EFFECT OF PERSONALISATION OF INSTUCTION ON SRUDENTS‘ ANXIETY IN MATHEMATICAL WORD PROBLEMS IN NIGERIA

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Abstract. This study determined the effect of personalisation of instruction on the anxiety in mathematics word problems of 450 senior secondary school year two students in Nigeria within the blueprint of quasi-experimental research of Solomon four non-equivalent control group design. It also examined the influence of ability level on anxiety in mathematics word problems and personalisation was accomplished by incorporating selected information with students' personal preferences into their mathematics word problems. Anxiety in mathematics word problems was measured by the mathematics word problems anxiety questionnaire and data collected for the study were analysed using the independent samples t-test, paired samples t-test and one-way ANOVA. The results showed significant main effect of personalization of instruction on students' anxiety in mathematics word problems whereas no significant main effect of ability level was found on the dependent measure. Personalisation of instruction was found to have reduced students' anxiety in mathematical word problems.

Keywords: personalisation of instruction, anxiety, mathematics, ability level, word problems

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Introduction

One major objective of school mathematics is to connect mathematics in the classroom to the society and mathematical word problems are a means of applying school mathematics to the real-world. Without real-world applications, skills acquired in school mathematics may become throwaway and easily disremembered. Aside the fact that, standard mathematical word problems can impair students' understanding (Reusser, 1988) many students find word problems in school mathematics to be disconnected from their everyday life experiences and interests (Akinsola & Awofala, 2008). Word problems may serve several important functions in school mathematics. Word problems may nurture mathematical reasoning beyond computational thinking, boost confidence in students with low basic fact mastery, and inspire students to gain and cultivate methods of consolidating information. However, word problems remain a tool to developing mathematical problem solving skills (Bates & Wiest, 2004) which is the cornerstone of school mathematics (NCTM, 2000). Researches have shown that mathematical word problems pose difficulty on the part of students' understanding of school mathematics (Awofala et al., 2011; Koedinger & Nathan, 2004; Ku & Sullivan, 2000; Hart, 1996). At least four reasons have been advanced for why students have difficulties in solving mathematical word problems. They are: lack of experience with the problem situation and information processing skills (Ku & Sullivan, 2002; Bailey, 2002), lack of motivation to solve word problems (Hart, 1996), irrelevancy of the word problem to students' lives (Ensign, 1997), and unfamiliarity with the language of the word problem (Ku et al., 2002). These problems could be addressed by creating learning environment that has the potential to teach, support and empower students thereby situating word problem instruction in contexts relevant to students' out-of-school interests and experiences (e.g., Carraher et al., 2006; Koedinger, 2001; Moses & Cobb, 2001; Noble et al., 2001; Chazan, 1999).

Placing mathematics in everyday contexts may make mathematics more accessible to students; connect real world problem solving with school mathematics problem solving; and make mathematics interesting to impact students' motivation (Boaler, 1994). However, experimental studies have shown that personalisation is one strategy that isolates the effect of relevant contexts on student word problem-solving (Akinsola & Awofala, 2009). Personalisation can make explicit connections between the interests and preferences students catch outside of school and the academic concepts they are learning in mathematical word problems. While personalisation has been studied in relation to students' mathematical word problem achievement (Akinsola & Awofala, 2009; 2008; Bates & Wiest, 2004; Ku & Sullivan, 2002; Cordova & Lepper, 1996; López & Sullivan, 1991; 1992), understanding (Davis-Dorsey et al., 1991), attitude (Awofala, 2010), self-efficacy (Akinsola & Awofala, 2009; Cordova, 1993) and interest (Awofala et al., 2013) it effect on anxiety in mathematical word problem is yet to be investigated. Mathematical word problems are anxiety inducing for many students at all grade levels (Awofala, 2014) and it is posited here that implementation of strategies to reduce or prevent mathematical word problem anxiety will improve mathematical word problem achievement for many students. In general mathematics-anxious students learn less mathematics compared to their low-anxious counterparts because they opt for fewer mathematics classes and get lower grades in the mathematics classes they do take (Blazer, 2011). While mathematics anxiety has been studied for many years and at different grade levels (Sparks, 2011; Hellum-Alexander, 2010; Ashcraft & Krause, 2007; Tobias & Weissbrod, 1980), investigations on mathematical word problem anxiety are scarce. Word problem anxiety is defined in this study as negative emotions that interfere with the solving of mathematical word problems. It is noted that the terms story problems and word problems can invoke uncomfortable memories for many people (Fairbairn, 1993) due to the fact that word problems can be boring and tedious to solve (Bates & Wiest, 2004) thereby creating anxiety for students (Awofala, 2014) irrespective of ability level. Ability grouping or tracking system is a practice that is alien to Nigeria but well established and practised in the developed countries such as USA and Britain. In the US placement into mathematics ability levels takes place in eighth grade and past achievement is a primary consideration when assigning students to ability group level. Students in high-level ability groups generally demonstrate greater achievement than those in low-level ability groups. The purpose of this study was to investigate the effect of personalisation of instruction on senior secondary school year two students' anxiety in mathematical word problems in Nigeria. The study also examined the effects of mathematical ability on students' anxiety in mathematical word problems. It should be noted that most researches on personalisation have been centred on elementary school children and interest on senior secondary school students is gathering momentum.

Review of related literature

Previous researches on personalisation can be delineated into two: personalisation as a strategy (Awofala et al., 2011) and personalisation as an assessment or testing tool (Bates & Wiest, 2004; López & Sullivan, 1992; Cordova & Lepper, 1996). While few researches have been conducted on the former, numerous researches have been conducted on the latter. The following studies investigated personalisation as an assessment or testing tool. Hembree

(1992) conducted a meta-analysis of 44 studies, involving Grade 4 to undergraduate students, in which word-problem context differed while the mathematical structure remained constant. Better performance was most strongly associated with familiar contexts. Concrete (vs. abstract) and imaginative (vs. ordinary) problems, the latter using fantasy or unusual circumstances, showed borderline significance in their positive impact on problem-solving performance. Wiest (2002) has warned against this global analytic study, which smooths out the findings of individual studies. In a study conducted in the US, Wiest (2001) reported on the efficacy of different contexts (fantasy, adult real- world and children real-world) for word problems given to grade four and grade six students. The study found that students expressed an interest in the fantasy contexts, and solved problems using these contexts as well as or better than real-world problems.

López & Sullivan (1992) found significant differences favouring personalisation-using students' names or personal information-on problem-solving scores for two-step but not for one-step problems, although students also scored higher on the latter, in comparison with non-personalised problems. They say personalisation may be particularly important for more demanding (e.g., unfamiliar or mathematically complex) cognitive tasks. Group personalisation-using dominant interests of a group of students-has also been shown to benefit students' problem-solving scores compared with non-personalisation (Lopez & Sullivan, 1992), but individual personalisation is more effective in impacting students' attitudes and preferences (López & Sullivan, 1992; Murphy & Ross, 1990). However, Ku & Sullivan (2002) conducted a study involving 136 fourth-grade Taiwanese students and their teachers and found group personalization to have a positive impact on attitudes. Both students and teachers using personalized problems showed better attitudes toward the programme than those using non-personalized word problems. They argue that familiarity (reduced cognitive load) and interest are the major factors that lead to greater success solving personalized versus non-personalized problems. Davis-Dorsey et al. (1991) investigated the effects of personalizing standard textbook word problems on 68 second-grade students and 59 fifth-grade students in which all of the students completed a biographical questionnaire that was later used to develop the personalized problems prior to the treatment. Personalization was seen to be highly beneficial to the fifth graders, but it did not positively impact the second-grade students' test scores.

Wright & Wright (1986) conducted a study on the use of personalized word problems with 99 fourth-grade students in which they examined both the processes used to solve the problems and the accuracy of the answers. The study showed that a correct process was chosen more often when the problems were personalized, but correct and incorrect answers were given equally on personalized and non-personalised problems. d'Ailly & Simpson (1997) used a type of personalisation known as *self-referencing* in which some of the character names in a variety of problems taken from a standard mathematics text were replaced with the word *you*. One hundred students in grades three, four, and five were requested to solve the problems within a mix of self-referencing and non-self-referencing problems. The study found, "when a *you* word was involved in the problem, children asked for fewer repeats for the problems, and could solve the problems in a shorter amount of time and with a higher accuracy" (d'Ailly & Simpson, 1997).

Cordova & Lepper (1996) conducted a research on personalisation in mathematics where fourth and fifth grade students engaged in computer-based learning games on order of operations. For students in the personalization condition, incidental elements of the game were personalized to students' background, based on a prior questionnaire. The study found that students who received the personalized version of the game had significantly higher performance on a post-test. However, more recent studies have found that personalization does not lead to increased performance. Cakir & Simsek (2010) also found that personalisation of arithmetic story problems did not increase performance for seventh grade students. Bates & Wiest (2004) investigated the impact of personalising mathematical word problems using individual student interests on fourth grade students' problem-solving performance. The results showed no significant increase in student achievement when the personalisation treatment was used.

Using personalisation as an instructional practice, the following studies have found the positive effect of personalisation. Awofala (2014) investigated the effect of a personalised print-based instruction versus a non-personalised print-based instruction on the attitudes toward mathematics word problems of 350 senior secondary school year one Nigerian students. The results of the data analyses showed that the personalised instruction students had higher levels of self-confidence, liking, usefulness, and motivation but recorded low level of anxiety regarding mathematics word problems compared with the non-personalised group students. While the personalised instruction students were more influenced by the context of the word problem than their non-personalised instruction counterparts, the experimental and control groups' students did differ on their attitudes toward mathematics word problem as a male domain. Akinsola & Awofala (2009) researched the effect of personalized print-based instruction on the achievement and self-efficacy regarding mathematics word problems of 320 senior secondary students in Nigeria. The moderator effect of gender was also examined on independent variable (personalization) and dependent variables (mathematics word problem achievement and self-efficacy). The results showed that significant differences existed in the mathematics word problem achievement and self-efficacy beliefs of personalized and non-personalized groups, male and female personalized groups and male and female non-personalized groups.

Akinsola & Awofala (2008) investigated the effects of a problem context variant- personalisation and reasoning complexity on mathematics problem-solving achievement and transfer of 126 junior secondary school students. Students received personalised or non-personalised instruction involving either simple or complex reasoning. Significant between-subjects main effects of problem context and reasoning complexity were found on students' problem solving achievement and transfer. For problem context, students who studied personalised problems performed better on the problem-solving achievement test than those who studied non-personalised problems whereas for reasoning complexity, students who studied complex problems recorded better performance than those that studied simple problems. On transfer task, students who studied personalised context performed better than those that studied non-personalised context whereas students that received complex treatment outperformed their counterparts on simple treatment. Significant two-way interactions for problem context by reasoning complexity on students' problem-solving achievement and transfer and reasoning complexity by question complexity on students' problem-solving achievement were recorded. Students on the complex and simple treatments separately produced better performance when the context is personalised than when it is non-personalised while those on complex treatment performed better on multi-step problems than one-step problems. Students who studied simple, personalized context showed significant better performance on the transfer task than those that studied simple, non-personalised context.

Awofala et al. (2011) studied the effects of modes of personalisation of instruction on the mathematical word problems achievement of 450 junior secondary Nigerian students. Personalisation was accomplished by incorporating selected information with students' personal preferences into their mathematics word problems content on either group basis, individual or self-referencing format. Students were randomly assigned to one of four treatment conditions: self-referencing, individual personalisation, group personalisation, and non-personalisation versions of an instructional programme on mathematics word problems. Results showed that treatment had significant main effect on students' achievement in mathematical word problems. Thus, students exposed to group personalisation performed significantly better than those in other groups followed by individual personalisation, self-referencing, and non-personalisation in that order. Awofala et al. (2013) investigated the effectiveness of personalisation of instruction in improving 240 senior secondary school students' interest in solving mathematics word problems in Nigeria. The results showed that significant differences existed in the mathematics word problem interest of personalised and non-personalised groups in favour of personalised group. Awofala (2016) investigated the effect of personalisation of instruction on the motivation to learn mathematics word problems of 450 senior secondary students in Nigeria within the blueprint of quasi-experimental research of Solomon four non-equivalent control group design. The results showed significant main effect of personalisation of instruction on students' motivation to learn mathematics word problems. Thus, the group personalisation strategy enhanced learners' motivation to learn mathematics word problems than the non-personalised instruction

With regard to ability level, Lee & Bryk (1988) found track placement to be the primary mediating factor between background characteristics and high school mathematics achievement. In USA Burks (1994) found that students in high ability groups had more positive attitudes toward mathematics, exhibited more appropriate behaviour in mathematics class, and did more mathematics homework than students in either the middle or the low groups. In England researchers followed 14,000 children through years 4 and 6 comparing those taught in sets with those grouped heterogeneously over the period of a year. They found that setting hindered the progress of students, and that those taught heterogeneously performed significantly better on tests of mathematical reasoning (Nunes et al., 2009). Boaler (2010) conducted longitudinal studies of students progressing through schools with contrasting grouping arrangements, in both UK and USA. In England Boaler followed 500 students through three years of two schools in England and in the USA she followed 700 students through four years of three schools in California. In both studies the students who worked in schools in mixed ability groups performed at higher levels overall than those who worked in setted or tracked groups. The schools teaching to mixed ability groups also achieved more equitable outcomes. Findings from numerous studies further indicate that the process of sorting students by perceived academic aptitude or vocational interest promotes to the achievement gap between students in vocational and academic tracks (Oakes, 2005; Gamoran & Mare, 1989; Chunn, 1989; Gamoran, 1987). These studies indicate that high-track classes like Advanced Placement and IB (International Baccalaureate) courses tend to attract students from high social economic status households and are taught by better-qualified teachers. Conversely, low-track courses are taught by less-qualified instructors, and course work is largely vocational in nature (Oakes, 2005; Carbonaro & Gamoran, 2002; Gamoran et al., 1997; 1995; Hallinan, 1994; Gamoran & Nystrand, 1991; Page, 1990; Dreeben & Gamoran, 1986; Gamoran, 1986; 1989).

Statement of the problem

In spite of the importance of the word problem concept to the field of mathematics, researchers (Akinsola & Awofala, 2009; Bates & Wiest, 2004; Onabanjo, 2004; Wiest, 2001) have expressed concerns about the difficulties students experience in the learning of this concept. These studies have shown that students find it difficult to understand the word problem concept. More worrisome is that word problem in mathematics could serve as a source of anxiety in students (Awofala, 2014). Word problem anxiety as a personal specific feature which has a debilitating effect on mathematics word problem performance and a learner's sense of self-worth contributes in no small measure to perceptions and attitudes that propagate a dislike for word problem and a lack of confidence when doing mathematics word problems. One way of ameliorating these difficulties in students may be to link the word problem context to their interests and preferences. As recorded in the literature, placing word problem instruction in contexts relevant to students' out-of-school experiences has been shown to improve students' achievement, self-efficacy and attitudes toward mathematics word problems while the presumed effect of personalisation of instruction on students' anxiety in mathematical word problems was ignored in previous researches. The present study therefore closed this gap in the literature by investigating the effect of personalisation of instruction on students' anxiety in mathematical word problems in Nigeria.

Research questions

The main purpose of this study was to investigate the effect of personalisation of instruction on senior secondary school students' anxiety in mathematical word problems. In achieving this purpose, answers were sought to the following research questions: (1) what is the effect of personalisation of instruction on senior secondary school students' anxiety in mathematical word problems; (2) what is the effect of ability level on senior secondary school students' anxiety in mathematical word problems.

Research hypotheses

The following hypotheses were formulated and put to test in this study:

HO_1: There is no significant main effect of treatment on senior secondary school students' anxiety in mathematical word problems.

HO_2: There is no significant main effect of ability level on senior secondary school students' anxiety in mathematical word problems.

Research method

This study employed quantitative research within the blueprint of the quasi-experimental design. The non-equivalent, Solomon four control group design was adopted to test the null hypotheses. The design was selected based on the fact that it was not possible to randomise students to the groups and partly because the unit of sampling a class had already been formed and, therefore, it was un-ethical to re-constitute one randomly. In addition, secondary school classes occur as intact groups and school authorities do not normally allow the classes to be pulled to pieces and re-formed for research purposes (Gall et al., 1996). Specifically, the research design is symbolically represented in Fig. 1.

Group E_1	O_1	X	O_2

Group C_1	O_3	-	O_4
Group E_2		X	O_5

Group C_2		-	O_6

Fig. 1. Solomon four non-equivalent control group research design

In the sequel, O_1 and O_3 were pre-test; O_2, O_4, O_5, O_6 were the post-test; X was the treatment where students were exposed to the personalised programme. The dotted line implied participation of whole groups and the design involved an arbitrary allotment of intact classes to four different groups. Group E_1 was the experimental group and was given the pre-test, the treatment X and the post-test. Group C_1 was the control group which was given the pre-test, followed by the control condition and then the post-test. Group E_2 was given the treatment X and post-test but was not given the pre-test. Group C_2 was given the post-test only because it was a control group. Group C_1 and Group C_2 were given the control condition of non-personalised programme while Groups E_1 and E_2 were given the experimental condition. This design prevented all major threats to internal validity except those connected with interactions of selection and maturation, selection and instrumentation and history. No major event was observed in any of the sampled schools that would have warranted interaction between selection and history. To control for interaction between selection and maturation, the schools were allotted arbitrarily to the control and treatment groups. To control for interaction between selection and instrumentation, the conditions under which the instrument was administered were kept as similar as possible in all the schools (Shihusa & Keraro, 2009; Gall, Borg & Gall, 1996).

Sampling procedure

The target population for this study consisted of all senior secondary school year two (SSS II) mathematics students in Ijebu-Ode and Odogbolu Local Government Areas of Ogun State, Nigeria. The Local Government Areas were selected because of its poor performance in mathematics at the senior secondary certificate examination and anxiety of the students in the learning of mathematics was considered as one possible factor contributing to this low performance. Thirty (30) schools were contacted for use for this study from among forty-two (42) senior secondary schools in the two local government areas. Twenty (20) schools were purposively selected and fifteen (15) of these schools were selected through a simple random sampling technique. Eight schools were randomly assigned as experimental group and seven schools as control group. In all, the sample consisted of 450 students. The average age of learners at this level was 16 years. These students were considered appropriate for this study because previous studies have shown that older children in elementary school benefited greatly from personalisation of mathematics word problem than younger children (Bates & Wiest, 2004; Davis-Dorsey, 1989). This is attributed to the fact that older children possess more developed schemata for processing information in a real-world context (Awofala, 2010). Table 1 showed the distribution of the students in the four group of the design.

Instruments

For the purpose of data collection, the following instruments were used for the study: (i) Mathematics Word Problem Anxiety Questionnaire (MWPAQ); (ii) Students' Personal Interest Inventory (SPII); (iii) Instructional Programme on Mathematics Word Problems (IPMWP)

Table 1. Distribution of students in the four group of the design by gender

Treatment Group	Gender	N
Experimental group I	Male	55
	Female	56
	Total	111
Control group I	Male	56
	Female	57
	Total	113
Experimental group II	Male	57
	Female	57
	Total	114
Control group II	Male	56
	Female	56
	Total	112

Mathematics word problems anxiety questionnaire (MWPAQ)

The MWPAQ was adapted from Wigfield & Meece's (1988) Mathematics Anxiety Questionnaire (MAQ) with some modifications to reflect anxiety in learning of mathematics word problems. It had a total of eleven items constructed on a five point Likert Scale of very often, quite often, occasionally, very rarely, and never. The elements in measuring anxiety were emotionality and worry. While the affective component contained seven items the cognitive component consisted of four items. The maximum score of the MWPAQ was 55 and the minimum 11. The questionnaire was validated by two experienced mathematics teachers and two mathematics educators. The MWPAQ was pilot tested in one secondary school in Odogbolu Local Government Area of Ogun State, Nigeria with 40 students. The Cronbach's Alpha analysis showed that the reliability for the MWPAQ was high (r = 0.92). A brief description of items which make up each of the two specific components of anxiety is described in Table 2.

Table 2. Components of anxiety

Component of Anxiety	Sample Item
Affective: When I am taking a mathematics word problem test, I usually feel nervous and uneasy	
Cognitive: In general, how much do you worry about how well you do in mathematics word problems?	

Students' personal interest inventory (SPII)

This instrument was designed to determine the personal background and preferences of the participants. The inventory items included student's name, something to shop for, favourite food, names of friend, name of a game, favourite type of vehicle, sports and so forth. The 18-item survey was in open-ended form so that students wrote in their answer for each item and this was used to personalise the original word problems based on the most common interests and preferences of all subjects in the treatment rather than for each individual based on that individual's interest and preferences. The frequency choice on any of the items was calculated and the percentage found. Table 3 below showed the sample analysis of participants' response to personal interest inventory by frequency count and percentage.

Table 3. Sample analysis of participants' response to personal interest inventory by frequency count and percentage

Item category	choice of item	frequency count	percentage
Food and drink	Maltina	380	84.4
	Fried Rice	409	88.9
	Chicken pie	356	79.1
	Milo	390	86.7
	Meat pie	426	94.7
Music, game and sport	Fuji	420	93.3
	Football	436	96.9
	Boxing	420	93.3
House material	Television	420	93.3
Vehicle and profession	Nokia phone	386	85.8
	Mazda 626	386	85.8
	Lawyer	356	79.1
Name of place, friend	Ijebu Ode	300	66.7
and institution	Zenith Bank	319	70.9
	Mr Biggs	319	70.9
	Segun	318	70.7
	TASUED	420	93.3

Instructional programme on mathematics word problems (IPMWP)

Two parallel versions of an instructional programme on arithmetic and algebraic word problems were developed in print form in English. One example each of arithmetic word problem and algebraic word problem follow:

Example 1 (arithmetic). Bob is reading a 445 pages' book. He has already read 157 pages. If he reads 24 pages a day, how long will it take him to finish the book?

Example 2 (algebraic). Friendly's clothing store bought handkerchiefs, six for $10, and sold them 4 for $10. They made $60 profit. How many handkerchiefs did they sell?

The two versions of the instructional programme used in this study were in a similar format to those enacted in the Awofala (2010) study covering the same instructional objectives. The problems were tailored along the senior secondary year two mathematics textbooks used by the participants. Both versions were paper-based because, as in the case generally in Nigeria, not enough computers were available at the school at the time to deliver the instruction by computer. Also, both versions required the same computational skills and numbers but the problem context differed. The non-personalised version was written first and provided only minimal, non-meaningful contextual information as obtained in the students' mathematics textbooks. The personalised version provided familiar, relevant problem contexts and was written by incorporating the most popular referents (places, foods, sports, etc) from the students' personal interest inventory. One example each of word problem in their personalised context and non-personalised context forms follow:

> *Example 1 (personalised context)*: Segun sold a Nokia phone for ₦1200 and made 20% profit. How much should Segun sell the phone to make a profit of 25%?
>
> *Example 2 (non-personalized context):* When a table is sold for ₦1200 the profit is 20%. What should be the selling price to make a profit of 25%?

A major distinction between examples 1 and 2 is that in example 1, the context of the word problem is derived from the students' repertoire of familiar experiences and preferences while in the example 2, the context of the word problem is non-familiar because none of the students chose the preferences used in the formulation of the word problem. It is noted that problem context is relative and as used here refers to the familiarity/non-familiarity of the word problem to students' experience and interest (Awofala, 2016; 2014).

It should be noted that the PII in itself is only one aspect of creating motivating tasks. For example, very often, the curiosity for the mystery of something unknown could be source of motivation in a problem. The personalised instructional programme was based on the Instructional Development Model (Gustafson, 1995) which has three phases: Define, Develop, and Evaluate in its development and implementation. The personalised version followed the heuristics given by Awofala (2010) which are: (i) interest oriented; (ii) use personal referent assessment; (iii) use individual prescription; (iv) allow student choice of problem context; (v) provide meaningful contextual information; and (vi) provide a stimulating study guide. The instructional programme also covered procedures for solving word problems. A Pólya's (2004/1945) four-part strategy was incorporated into the instructional programme for both the personalised and the non-personalised treatments; (a) understanding the problem; (b) devising a plan; (c) carrying out the plan; (d) looking back.

Understanding involved asking questions and identifying what needed to be found or learned and what information was available. Planning required reflecting about alternative methods for tackling the problem at hand, while carrying out the plan involved the appropriate selection and implementation of one or more of the alternatives considered. Looking back emphasised reflection in the form of ways to check and validate answers and methods, and verifying whether or not the solution tackles the problem.

Sample personalised version of the instructional programme

Pr**oblem 1**. A Mazda 626 filled with Milo travels 132km from Ijebu Ode in 1¼ hours. Calculate the speed of the car.

Solution

1. Understanding the problem: In this step the learner is encouraged to find the unknown, gather the data and separate the data into parts. The learner is encouraged to answer the following questions:

(i) What is the distance travelled by the car?

(ii) For how many hours did the car travel?

(iii) What is the speed of the car?

2. Devising a plan

(i) The car travels 132km and uses 1¼ hours

(ii) Speed = $\frac{\text{distance travelled}}{\text{time taken}}$ i.e., S= D/T

Solve for S.

3. Carrying out the Plan: In the 'solve' step, the students will perform the mathematical computations necessary to determine an answer.

Speed = D/T = 132km / 1¼ = $\frac{132\text{km} \times 4}{5\text{h}}$

Speed =105.6 km/h. Thus, the speed of the car is 105.6km/h

4. Looking back: Examine the solution obtained: In this step, the students are encouraged to check the result, think of other methods to solve the same problem and decide if the strategy could be used for other problems.

Distance travelled = speed × time taken =105.6km/h× 1¼ =105.6km/h × 5/4 h =132km.

Sample non-personalised version of the instructional programme

Problem 2.

A car travels 132km in 1¼. Calculate the speed of the car.

Solution

*Understanding the problem***:** In this step the learner is encouraged to find the unknown, gather the data and separate the data into parts. The learner is encouraged to answer the following questions: (i) what is the distance traveled by the car; (ii) for how many hours did the car travel; (iii) what is the speed of the car.

Devising a plan: (i) The car travels 132km and uses 1¼ hours; (ii)

$$\text{Speed} = \frac{\text{distance traveled}}{\text{time taken}} \quad \text{i.e., } S = D/T$$

Solve for S.

*Carrying out the plan***:** In the 'solve' step, the students will perform the mathematical computations necessary to determine an answer.

$$\text{Speed} = D/T = 132\text{km} / 1\tfrac{1}{4} = \frac{132\text{km} \times 4}{5\text{h}} = 105.6 \text{ km/h}$$

The speed of the car is 105.6km/h

Looking back: Examine the solution obtained: In this step, the students are encouraged to check the result, think of other methods to solve the same problem and decide if the strategy could be used for other problems.

Distance travelled = speed × time taken=105.6km/h× 1¼ h=105.6km/h × 5/4 h

=132km.

Instruction on the strategy for solving the word problems contained the rule and its application with appropriate examples and practice problems were provided. Answers to all problems were provided at the end of the instructional programme to enable self-checking. A review was provided after the completion of the practice problems by the students. The review contained a summary of the procedures for solving the problems. The two versions of the instructional programme were given to three English Educators and four Mathematics Educators in Tertiary Institutions for assessment in terms of: (a) language clarity to target population; (b) content coverage; (c) relevance to stated objectives.

Some changes connected to grammatical errors (e.g. 'was' changed to 'were') in the personalised version were made by the English Educators while the Mathematics Educators made changes in connection to typographical errors in the solutions of the word problems in both versions of the instructional programme. Thus, all the experts' opinions were incorporated into the final versions of the instructional programme before its implementation in the classrooms.

Procedure

The study was carried out in four weeks and it involved fifteen classrooms with a teacher and a research assistant in each class. So, a total of 15 mathematics teachers and 15 research assistants were recruited for the study. During the first week, students responded to two instruments i.e. Personal Interest Inventory (PII) and Mathematics Word Problems Anxiety Questionnaire (MWPAQ) as pretest, second week was utilized to develop the personalized versions of the instructional programme on mathematics word problems using the students' Personal Interest Inventory. In the first day of third week, schools were arbitrarily allotted to one of two treatment conditions: personalisation and non-personalisation and participants were given lectures on the study's purpose, procedures and lesson materials. In the second day the treatment started and participants in each intact class were given their corresponding version materials for studying independently for four consecutive days during a single 40-minutes class period. The option of a longer treatment was not considered because the author was of the opinion that the content areas for the study could be learnt within the small treatment period. The participants were involved in individualised learning of the instructional programme. During the lesson, teachers and research assistants acted as a medium for management and control. So no teaching was carried out in any of the fifteen classes because the participants were to learn the instructional programme on their own. The teachers and the research assistants helped in the administration of the two versions of the instructional programme to the respective participants. They also helped in the administration of MWPAQ as pretest and posttest. The last week was used for administration of MWPAQ as posttest. All the participants that studied the personalised version and received pre-test and post-test were classified as Experimental group I (n =111), those that studied the non-personalised version and received pre-test and post-test, Control group I (n =113) while those participants that studied the personalised version and received only post-test were regarded as Experimental group II (n =114). The Control group II (n =112) studied the non-personalised version and received only post-test.

Data analysis

In this study, the multiple Likert statement responses to the mathematics word problems anxiety questionnaire were summed together and this allowed the use of parametric tests in that all items used the same Likert scale, a defendable approximation to an interval scale (i.e. coding indicates, magnitude of difference between items, but there is no absolute zero point), and all items measured a single latent variable (i.e. a variable that is not directly observed, but rather inferred from other variables that are observed and directly measured). The results of the histogram with normal curve conducted indicated that the dependent measure was normally distributed across treatment conditions ($p>0.05$). Also, the non-significant F test from Levene statistic was the sign of homogeneity of variance ($p>0.05$). The normality of the data showed that parametric statistic could be adopted. The descriptive statistics of mean and standard deviation were employed as precursors to adopting the inferential statistics of one-way Analysis of Variance (ANOVA), paired samples t-test and independent samples t-test. ANOVA was used to determine if the four groups differed significantly among themselves on experimental variable. An independent samples t-test was used to test differences in the pre-treatment (post-treatment) mean scores on the dependent measure between the experimental and control groups (high and low ability participants) because of its superior quality in detecting differences between two groups. A paired samples t-test was used to test differences in the pre-treatment and post-treatment mean scores for E_1 and C_1 separately.

Results

This section showcased the results of the study based on the null hypotheses formulated for the study. A prior assumption made in the study was that the two groups to be used in the study were homogenous in terms of their responses to the pre-treatment questionnaire and not regards to groups' achievement levels or mathematical talent or grades before the application of the treatment procedure (Wiersma & Jurs, 2005). A pre-treatment questionnaire on mathematics word problems anxiety was administered on two groups. The groups were experimental group (E_1) and the control group (C_1). Table 4 below showed that the mean for group E_1 was 37.49 while that of group C_1 was 37.50. Thus, the level of anxiety between groups $E_1$and C_1 was not significantly different [t (222) = -0.021, p>.05]. Hence, the groups used in this study showed similar features and were therefore found to be relevant for the study.

Table 4. Independent samples t-test results of the pre-treatment scores on MWPAQ by pre-treatment groups

Group	N	Mean	SD	Df	t-value	p-value
E_1	111	37.49	6.38	222	-0.021	0.98
C_1	113	37.50	6.44			

The results in Table 5 showed that the mean score for high ability students was 36.98 while that of their low ability counterparts was 38.06. The t-value was -1.26 and this showed that a statistically non-significant difference existed in mathematics word problems anxiety between the high and low ability participants. The non-significant difference in mean scores for both the pre-treatment groups and ability necessitated the use of ANOVA to analyse the difference among the four groups on the post-treatment score on MWPAQ.

Table 5. Independent samples t-test results of the pre-treatment scores on MWPAQ by ability

Ability	N	Mean	SD	Df	t-value	p-value
High	117	36.98	6.31	222	-1.26	.21
Low	107	38.06	6.47			

The MWPAQ mean scores of students from the four groups were compared using one-way ANOVA. As contained in Table 6 below, the post-treatment mean scores on MWPAQ for the four groups were not the same. Groups E_1 and E_2 had mean scores of 33.02 and 33.26 in that order while Groups C_1 and C_2 had mean scores of 36.50 and 36.10 respectively.

Table 6. Post-treatment means scores on MWPAQ of students in the four groups

Group	N	Mean	SD
E_1	111	33.02	6.21
C_1	113	36.50	6.05
E_2	114	33.26	6.19
C_2	112	36.10	5.35
Total	450	34.72	6.15

One-way ANOVA was carried out in order to find out whether these means were significantly not the same. The results are shown in Table 7.

Table 7 showed that the difference in the mean scores among the four groups were significant [$F_{(3,446)} = 10.61$, $p<.05$]. After establishing that there was a significant difference between students on personalised instruction and those on non-personalised instruction, it was pertinent to confirm further the direction of the difference. This was accomplished via post hoc tests of multiple comparisons using Tukey's Honesty Significance Difference (HSD) test (Montgomery, 2013). This test was considered suitable in this study because there are a large number of groups being compared and that the test helps in reducing the chances of a Type I error occurring by detecting differences between groups. The results showed that the differences in the mean scores of groups E_1 and C_1 groups E_1 and C_2, groups E_2 and C_1 and groups E_2 and C_2 were statistically significant ($p<.05$).

Table 7. ANOVA results of the post-treatment scores on MWPAQ in the four groups

Source of variance	Sum of Square	Df	Mean Square	F	Sig.
Between groups	1132.48	3	377.49	10.61	0.00*
Within groups	15862.24	446	35.57		
Total	16994.72	449			

*Significant at p<.05 level

A paired samples t-test was conducted between pre-E_1 and post-E_1 in order to determine its significance. Table 8 below showed that the pre-treatment mean score for group E_1 was 37.49 and the post-treatment mean score for group E_1 was 33.02. Thus, the difference in mean score of (4.47) between the post-treatment and pre-treatment mean scores for E_1 was statistically significant [$t(110) = 5.29$, $p<.05$].

In addition, a paired samples t-test was conducted between pre-C_1 and post-C_1 in order to determine its significance. Table 9 below showed that the pre-treatment mean score for group C_1 was 37.50 and the post-treatment mean score for group C_1 was 36.50. Thus, the difference in mean score of (1.00) between the post-treatment and pre-treatment mean scores for E_1 was statistically not significant [t (112) = 1.20, p>.05].

Table 8. Paired samples t-test results between the pre-treatment scores and post-treatment scores on MWPAQ by experimental group I

Group	N	Mean	SD	Df	t-value	p-value
Pre-E_1	111	37.49	6.38	110	5.29	0.00*
Post-E_1	111	33.02	6.21			

*Significant at p<.05 level

Table 9. Paired samples t-test results between the pre-treatment scores and post-treatment scores on MWPAQ by control group

Group	N	Mean	SD	Df	t-value	p-value
Pre-C_1	113	37.50	6.44	112	1.20	.44
Post-C_1	113	36.50	6.05			

The results in Table 10 showed that the difference in the post-treatment mean scores on MWPAQ between the low and high ability participants was statistically not significant [t (448) = -0.47, p>.05]. This showed that ability level had no variant effect on students' anxiety in mathematics word problems.

Table 10. Independent samples t-test results of the post-treatment scores on MWPAQ by ability

Ability	N	Mean	SD	Df	t-value	p-value
High	233	34.59	6.12	448	-0.47	.64
Low	217	34.86	6.20			

Discussion

The results of this study have indicated that the group personalisation strategy reduced learners' anxiety in mathematics word problems than the non-personalised instruction. This result showed the efficacy of personalisation of instruction in reducing students' anxiety in mathematics word problems thereby supporting the advocates of personalisation strategy (Awofala, 2016). The significant main effect of treatment is consistent with several results on personalisation studies (Awofala, 2016; 2014; 2011; 2010; Awofala et al., 2011; Akinsola & Awofala, 2009; 2008; López & Sullivan, 1992; Murphy & Ross, 1990; Anand & Ross, 1987). However, this significant effect in favour of personalisation is inconsistent with some results obtained as well (Bates & Wiest, 2004; Ku & Sullivan, 2000; Choi & Hannafin, 1997). One factor that could be responsible for the inconsistency in results might be the age of the participants in the study. Studies that found non-significant effect of personalisation on learning outcomes used small samples from elementary school children whereas studies that found significant effect of personalisation on learning outcomes used large samples from higher grade levels. Thus, age may be a determining factor in the choice of technique(s) to reduce students' anxiety in mathematics word problem solving. While higher grade levels are noted for increasingly difficult mathematics problems, the complexity of these problems may enhance personalisation strategy to reduce students' word problem anxiety (Awofala, 2014). Thus, the inconsistency in results could also be explained by the differences in sample used for the study. In addition, inconsistency in results could be explained by the differences in usage of personalisation of instruction. Most studies that rely on personalisation as a testing method showed non-significant effect (Şimşek & Çakır, 2009; Anzelmo-Skelton, 2006; Bates & Wiest, 2004) while those studies that employed personalisation as an instructional strategy exhibited significant effect (Awofala, 2016; Awofala et al., 2011; Akinsola & Awofala, 2009; 2008). The present study used personalisation as an instructional practice rather than as a testing tool. The presence of a personalisation effect on word problem anxiety was probably as a result of many factors.

Generally, personalisation stimulates inherent interest and enhances personal meaning of new content. This was accomplished in this study by implanting dominant and interesting learner's personal referents into the problem context, thereby situating the complexity of the environment of the learner's everyday life in the context. Essentially, learners imagined being in the problem context and this degree of relationship might have assisted them in housing new information with existing knowledge configurations. In this way, learners may have attended to the personal meaning and relevance of the context to their everyday life experience (Akinsola & Awofala, 2009) thereby reducing their anxiety in mathematics word problems. Awofala (2014) has shown that increased personalised context in mathematics word problem resulted in low anxiety regarding mathematics word problem whereas reduced personalised context (non-personalised) resulted in higher anxiety regarding mathematics word problem.

That personalisation of instruction makes mathematical word problem less anxiety inducing has serious implication for struggling learners in mathematical problem solving in their attempt to close the gap between conceptualising problem structure and devising an appropriate plan of action. This is particularly important in reducing the achievement gap between higher-achieving and low achieving students in word problem solving performance. For instance, Awofala (2011) found that low-achieving students recorded greater gains than higher-achieving counterparts in solving personalized word problems in mathematics. This study confirmed that personalisation of instruction helped the problem solving efforts of struggling learners in their attempts to solve more demanding and difficult problems. The present study finding might explain why low-achieving students in Awofala's (2011) study performed better in personalised word problems. Because low-achieving students are sometimes not suffering from cognitive deficiency but irrelevance of the problem to their life experience, they might to a large extent rely on understanding and solving word problems that are enmeshed in personal context that give meanings to the problems. The familiarity of the word problems to their life experience may block the anxiety they normally experience with non-familiar word problem context thereby enhancing their comprehension and ability to devise a method for solving the problems.

Embedding instruction in relevant, interest-based contexts can promote the integration of prior knowledge with formal representations by allowing learners to focus attention on the difficult task thereby reducing anxiety over such task. In the present study, personalisation of instruction may have helped students counter past feelings of failure in mathematics word problem occasioned by non-familiarity of the context of the word problem to their everyday life and offer an emotional safety net for test anxious students in mathematics word problem.

Another reason for the presence of significant personalisation effect on anxiety in mathematical word problems may be associated with the relevance of the learning tasks to everyday life experience of the learners. This relevance could increase learners' motivation and lessen their anxiety in mathematical word problems. In this study, leaners were able to picture personal referents in the problem and this experience may have made the mathematical word problems relevant to everyday life experience of the learners thereby lessening their anxiety in mathematical word problems. In essence, the personalised treatment enacted in this study may have adequately addressed the irrelevance of word problems to students' lives (Ensign, 1997) often cited as one of the major clogs on the path of students' understanding of word problems and thus lessening their anxiety in mathematical word problems. Thus, personalization of instruction could be used to halt the deadliness of mathematical word problems with unfamiliar, irrelevant, and uninspiring contexts.

The significant effect of treatment on students' anxiety in mathematics word problems recorded in this study may not be unconnected to the ability of students exposed to the personalised programme to find more personal attachment and deeper meaning in their learning than the non-personalised group. The personalised programme contributed to the lessening of the anxiety in mathematics word problems. This finding can be described in that the personalised programme which is interest-based allows students' choice of problem context and provides meaningful contextual information and this could have reduced their fear of the mathematical word problems to the enhancement of the satisfaction of psychological and social needs of the personalised group. This meaningful problem context may serve as a catalyst for reducing students' anxiety in word problems in mathematics and this may result in increased students' comprehension of the material (Awofala, 2014).

The non-significant difference established in anxiety in mathematics word problem between high and low ability students showed that ability level had no effect on students' anxiety in mathematics word problems. The non-significant effect of ability level on students' anxiety in mathematics word problems could be as a result of the interaction pattern that prevailed in the classrooms which did not favour one ability level above the other. It could be said that both high and low ability level were maximally motivated to learn in classrooms which fit well into their needs, interests, and skill levels. In addition, activities and learning materials in mathematics word problems provided might have been better aligned with the learning interests and preferences of both high and low ability students in this study. Thus, this might have shortened out ability level difference in anxiety in mathematics word problems in the study.

Conclusion and recommendations

Word problems in school mathematics textbooks are rarely relevant to students' out-of-school experiences. Thus teachers will need to artificially construct word problems that are relevant to students' out-of–school experiences and that could serve as sources of mathematical thinking in their quest to transfer mathematical knowledge for immediate usability. Research into personalising instruction to students' out-of-school experiences is gradually gaining momentum in the mathematics education community and mathematics teachers need to make conscious effort to learn the interests and preferences of their students and to incorporate them regularly into their mathematics instruction. Teachers should be preoccupied with finding ways to helping struggling students make sense of word problems without reducing the features inherent word problem solving performance. However, two major limitations of this study are that attempts were not made to investigate: (i) the interaction effect of personalisation and ability level on students' anxiety in mathematics word problems and (ii) the main effects of personalisation and ability level on the individual subscale of anxiety in mathematics word problems. These limitations notwithstanding, present themselves as implications for further research. In conclusion, it may be reasonable to carry out a longitudinal research on the effect of personalisation of instruction on anxiety in mathematics word problems for possible generalisation of the results of this study.

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