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Teacher-Factors Influencing the Adoption of Physics SMASSE Teaching Skills by Physics Teachers in Secondary Schools in Kenya

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Abstract

The number of students selecting PHYSICS subject have remained only about one quarter those selecting chemistry or biology subjects at KCSE. The purpose of this study was to establish teacher related factors that influence the adoption of physics SMASSE teaching skills. The study utilized descriptive survey research design and was guided by Cognitive Response Theory by Ortony, Clore and Collins. The study targeted 177 secondary school principals, 214 physics teachers and 34705 Physics students in Uasin Gishu County. Determination of sample size table by krejcie, Robert & Morgan and Daryle was used to determine sample size for each category of schools, their teachers and students to produce a sample size of 125 principals, 152 physics teachers and 1632 physics students. Simple random sampling was used to determine the particular schools, teachers and students to be included in the study. All the principals of the selected schools were included in the study. The data from teachers was collected using questionnaires and observation, structured interview guide for principals, focused group discussion for students and document analysis at county director's office for schools data. Data analysis techniques used were means, percentages, frequencies and chi-square. The study established that a majority of the physics teachers appreciate the role of SMASSE skills in continuous professional development. It was also found that teachers' gender, age, qualification and experience had influence on the adoption of SMASSE skills by physics teachers in the teaching and learning of physics. The findings of this study will be useful to the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA), Ministry of Education and the entire Education stake holders to ensure the skills learned in SMASSE are possibly put to use such that KCSE physics results are improved.

Keywords: SMASSE, Adoption, Teacher-factors, Teaching skills, Physics

1. Introduction

Science as an instrument of development plays a dominant role in bringing about changes in the society by advancing technological development, promoting national wealth, improving health and industrialization as noted by Rutto (2005). Linder (2010) emphasized that Physics is and will remain the fundamental science. The Ministry of Education considered evolving appropriate pre- and in-service training so as to raise relevance and quality in secondary education (SMASSE Project, 2008). Strengthening Mathematics and Sciences in Secondary Education(SMASSE) was started in 1998 in Kenya as pilot project and was later scaled up to cover the whole country. Between the years 2003- 2008, SMASSE was scaled up to a national program, reaching over 22,000 teachers and education managers through capacity building programs aimed at improving teacher pedagogical skills among science and mathematics teachers and improve student attitude towards science and mathematics.

In SMASSE the teachers are taken through a four-cycle training. The first cycle involves teachers being trained on attitude change. The second cycle involves teachers being taken through the actual SMASSE skills. The third and fourth cycles involve teachers being given a chance to actualize in selected schools. The intention is that when teachers apply these skills the performance at KCSE would improve and the students would develop a liking for these subjects as per training in cycle one. However, this has not been the case considering National and even County statistics. The Physics subject has for the last 5 years upto year 2012 registered mean scores that are below average; the popularity of Physics has also not improved significantly among students compared to the case in Biology and Chemistry. Students who select physics have been about a quarter of those selecting chemistry or biology subjects. The national KCSE physics mean score in the year 2013 and 2014 was 40.10 percent and 38.84 percent respectively, an indication that the situation was getting worse. The situation in Uasin Gishu County has been the same with physics subject registering a mean score of 5.9744 in KCSE 2012, year 2013 mean score was 5.8004 and the candidate population being far lower than in chemistry or biology subjects.

Becker and Riel (2000) discovered that teachers who regularly participate in professional interactions and activities beyond their classrooms teach in different and better ways than their counter parts who have minimal

contact with their peers. Daves (1999) argues that teacher resistance is a convenient phrase arising from lack of understanding of the work that goes on in schools. Teachers take decisions that are intended to confirm their beliefs about the educational effectiveness of innovations and in fact practicable innovation and organized change happen constantly in schools. This therefore means that teachers are not necessarily resistant to change but selectively and prudently welcome suitable change. This means that certain particular factors determine teachers' adoption of an innovation in their teaching. This study sought to establish the teacher-factors influencing the adoption of SMASSE physics teaching skills in secondary schools in Uasin Gishu County, Kenya.

2. Statement of the Problem

The SMASSE initiative aims at improving performance of students at KCSE in sciences and mathematics and also to make learners like the subjects through capacity building of the relevant teachers. This program has gone on throughout the country since the year 2004 and a good percent of Science and Mathematics teachers have gone through this training. However the performance at KCSE for the sciences and mathematics has remained below average in the last 5 years up to year 2012. A national SMASSE impact assessment report by Njuguna (2007) similarly revealed that performance in Science and Mathematics in schools remained the same or had not improved significantly since the year 2001 and even after the introduction of the SMASSE program. A report on SMASSE impact assessment done in Uasin Gishu district between 3rd and 6th October 2006 indicated that 75% of Science and Mathematics teachers were SMASSE trained and were expected to be SMASSE complaint. However, the survey established that very little impact was noted on the mean grades of various science and Mathematics subjects before SMASSE training and after the training. The mean grades could not give a significant indication of an improvement in the KCSE performance of these subjects (D.P.C. – SMASSE impact report, 2006). Physics subject has remained relatively unpopular among secondary school students, despite teachers having been trained in cycle one which addresses attitude change for teachers and students. This prompted the researcher to carry out a study in order to establish teacher factors influencing the adoption of physics SMASSE skills at school level and possibly preventing the skills from reaching the classroom; which is the final destination for this skills otherwise it may be an exercise in futility. The study was guided by the following null hypothesis:

HO_1: There is no statistically significant relationship between teacher-related factors and adoption of physics SMASSE teaching skills.

3. Literature Review

Given that teachers play a significant role in instruction; efforts to improve education have been seen to depend on their beliefs, attitude and conception of teaching and learning (Odhiambo, Ogwel & Kibe, 2008). In order for teachers to considerably shift from their current practices, they require efforts that integrate reform agenda with their professional challenges, consequently, in-service education and training (INSET), as part of professional development holds key to meaningful interventions in the classrooms.

Gender difference has been reported to be a factor that can influence adoption of technology/innovation in various studies. Some studies concerning teachers' gender and innovations use have cited female teachers' low levels of willingness to use new technology or innovations in teaching mainly due to their limited technology access, skill and interest, Voluman and Van Eck (2001). Similarly some research studies in the UK have revealed that male teachers used more technological innovations in their teaching and learning process than their female counterparts, Kay (2006) and Wozeney et al (2006). Similarly, Marker (2006) investigated gender differences in the UK among self reported innovation experience and ICT literacy among first year graduate trainee teachers. The study revealed significant differences between males and females technological use capabilities and orientations as well as longitudinal sustainability. The males scored higher than the females. Jamiefon, Factor, Burnett, Finger and Watson (2006) conducted a study on teachers' integration of new pedagogical, innovations in schools in Queensland State. However, the situation in mid-west USA basic schools was different; Breisser (2006) found that females self perceptions about technology competence improves significantly while the males self-perceptions about technological innovations in teaching remained unchanged (lego-lego project). Adams (2002) also revealed that female teachers applied new pedagogical innovations in their teaching more than the male teachers.

Onah and Ugwu (2010) established that teacher gender had a significant effect on performance of students in physics at secondary school level. In Kenya Changeiwo, Ngeno and Barchok (2012) did a study on differences

in teacher intention to apply SMASSE method in teaching secondary school mathematics and science based on gender and working experience in Kericho and Bomet counties of Kenya. The findings were that there was no statistically significant difference in teaching secondary school mathematics by gender. This was the case in Kericho and Bomet with different socio-economic and geographical conditions from Uasin Gishu County.

Teacher work experience was another factor that influences adoption of SMASSE skills. Gorder (2008) reported that teacher use of innovations was related to comfort levels in the use of the technological innovations. Law and Sim (2008) established that older teachers frequently use technological innovations in their teaching than the younger teachers. However, Russel, Bebell, Dwyer and O'Conner (2003) found out that new teachers were highly skilled with technology more than the older ones; but incorporated technological innovations in their teaching less. Another study by Granger Morbey, Lotherington, Owston and Wdeman (2002) found no relationships between teachers adoption of innovation and teaching experience, hence teachers teaching experience could not be used as a predictor. Changeiyo et al. (2012) found that there is a statistically significant difference in teachers' attitudes towards SMASSE approaches in teaching secondary school mathematics and science by teaching experience in favor of the most experienced.

Teachers' professional development is a key factor to successful interaction of innovation in classroom teaching (Franklin, 2007). Sandhocts and Reilly (2004) claim that teachers' technology skills are strong determinants of adaption of new innovation to their teaching. Miller et al (2008) showed that professional development and the continuing support of good practice are among the greatest determinants of successful innovation integration in teaching. Sandholts and Reilly (2004) argue that training programs that concentrate on pedagogical training instead of the technical issue (e.g. Use of computer and effective technical support), help teachers apply innovation in teaching and learning better. Brinkerhoff (2006) and Deehl (2005) say quality professional training programs helps teachers implement innovation and transform in their teaching for the better. Hawless (2006) and Deilit (2005) say that if a training program is of high quality, the period of training lasts longer, new technologies for teaching and learning are offered, educators are eagerly involved in important context activities, team work is improved and has clear vision for student attainment. According Pliers (2008), teachers easily adopt innovation in their teaching when training programs concentrate on subject matter, values and the technology. Teachers who are committed to professional development activities gain knowledge of innovation integration and classroom technology organization better (Wepher, Tao & Ziomek, 2006). Baylor and Ritchie (2002) argue that regardless of sophistication; technology will not be used unless the teacher has the relevant skills, knowledge and attitudes. Kibe, Odhiambo & Ogel (2008) say that in Kenya even in schools where there are qualified teachers or adequate equipment and materials, students' achievement in the science subject has not been necessarily high on the contrary, there are schools with minimum facilities and instructional materials, less qualified teachers and where teachers still teach effectively and examination results have improved.

The number of years a person has lived is one's chronological age; (American Heritage dictionary of English Language, 2009); this can be used especially in psychometrics as a standard against which certain variables, such as behavior and intelligence are measured. The actual age from birth regardless of pre- birth time after conception is one's chronological age. Teresita (2001) observed that teachers number of years had significant correlation tested at the 0.05 level (2 tailed), with the teacher instructional skills. The older and more experienced teachers mastered the new teaching skill and applied them in their teaching more than the younger less experienced teacher. Labov (2001; 101) describes age as the important life stages of modern American societies. The teachers of physics in Kenya fall between the age groups of about between 24-60 years of age. These are people at the adult age group. However, there are disparities also within this group. There are the younger teachers, middle aged teachers and the older teachers. The younger teachers are roughly between age 24 and 35; middle aged teachers are roughly between age 36 and 50 and the older teachers are roughly between age 51 and 60. Teachers at these different age groups may have different orientation or abilities regarding their cognitive abilities and their life may also be different from one part of the world to another.

The attitude a teacher develops about an innovation largely determines whether the teacher would adopt an innovation or not. Ferguson (2004) says that instructors (teachers) are at times not enthusiastic about an innovation, and that affects their level of adoption of the innovation. This is supported by Ronald Weston, (2006) who says that Essential Conditions for the sustainability of classroom innovation include both teacher and student support of the innovation. Watson (2006) says understanding educators' perception of an innovation is key to successful adoption of an innovation in learning. Rogers (2003) stresses the need to understand perception

of an innovation, as this has strong influence on future prediction of adoption of specific innovations. Understanding educators' perceptions of innovations is key to successful adoption of technology in learning, which according to Watson (2006) is a particular kind of instructive innovation.

4. Research Methodology

Descriptive survey research design was used in this study. The study was based on the cognitive response theory whose proponent was Ortony et al (1990). This study was conducted in Uasin Gishu County. The study population involved all secondary schools in Uasin Gishu County among which there were private, national, extra county, county and district schools. There were 177 secondary schools in Uasin Gishu County. The research involved all teachers of physics, secondary school students of physics and principals of secondary schools in the county. In this study all the 177 secondary schools in the county were stratified as national, extra county, county, sub-county and private schools. For the purpose of this study sample sizes was determined using sample size table by Krejcie, Robert, Morgan and Daryle All the 125 head-teachers of the selected schools participated in this study. Simple random sampling was used to select a maximum of two physics teachers per selected schools (where the number was two or less, they automatically were included in the sample). Therefore, 152 teachers, 1632 students and 125 head teachers participated in this study, making a total sample of 1909 respondents. The data collection instruments used were questionnaire, interview schedule, observation and document analysis. The data collected was organized, presented, analyzed and interpreted using descriptive and inferential statistics. Descriptive statistics that were used included frequencies, percentages and means. The inferential statistics chi-square (x2) was used to test the hypothesis and verify on the relationship between the teacher factors and adoption of Physics SMASSE skills.

5. Findings

The study was concerned with establishing teachers' factors influencing the adoption of SMASSE skills by physics teachers. Teachers age, gender, professional qualification and experience, were considered as the teacher factors influencing the adoption of SMASSE skills by physics teachers. The responses are presented in the following sub-sections.

5.1 Gender and Adoption of SMASSE Skills

Table 1 shows cross tabulation of teacher gender and adoption of SMASSE skills.

Table 1. Gender and Adoption of SMASSE Skills

			adoption level				Total
			Low	average	Fairly high	high	
gender	male	Count	28	51	15	4	98
		% within gender	28.6%	52.0%	15.3%	4.1%	100.0%
		% within adoption level	65.1%	68.9%	71.4%	57.1%	67.6%
		% of Total	19.3%	35.2%	10.3%	2.8%	67.6%
	female	Count	15	23	6	3	47
		% within gender	31.9%	48.9%	12.8%	6.4%	100.0%
		% within adoption level	34.9%	31.1%	28.6%	42.9%	32.4%
		% of Total	10.3%	15.9%	4.1%	2.1%	32.4%
Total		Count	43	74	21	7	145
		% within gender	29.7%	51.0%	14.5%	4.8%	100.0%
		% within adoption level	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	29.7%	51.0%	14.5%	4.8%	100.0%

As presented in Table1, 19.3% (28) of the teachers who achieved low level adoption were male while 10.3% (15) were female. Out of 74 teachers who achieved an average level of adoption, 35.2% (51) were male, whereas 15.9% (23) were female. Further 10.3% (15) of the teachers were male who were considered as fairly high in their adoption of the SMASSE skills in teaching physics while 4.1%(6) were female. Only 2.8%(4) male and 2.1%(3) female teachers achieved high level of adoption of SMASSE skills in teaching physics. In general there were more female teachers (29.7%) who achieved low level of adoption of SMASSE skills than male (28.6%). However, more male (52%) were at average level of adoption than female (48.9%). The study was very much in agreement with similar research studies in the UK which revealed that male teachers used more technological innovations in their teaching and learning process than their female counterparts (Kay, 2006; Wozeney et al,

2006; Marker, 2006).

5.2 Age and Adoption of SMASSE Skills

Cross tabulation of age and adoption levels was done to establish the levels of adoption across different age bracket of the teachers who participated in this study. The results are presented in Table 2.

Table 2. Age and Adoption of SMASSE Skills

			Adoption level				Total
			Low	average	Fairly high	high	
	18-30yrs	Count	5	19	5	2	31
		% within age	16.1%	61.3%	16.1%	6.5%	100.0%
		% within adoption level	11.6%	25.7%	23.8%	28.6%	21.4%
		% of Total	3.4%	13.1%	3.4%	1.4%	21.4%
	31-45 yrs	Count	27	38	6	4	75
		% within age	36.0%	50.7%	8.0%	5.3%	100.0%
		% within adoption level	62.8%	51.4%	28.6%	57.1%	51.7%
		% of Total	18.6%	26.2%	4.1%	2.8%	51.7%
	45-55 yrs	Count	6	14	6	1	27
		% within age	22.2%	51.9%	22.2%	3.7%	100.0%
		% within adoption level	14.0%	18.9%	28.6%	14.3%	18.6%
		% of Total	4.1%	9.7%	4.1%	0.7%	18.6%
	Over 55 yrs	Count	5	3	4	0	12
		% within age	41.7%	25.0%	33.3%	0.0%	100.0%
		% within adoption level	11.6%	4.1%	19.0%	0.0%	8.3%
		% of Total	3.4%	2.1%	2.8%	0.0%	8.3%
Total		Count	43	74	21	7	145
		% within age	29.7%	51.0%	14.5%	4.8%	100.0%
		% within adoption level	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	29.7%	51.0%	14.5%	4.8%	100.0%

The findings shows that 3.4%(5), 18.6%(27) ,4.1%(6) and 3.4%(5) of the teachers who achieved low level of adoption of SMASE skills in physics were 18-30, 31-45, 45-55 and over 55 years old respectively. Further analysis indicates that the teachers who were over 55 years old had the highest number of teachers at low level of adoption of SMASE skills in physics (41.7%), followed by 31-45 years (36%), then 45-55 years(22.2%) and 18-30 years(16.1%). It is further revealed that 13.1%(19), 26.2%(38),9.7%(14) and 2.1%(3) of teachers at average adoption level were 18-30 years, 31-45 yeas, 45-55 years and above 55 years old respectively. Teachers aged 18-30 years were the majority (61.3%) in this category (average level of adoption). Findings also reveals that those aged 18-30 years were leading in the high level of adoption of SMASSE skills (6.5%) compared to5.3%(4), 3.7%(1) and 0%(0) for those aged 31-45 years 45-55 years and over 55 years respectively. The over 55 years category were leading in the fairly high adoption level at 33.3%(4) followed by 45-55 years(22.2%), 18-30 years(16.1%) and 31-45 years(8%). This was in consistent with Russel, Bebell, Dwyer and O'Conner (2003) who found out that young teachers were highly skilled with technology more than the older ones; but incorporated technological innovations in their teaching less.

5.3 Professional qualifications and adoption of SMASSE skills

The results are shown in Table 3.

Table 3 Professional qualifications and adoption of SMASSE skills

		adoption level				Total
		Low	average	Fairly high	high	
Diploma	Count	6	11	5	1	23
	% within qualification	26.1%	47.8%	21.7%	4.3%	100.0%
	% within adoption level	14.0%	14.9%	23.8%	14.3%	15.9%
	% of Total	4.1%	7.6%	3.4%	0.7%	15.9%
Degree	Count	36	59	13	6	114
	% within qualification	31.6%	51.8%	11.4%	5.3%	100.0%
	% within adoption level	83.7%	79.7%	61.9%	85.7%	78.6%
	% of Total	24.8%	40.7%	9.0%	4.1%	78.6%
Masters degree	Count	1	4	3	0	8
	% within qualification	12.5%	50.0%	37.5%	0.0%	100.0%
	% within adoption level	2.3%	5.4%	14.3%	0.0%	5.5%
	% of Total	0.7%	2.8%	2.1%	0.0%	5.5%
Total	Count	43	74	21	7	145
	% within qualification	29.7%	51.0%	14.5%	4.8%	100.0%
	% within adoption level	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	29.7%	51.0%	14.5%	4.8%	100.0%

The finding shown in Table 3 indicates that 4,1%(6), 24.8%(36) and 0.7%(1) of the teachers who were at low level of adoption were diploma, degree and masters degree holders respectively. The study shows that there were more degree holders who were in the category of average adoption level at 40.7%(59), followed by diploma holders(7.6%) and lastly the masters degree holders(2.8%). Degree holders were also more than the diploma and masters holders in terms of achieving high level of adoption of SMASSE skills in physics. This is shown by 5.3%(6) while the diploma holders who achieved high level of adoption were 4.3%(1). It should be noted that there were no masters holders who achieved a high level of adoption.

5.4 Experience and Level of SMASSE Skill Adoption

Teacher work experience refers to the number of years the teacher has been teaching the relevant subjects. The more someone does a particular job in a certain way many times people are reluctant to change and do the same things in a different way. As earlier presented, majority (53.1%) of the teachers had been teaching for 5-10 years. This category of teachers also had achieved fairly high level of adoption. This implies that 28.3%(41) of the teachers who were average in adoption of SMASSE skills in teaching physics had been teaching for 5-10 years compared to 9.0%(6) and 11.0%(16) who had an experience of below 5 years and 10-20 years respectively. Further, out of 43 teachers at low level of adoption, 16.6%(24), 8.3%(12), 4.1%(6) and 0.7%(1) had an experience of 5-10 years, 10-20 years, below 5 years and above 20 years respectively. Table 4 also shows that 2.8%(4) of the teachers who participated in this study and with experience of 5-10 years were leading in the high level of adoption category followed by those with below 5 years at 2.1%. However, those above 10 years of experience did not achieve high level of adoption of SMASSE skills. On the contrary (Niederhauser & Stoddaart, 2001) say that teachers experience in teaching has no effect on his or her use of innovations in teaching.

Table 4 Experience and Level of SMASSE Skill Adoption

		adoption level				Total
		Low	average	Fairly high	high	
Below 5 yrs	Count	6	13	3	3	25
	% within experience	24.0%	52.0%	12.0%	12.0%	100.0%
	% within adoption level	14.0%	17.6%	14.3%	42.9%	17.2%
	% of Total	4.1%	9.0%	2.1%	2.1%	17.2%
5-10 yrs	Count	24	41	8	4	77
	% within experience	31.2%	53.2%	10.4%	5.2%	100.0%
	% within adoption level	55.8%	55.4%	38.1%	57.1%	53.1%
	% of Total	16.6%	28.3%	5.5%	2.8%	53.1%
10-20 yrs	Count	12	16	9	0	37
	% within experience	32.4%	43.2%	24.3%	0.0%	100.0%
	% within adoption level	27.9%	21.6%	42.9%	0.0%	25.5%
	% of Total	8.3%	11.0%	6.2%	0.0%	25.5%
above 20 yrs	Count	1	4	1	0	6
	% within experience	16.7%	66.7%	16.7%	0.0%	100.0%
	% within adoption level	2.3%	5.4%	4.8%	0.0%	4.1%
	% of Total	0.7%	2.8%	0.7%	0.0%	4.1%
Total	Count	43	74	21	7	145
	% within experience	29.7%	51.0%	14.5%	4.8%	100.0%
	% within adoption level	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	29.7%	51.0%	14.5%	4.8%	100.0%

5.5 Attitude of Teachers on the Role of SMASSE

The other teacher factor investigated was the attitude of the teachers towards SMASSE programme and how it affects the adoption of SMASSE skills in the teaching and learning of physics. To achieve this, the teachers were asked whether they support SMASSE programme as a means of improving teacher professional development in the teaching of physics in secondary schools. The findings are presented in Table 5.

Table 5 Whether Teachers Support SMASSE Programme

Response	**Frequency**	**Percentage**
Yes	102	70.3
No	43	29.7
Total	**145**	**100**

As presented in Table 5, majority (70.3%) of the teachers asserted that they support SMASSE programme as a means of improving teacher professional development in the teaching of physics in secondary schools, whereas 29.7%(43) disagreed. This shows that majority of the teachers have a positive attitude towards SMASSE programme. The attitude of teachers is important in stimulating student interest in learning thus improving their achievement in physics. Positive teacher attitudes contribute to the formation of positive student attitudes (Sullivan, 1989).

Chi-square was used to establish whether there existed a significant relationship between teacher-related factors and adoption of SMASSE skills by physics teachers.

HO1: There is no statistically significant relationship between teacher related factors and adoption of SMASSE skills by physics teachers.

A chi-square of 46.371, d.f. =4 and p-value of 0.001 was obtained. Since $p<0.05$, the null hypothesis is rejected which implies that there is a significant relationship between teacher factors and adoption of physics SMASSE skills.

6. Conclusion

Based on the findings of the study, it can be concluded that teachers' gender, age, qualification and experience had influence on the adoption of SMASSE skills by physics teachers in the teaching and learning of physics. It was found that degree holders were more than the diploma and masters' holders in terms of achieving high level of adoption of SMASSE skills in physics with none of the masters' holders achieved a high level of adoption. Similarly, majority of the teachers who were average in adoption of SMASSE skills in teaching physics had been teaching for 5-10 years. There were more female teachers who achieved low level of adoption of SMASSE skills than male whereas more male were at average level of adoption than female. Teachers aged 18-30 years were the majority in the category of average level of adoption while those aged 18-30 years were leading in the high level of adoption of SMASSE skills. Further, teachers had a positive attitude towards SMASSE as a means of enhancing professional development.

7. Conclusion

In view of the findings of this study, it is prudent that older and more experienced teachers need more sensitization workshops for them to embrace the use of physics SMASSE skills in teaching.

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