.	Workshop	6	4	4	8
2.	Conference	9	5	5	9
3.	Seminar	5	3	3	6
4.	Mentoring/Coaching	4	2	1	2
5.	Online courses	0	0	0	0
6.	Supervision	15	9	5	9
7.	Teacher collaborations	0	0	1	2
8.	Short full-time courses	0	0	0	0
9.	Vacation courses	5	3	4	8
10.	Radio-TV courses	0	0	0	0
11.	Distant learning	12	7	5	9
12.	Study leave with pay	35	21	11	21
13.	Study leave without pay	0	0	0	0
14.	Full sponsorship study leave	0	0	0	0

Table 3. Mean ratings and rank order analysis of areas of professional development needed by science and mathematics teachers.

S/N	Areas of professional development need	Science teachers		Mathematics teachers	
		$\bar{X}$	Ranking	$\bar{X}$	Ranking
1.	Classroom management	2.19	14	3.66	4
2	Student assessment practices	3.8	5	3.63	5
3	Content knowledge of my subjects	3.98	1	3.92	1
4	Pedagogy in teaching my subject	3.97	2	3.90	2
5	Application of ICT skills in teaching	3.89	4	2.63	10
6	Selection and use of relevant instructional materials	3.3	9	3.81	3
7	Student discipline and behaviour problems	3.11	10	2.60	12
8	Student counselling	2.00	16	3.55	6
9	Teaching students with special learning needs	3.78	6	3.50	9
10	Communication skills	3.52	8	2.17	14
11	Time management	2.22	12	2.46	13
12	Questioning skills	3.62	7	3.51	8
13	Reinforcement skills	2.09	15	2.61	11
14	Mentoring/coaching peers	2.21	13	1.99	15
15	Application of academic research findings in classroom	3.91	3	3.52	7
16	Interdisciplinary teaching/integration of concepts	2.51	11	1.48	16
	Grand mean	3.13		3.06	

Research Question 4: What are the perceived barriers to participation in professional development by science and mathematics teachers in Zamfara State?

Table 4 shows that both science and mathematics teachers agreed to the statement in items 3, 6, 7, and 8 on the barriers to participation in professional development. This is because their mean scores are above the 2.50 mean benchmark. The two groups, however, disagreed with the statements in items 1, 4, and 9 whose mean responses were below 2.50. Also, they have contradictory responses in items 2 and 5. 'Lack of employer support' was perceived by both science and mathematics teachers as the major barrier to their participation in professional development in Zamfara State. The overall mean responses of 2.86 and 2.74 for the science and mathematics teachers respectively indicate that science teachers have a higher mean than the mathematics teachers.

Table 4. Mean and standard deviation on the perceived barriers to participation in professional development by science and mathematics teachers.

S/N	Items	Science teachers			Mathematics teachers		
		$\bar{X}$	SD	Remark	$\bar{X}$	SD	Remark
1	Professional development conflicts with my work schedule	2.15	0.88	Disagreed	2.22	1.01	Disagreed
2	There is no free relevant professional development offered in my teaching subject	2.12	0.86	Disagreed	2.76	0.89	Agreed
3	There are no incentives for participating in Professional development	3.72	0.89	Agreed	2.73	0.95	Agreed
4	Lack of time due to other non-teaching responsibilities	2.19	0.87	Disagreed	2.17	0.97	Disagreed
5	Lack of interest of some teachers in participation in professional development	2.29	0.99	Disagreed	2.59	0.82	Agreed
6	There is a lack of employer support	3.89	0.73	Agreed	3.46	1.05	Agreed
7	Professional development is too expensive/unaffordable	3.81	0.81	Agreed	2.98	0.92	Agreed
8	Poor publicity of professional development for teachers	3.51	0.92	Agreed	3.40	0.79	Agreed
9	I do not possess the pre-requisites (e.g. qualifications, experience, seniority)	2.07	0.96	Disagreed	2.36	1.03	Disagreed
	Grand mean	2.86			2.74		

Table 5. z-test of significant difference in mean responses of science and mathematics teachers on the areas of professional development need in Zamfara State.

Variables	N	$\bar{X}$	SD	Df	z-cal	z-crit	Level of sig.	Decision
Science teachers	53	3.13	0.67	215	0.64	±1.96	0.05	Accept Ho_1
Mathematics Teachers	164	3.06	0.63					

Table 6. z-test of significant difference in mean responses of science and mathematics teachers on the barriers to participation in professional development in Zamfara State.

Variables	N	$\bar{X}$	SD	Df	z-cal	z-crit	Level of sig.	Decision
Science teachers	53	2.86	0.61	215	0.47	±1.96	0.05	Accept Ho_2
Mathematics Teachers	164	2.74	0.59					

Hypothesis 1: There is no significant difference between the mean rating of science and mathematics teachers in the areas of professional development needed in Zamfara State

Table 5 shows that the z-calculated value of 0.64 is below the z-critical value of ±1.96 at 215 degrees of freedom and 0.05 alpha level. Therefore, the null hypothesis is upheld or accepted. The result indicates that there was no significant difference between the mean responses of science and mathematics teachers in the areas of professional development needs in Zamfara State.

Hypothesis 2: There is no significant difference between the mean rating of science and mathematics teachers on the barriers to participation in professional development in Zamfara State

Table 6 shows the z-test analysis of the significant difference between the mean responses of science and mathematics teachers on the barriers to participation in professional development. The result revealed that the z-calculated value of 0.47 is less than the z-critical value of ±1.96 at 215 degrees of freedom and 0.05 alpha level. Therefore, the null hypothesis is upheld or accepted. Thus,

there is no significant difference between the mean scores of science and mathematics teachers on the barriers to participation in professional development in Zamfara State.

DISCUSSION

The findings of this study revealed that the level of awareness of science and mathematics teachers in Zamfara State on the types of professional development programmes is low. They had little or no idea about mentoring/coaching, online courses, teacher collaborations, short full-time courses, vacation courses, Radio-TV courses, study leave without pay, and full sponsorship study leave. However, they have a high level of awareness about workshops, conferences, seminars, supervision, distance learning, and study leave with pay. The low level of awareness of science and mathematics teachers in Zamfara State on the different types of professional development programmes may be linked to not having access and lack of orientation.

The result of this study also revealed that a large percentage of science and mathematics teachers in Zamfara State has not been participating in professional development. Only 21% of science and mathematics teachers responded to have benefitted from 'study leave with pay'. This finding is in line with the finding of Nwarie and Nwakudu (2019) who found that workshops, seminars, conferences, supervision, information and communication technology, communication skills, and classroom management were not readily available for secondary school teachers in Abia State. This finding also substantiates ZSSEAC (2014) report that, regular training and retraining are lacking in Zamfara State and that many senior secondary school teachers have not enjoyed any form of short-term training such as conferences, seminars, and workshops for the last 5 years as at the time the report was presented to the State Government. Therefore, the finding indicated that nothing has changed in providing professional development for science and mathematics teachers to date in the State. This finding is also consistent with the contention of Awodjii et al. (2020) that little is done to promote teachers' professional development in Nigeria. Not emphasis on the professional development of teachers clearly contravenes the National Policy on Education (FRN, 2013) which declares "in-service training shall be developed as an integral part of continuing teacher education and shall also take care of inadequacies". In this regard, Awodjii et al. (2020) expressed dismay that, even now in the 21st century, when so much is known about the skills and knowledge that teachers need to learn and practice in and outside of teaching, yet professional development is not of great importance in Nigeria.

The finding of this study also revealed that science and mathematics teachers in Zamfara State reported the need of professional development for effective teaching of their subjects. They ranked content knowledge of subject and pedagogy of teaching as 1st and 2nd major areas they felt had a need of professional development. These two areas of need revealed in this research is not surprising given that empirical results of Banilower et al. (2007) and Capps et al. (2012) reported that, content knowledge and pedagogical skills should be a core feature of teachers' professional development. The intensity of need of professional development in content knowledge by science and mathematics teachers in Zamfara State reaffirmed reports on teachers' lack of content knowledge. Abayomi (2013) reported a shocking revelation by the then Commissioner for Education, Kaduna State that "a total of 1,599 teachers selected from across the state were given primary four tests in Mathematics and Basic literacy, and only one of them scored 75%, 250 scored between 50% to 75% and 1,300 scored below 25%". Also, Lere (2017) reported that about 21,780 out of 33,000 teachers failed the primary four tests administered to test their content knowledge in Kaduna State. Also, an empirical study conducted by Isma'il et al. (2019) revealed a significant low performance among secondary school science and mathematics teachers in their ability to integrate STEM concepts in Zamfara State due to a lack of content knowledge.

The finding of this study showed that the least area that science teachers need professional development is 'student counseling' while for mathematics teachers it is 'Interdisciplinary teaching/integration of concepts' which were ranked 16th by the two groups. The findings of the study also revealed that both science and mathematics teachers reported a 'lack of employer support' as the major barrier to their participation in professional development in Zamfara State. Other barriers reported were; no incentives for participation, too expensive/unaffordable, and poor publicity. This finding is in agreement with Nwarie and Nwakudu (2019) who reported the high cost of registration, poor publicity, and lack of incentives as some of the barriers to teachers' participation in professional development. This study also revealed no significant difference between science and mathematics teachers in the areas they need professional development as well as on the barriers impeding their participation.

Conclusion

This study surveyed the views of secondary school science and mathematics teachers concerning their professional development in Zamfara State. It was found that science and mathematics teachers in the State have a low level of awareness of the various types of professional development programmes they can engage in for their improvement. More so, they have not been benefitting or participating in professional development.

They attributed these situations to the lack of incentives, lack of employer support, too expensive/unaffordable, and poor publicity. Also, science and mathematics teachers in Zamfara State identified content knowledge and pedagogy of teaching as the two major areas they needed professional development. No significant difference was found between science and mathematics teachers' responses on the areas they need professional development as well as on their perceived barriers impeding their participation in the State.

Implications of the Study

It is insufficient for government to employ science and mathematics teachers to teach in secondary schools. They also need to be continuously retrained through the various types of professional development programmes to efficiently manage the teaching and learning demands of science students in the rapidly changing world. The negative implications of not having professional development for science and mathematics teachers in Zamfara State are enormous. It cannot be divorced from the poor academic performance being experienced by science students in the state. Another implication is that non-participation in regular professional development renders science and mathematics teachers of the State obsolete, thus not being able to cope with both national and global competitiveness in science and mathematics content delivery. Therefore, investing in the professional development needs of teachers is an effective way of strengthening their subject knowledge base, pedagogical content knowledge, and teaching skills. This, in turn, has a direct impact on students' improvement. Thus, depriving teachers of this opportunity results in reduced productivity, persistent students' poor performance, and a dearth of scientific and mathematics literacy in Zamfara State, as they cannot teach what they do not know.

Recommendations

The following recommendations were made based on the findings of the study:

1. Zamfara State government should grant sponsorship and more study leave with full pay to science and mathematics teachers to undergo professional development programmes in order to acquire higher teaching qualifications.
2. Zamfara State government should regularly sponsor teachers to attend professional development programmes (such as conferences, workshops, seminars, etc.) organized by teachers' professional bodies such as STAN and MAN by paying their participation fees, transport, feeding, and accommodation.

3. Partnership between the Ministry of Education, Science and Technical Board, and/or with other agencies/sectors (such as NGOs, industries) should be nurtured to periodically organize professional development that would address specific professional needs of science and mathematics teachers in Zamfara State.
4. Teachers should be encouraged by principals and heads of science departments to keep themselves abreast of new knowledge and skills through collaboration, mentoring/coaching, seminars, etc.
5. Science and mathematics teachers should explore and take advantage of numerous free professional development opportunities available online or organized by other agencies, and actively participate in them.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

HOW TO CITE THIS ARTICLE

Sodangi, U., Isma'il, A., & Abdulrahaman, A. (2022). Perception of secondary school science and mathematics teachers on Professional development participation in Zamfara State, Nigeria. *Integrity Journal of Education and Training*, 6(2), 37-45.

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