Methodology Issues and Design Approach of VLE on Mathematical Concepts Acquisition within Secondary Education in England

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Abstract—This study used positivist quantitative approach to examine the mathematical concepts acquisition of' KS4 (14-16) Special Education Needs (SENs) students within the school sector education in England. The research is based on a pilot study and the design is completely holistic in its approach with mixing methodologies. The study combines the qualitative and quantitative methods of approach in gathering formative data for the design process. Although, the approach could best be described as a mix method, fundamentally with a strong positivist paradigm, hence my earlier understanding of the differentiation of the students, student – teacher body and the various elements of indicators that is being measured which will require an attenuated description of individual research subjects. The design process involves four phases with five key stages which are; literature review and document analysis, the survey, interview, and observation; then finally the analysis of data set. The research identified the need for triangulation with Reid's phases of data management providing scaffold for the study. The study clearly identified the ideological and philosophical aspects of educational research design for the study of mathematics by the special education needs (SENs) students in England using the virtual learning environment (VLE) platform.

Keywords—VLE, Special Education Needs, Key stage4, School, Mathematics, Concepts Acquisition

I. INTRODUCTION

THIS study in its form and context provides a methodological approach that seeks to identify the ideological and philosophical aspects of educational research design on the impact of VLE on Mathematical concepts acquisition within secondary Education KS4 (14-16) Special Education Needs (SENs) students in England. Although the term 'design' is so broad, however, based theoretically on key design notions from Denscombe (2003) introduction to basics of social research [1], this paper sets out, theoretically, analytically and ideologically, to present a pedagogic-didactic features of my design approach to the study.

The main purpose of this research is to assess and analyze

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the impact of technology (termed as VLE) on mathematical concepts acquisition of the special needs (SENs) students. This involves (SENs) KS4 students and the instructional activities by their teachers within secondary school education sector in England, UK. Compact Oxford English (Concise) Dictionary of Current English (2008) defines research as the systematic investigation into, and the study of materials and sources in order to establish facts and reach new conclusions [2]. According to McNiff, (2002);

> "Education research is socially and politically entrenched. It is always undertaken by real person or persons, within a particular context, for a designated purpose. Research does not happen, it is planned to greater or lesser degrees, and has an overall design for what it hopes to achieve. Which is a claim to knowledge, how it is going to gather and present data in support of the claim to knowledge, and how it is going to show the validity of the claim to knowledge through some kind of legitimization process" [3]

Denscombe (2003) in his introduction to the basics of social research, 'The Good Research Guide', classifies research according to its appropriateness (a) for particular kinds of investigation and (b) for addressing particular kinds of theoretical or practical problems. He describes good research in terms of 'fitness for purpose' and then outlines various types of strategic approach to research [1]. In his contribution Opie (2004) states that our views of research depend mainly on our views about how knowledge is gained and how it is communicated [4] Opie continues to argue that if we view knowledge as 'hard, real, and capable of being transmitted in tangible form; then we have an empiricist's view of knowledge, and as a result we are most likely to use quantitative research methodology. On the other hand, if we view knowledge as 'soft, subjective, and based on experience and insight of an essentially personal nature' then we have rationalist's view of knowledge, and as a result one is likely to use qualitative research methodology.

Opie's study is complemented by Hitchcock and Hughs (1995) work on research methodology, cited in McNiff, 2002. According to Hitchcock "there are three paradigm approaches to research which is widely accepted today, and the main research paradigms include; the empirical, the interpretative and the critical theoretic" [5]. In "empirical research approach, participants are data whose personal involvement is factored

out: and personal intervention by them would contaminate and potentially skew the results" [3].

II. ARGUMENT ON THEORETICAL PERSPECTIVES

The theoretical perspective behind the design approach in this research draws on several sources. This study is organised through the overall concept, problem oriented project pedagogy [6], and finally we draw upon Saunders et al research philosophical metaphor in conducting research using the onion ring model. Gray, 2004 states that; of the different theoretical perspectives available, positivism and various strands of interpretivism are, or have been (arguably) among the most influential approaches to research [7]. Positivism entails ontology of an ordered universe made up of atomistic, discrete and observable events. This order can be represented by universal propositions or constant conjunction [8]. Blaikie further states that human activity is understood as observable behaviour taking place in observable, material circumstances. Interpretivism on the other hand, entails an ontology in which social reality is regarded as the product of processes by which social actors negotiate the meanings for actions and situations *which is a complex of socially constructed meanings*. Human experience is characterised as a process of interpretation rather than sensory, material apprehension of the external physical world, and human behaviour nonetheless depends on how individual interpret the conditions in which they find themselves [8].

In this work, the research methodology assumes a mixed method approach, combining ethnography, phenomenological research and heuristic inquiry. Creswell maintained that qualitative and quantitative approaches represent different ends on a continuum [9]. He went on to state that mixed methods research resides in the middle of this continuum because it incorporates elements of both qualitative and quantitative approaches [10]. These areas of methodology deal with questionnaires, observational, interviews and a case study. These and a number of other methods such as statistical analysis and document analysis were equally used in this study in order to illustrate fully the value of adopting the theoretical perspectives that are congruent with my epistemological research paradigm. Phenomenological research and ethnography are based upon description and interpretation of data, and while both are true, ethnographic research tilts more on discovering the relationship between culture and behaviour as well as studying sites. Phenomenological research on the other hand, is based on human experience of "life-world" i.e. Exploring the personal construction of the individual's world [7].

III. RESEARCH DESCRIPTION AND CONCEPT MAP

As described above, one of the main purposes of this research was to assess and analyse the impact of virtual learning environment (VLE) on instructional activities by teachers and students in the secondary school sector in England. A model was derived empirically from data collected

on the sampled school as well as from practical and theoretical bases from the literature. Research methods adopted in this work spans across more than one approach. Methods include standardised acceptable questionnaires which were used to obtain information from selected participants. This was supplemented by face-to-face interviews and focus groups. A small focus group of SENs students with various disabilities were used to create a case study approach. Questionnaire(s) and observation tool(s) used in this pilot study enabled me to verify technique and to ensure they are suitable. Selection of institution and participants for the generalised views considers issues such as differences in geographical location, overriding local regulations, practices and factors such as ethics which may distort the result of the study. The concept mapping of my research holistically is presented in figure 1.
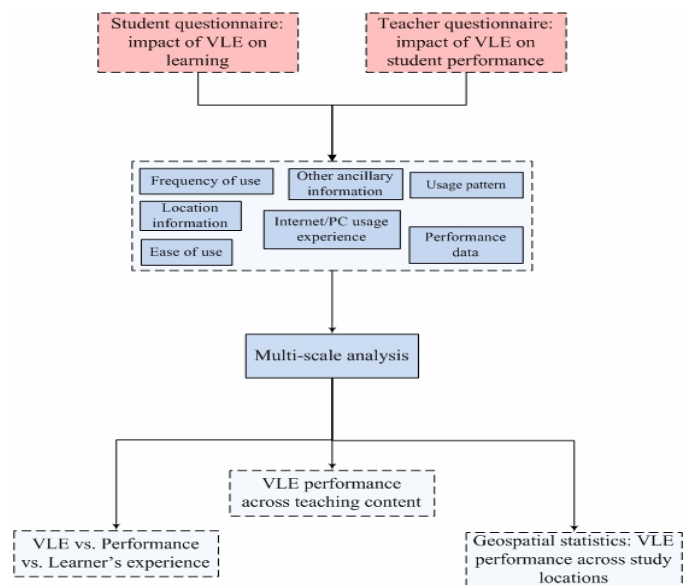

Fig. 1: Represents the conceptual mapping of the Research, holistically

IV. METHODOLOGY –DATA GATHERING

Three questionnaires and one observation protocol were developed by the researcher that contained a list of research questions to be addressed to school head teacher, teachers and students. These research questions sought for answers on the status of VLE in schools in England and in consequence, its impact on teaching and learning mathematics by the students.

A. Empirical Studies 1, Data Gathering

The epistemological basis for the selection of methodologies to answer the aforementioned research questions were founded upon an empiricist view of knowledge [10]. In this preliminary investigation (Pilot Study), only one secondary school in England was selected for the survey. Questionnaires formulated include open and highly structured questions. The main purpose was to enable

the conduct of a formal research through a developed set of questionnaires which reflected the true KS4 special education needs (SENs) scenario in the teaching and learning of mathematics in secondary school. It also enabled me to gain information on the problems related to mathematical concepts acquisition by the target group via virtual learning environment platform.

B. Empirical Studies 2, Data Gathering

Methodological concerns ultimately lead to a quantitative versus qualitative data source debate. The relative values of qualitative and quantitative methods to test hypothetical generalizations have long been debated between researchers [12]. In this study, I adopt a mixed or balanced approach (quantitative and qualitative methods) which, in my opinion is best suited for this research because they focus on the different dimensions of the same phenomenon. In this preliminary (pilot) study, school visitation, case study and interviews were arranged with only one school for the KS4 SENs students. This empirical study provided the best possible and accurate data because of the face-to-face interaction, discussions and observation of performance (daily engagement), collaboration activities, which resulted in more on-task behaviour, greater persistence and deeper understanding with VLE. The teachers' questionnaire enabled me to collect data related to VLE and the specific information on the performance and impact of VLE on learners. This questionnaire provided a knowledge gap between teachers and learners on the one hand, and management of VLE on the other hand. This step allowed me to create a live case study for comparative analysis in order to build a clear insight into the problems of association with SENs and the mathematical concepts acquisition within the virtual learning environment (VLE), school version.

C. Empirical Studies 3, Data Gathering

This research, as the case in any field research, has to pass through the five stages of research process developed by Saunders et al. (2007) and known as the 'Onion Model' [13]. The onion ring model adopted in this study has been slightly modified by the researcher. As shown in the figure 2, on the next page, the first stage is the "research philosophy" which shows the positivist view of conducting research. This step enabled me to decide the best research approach to follow; "stage two" helped in running a deductive reasoning theory to test presumed hypothesis or questions to answer. "Stage three" depicted the survey strategy. As a result of choosing the survey strategy, it became clear that the time horizon to take is cross sectional, "stage four". The final stage is the "data collection method" used to guide the researcher to adopt the questionnaire method, interviews and observations in order to generate the desired data for the questions raised in this research. The survey/questionnaire method is a widely used tool of data collection that allows the codification of the data gathered, which becomes very useful in statistical correlation studies. I administered three surveys. The version

administered to students was more structured, while that of the head teacher and teachers less so to afford room for expression of opinions. The Nwabude modified onion ring model is presented in figure 2.
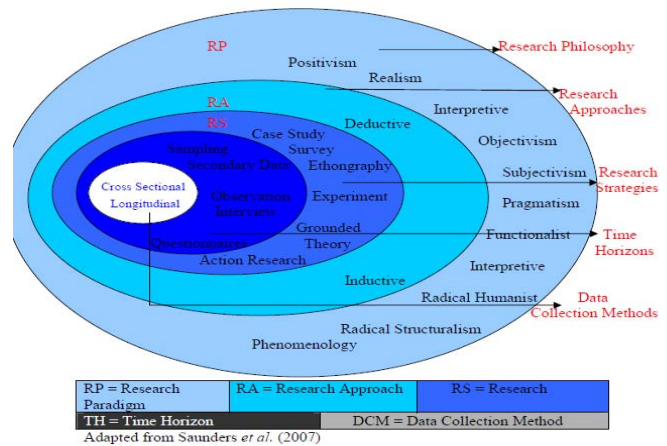

Fig. 2: The research process using "Nwabude modified onion model" adapted from Saunders et al (2007)

V. ETHICAL ISSUES

Ethical issues emanate from the nature of problems investigated by social scientists and the methods used to obtain valid and reliable data. In this study, all precautions were taken to ensure that the research was conducted in a professional and ethical manner. The school head teacher was informed about the nature and progress of the study. Permission was sought from the school head teacher who consequently gave her authorisation to the study. Giordano, O'Reilly, Taylor and Dogra, (2007) state that a researcher should be aware of the commonly accepted ethical research principle that includes matters of informed consent, privacy, anonymity, confidentiality, betrayal and deception [14]. Bell (2005) also points out that; no researcher can demand access to an organization without seeking permission from that particular organization [15]. This research relied on data (students' experience) collected via questionnaire and observation. I ensured that accepted principles covered by data protection Act 1998 as it applies to research are observed in full. I ensured anonymity of participants by following a standard set of protocols for dealing with sensitive professional information which includes giving a code to schools, and students' names were not mentioned in the research analysis.

Permission was granted under the conditions and guarantees presented below:

- All participants were to remain anonymous [16]. The essence of anonymity is that information provided by participants should in no way reveal their identity. The obligation to keep research data confidential is all-inclusive. It should be fulfilled at all costs. [17] ; [18]
- All information is to be kept confidential. This means that although researchers know who has provided the information or are able to identify participants from the

information given, they will in no way make the connection known publicly; the boundaries surrounding the shared secret will be protected [19].

- Participants should be offered the chance to receive a copy of the final report.

Any generic conclusions and deductions made from data collected will be shared with all schools that participated in the entire research without mentioning of any individual student or school. Furthermore, the nature of the investigation and any possible risk were fully explained to the participants as highlighted by the University of Greenwich ethics declaration statement which states that participants would be informed that : -

1. They are in no way obliged to volunteer if there is any personal reason (which they are under no obligation to divulge) why they should not participate in the programme.
2. They may withdraw from the programme at any time, without disadvantage to themselves and without being obliged to give any reason.

A. Sample selection

In sample selection, literature suggests that survey research sample size should not be fewer than 100 cases in major groups and twenty to twenty five in each subgroup [20]. The size of a sample (random sample) can be determined in two ways; researchers exercising prudence by making sure sample represents a wider population or by using a table (Mathematical formula) that indicates appropriate size of a random sample for a wider population [21].

My research target population includes KS4 special education needs (SENs) students in the secondary school sector, chosen at random from a list of schools that are currently using VLE obtained from Local Education Authority (LEA). The number of students targeted in the school was thirty, chosen at random from the above key stage. The number of teachers targeted in the school was three, which includes two mathematics teachers and one head teacher, chosen at random by the head teacher. According to Krejcie and morgan, (1970), a sample size of 120 students and 8 teachers is representative with a confidence level of 95 percent and a sampling error of 5 percent [22]. However, in this preliminary study, investigation was based in one school and the target sample includes twenty special education needs students of which fifteen (15 SENs) students and 3 teachers (2 mathematics teachers and a head teacher) actually participated.

VI. RESEARCH DESIGN STRATEGY

In my opinion, the need for selection of research strategies that will most effectively probe the research questions and provide understanding of key issues in research question according to Johnson and Christiansen (2000), Olson (2000), and Wilson and Natale (2001) is fundamental [23], [24], [25]. Consequently, my research design involves both quantitative and qualitative components. I developed three arms of

instruments for data collection in this study namely; questionnaires, interviews and direct observation. The interview type was in the form of open ended questions, which were sent to the head teachers and mathematics teachers in the sampled school as per request. It is imperative however, as a good research practice to employ triangulation as a method, and certainly, my research employs some measure of triangulation (i.e. use of multiple methods and data sources). This enables the enhancement of validity of my research finding [26]. The study was divided into four possible phases. In table 1, the outline of each phase provides an account of the process, technique and approach applied to the specific tasks.

TABLE 1
RESEARCH DESIGN AND ATRATEGIES

A. Literature Review and Document Analysis

Phase one	Phase two
Literature review and document analysis	**The survey instrument:** Design, pilot and implementation - head teacher, mathematics teacher and SEN students at sample school in England **Qualitative:** Data was quantified and statistically analysed with the use of PASW/SPSS **Qualitative:** Open ended questions was used
Phase three	**Phase four**
Qualitative: Interviews to head teachers and Mathematics teachers. Data was quantified and statistically analysed. **Observation Technique:** Observation in class with KS4 special education needs (SENs) students	**Analysis of the total data set:** In order to derive a model which will reflect the factors that enable mathematical concepts acquisitions in schools, the quantitative and qualitative data collected in the previous phase was used to guide the final assertion made in this research.

In this research a number of major writers and researchers including; [27], [28], [29], [30], [31], [32], to mention but a few, were identified from the literature search; these help to guide the literature search further. Meanwhile, further detail examination of theories and concepts of change and issues that emerged regarding the impact of VLE in secondary education sector provided the basis for initial instrument design. Relevant education stakeholders' strategic plans and policy documentations were also studied with respect to the issues of VLE in schools with particular reference to mathematical concepts acquisition by the special education needs students in KS4 school sector. The findings from these literatures form part of the initial survey instruments. It is a known fact that in areas such as VLE and technology as a whole, changes are rapid, therefore, the imperativeness to maintain constant review of literature throughout the research

period. Access to informational research and literature is made possible by the use of internet, as various authors constantly publish their findings on the web. In this research, I use the following bibliographic indexes to search for information; British Education Index (BEI), Universities Indexes, European Educational Research Association (EERA), Australian Education Index (AEI), British Library (BR), University Portals and Education Resources Information Centre (ERIC). The key word searched include; Virtual Learning Environment (VLE) in schools, integration of technology in education, the impact of VLE in teaching and learning, the impact of VLE on mathematical concepts acquisition, the impact on SENs, the use of VLE in schools/learning and teaching, role of VLE in enhancing learning, schools sector and VLE, curriculum content for KS4 education and special education needs (SENs).

B. Survey Instruments –Designing the Questionnaire

Questionnaires are perhaps the most commonly used descriptive method in educational research; however questionnaires vary in their level of complexity and granularity [33]. To the useful responses in a cost effective way, it is important to be clear about the aim of the questionnaire and how the responses will enable you improve the learning technology or its implementation [34]. However, when correctly constructed, they are a rapid, inexpensive method of gathering data, especially for the small scale research undertaken by one person [15]. Cohen, Manion & Morrison (2004) identified two types of questionnaires; the open format and closed format. "Highly structured, closed questions are useful in that they can generate frequencies of response amenable to statistical treatment and analysis" [35]. Taking these points into consideration and additional factors such as time available, I decided to use questionnaire which were presented to students on line at the end of case study approach; - observation. I used closed questions for ease of coding and, in order to generate a more distinctive and clear responses. (Since the responses received from both the questionnaires and open ended interviews in this pilot study was greater than >70%, the response rate is considered appropriate [33]. I used a likert scale, such as " 'strongly agree', agree', disagree', and 'strongly disagree. I tried to avoid double questions, hypothetical questions or leading questions however, [15]. Although the number of questions was so many, most were straightforward and easy to complete. All questionnaires were designed taking into account the nature and the age (14 -16) of the students (SENs) involved in the study.

C. Case study Approach

Case study enables researcher to choose appropriate research group in order to narrow down the sample size to a manageable number of participants. Hopkins (2002) suggests that one of the advantages of this method over others is relatively its simple way of plotting a group's reaction to

teaching [and learning] methods [36]. Conversely, Creswell (2009) warned against using convenience sampling since the researcher cannot say with confidence that the individuals are the representatives of the [school] population [10]. The researcher used a systematic probability sampling technique and baseline data on the special education needs group register to identify research group, hence the sampling could be said to be a representative of the whole population and not purely on the bases of convenience. This techniques is also favoured by Creswell (2009)

D. The Direct Observation

Diebold Miller, Gensheimer, Mondschein & Ohmart, 2000), insists that classroom observation has resurfaced as a method of understanding and evaluating instructional practices and for documenting outcomes of reform efforts [37]. Classroom observations provide information about the frequency and the duration of teachers and students interaction. Turner & Meyer, (2000) maintain that observational data can be used to triangulate reports of classroom practices between students and teachers [38]. Nuthall, (2004) in his contribution argues that Feedback generated from classroom observation can be used by schools and teachers to reflect on the strengths and weaknesses of the instructional practices that are being used in the classroom [39]. Conversely, Stringfield & Teddie, 2004, criticised classroom observation as loosely focusing too narrowly on academic variables [40]. Meanwhile, concerns over classroom observation nonetheless include cost (time and money) of training observers and perhaps misuse of classroom observational data which is second most important limitation of using classroom observational process research [41]

VII. CONCLUSION

The study clearly identified the ideological and philosophical aspects of educational research design with special preference to the impact of VLE on Mathematical concepts acquisition within secondary Education KS4 (14-16) Special Education Needs (SENs) students in England. In doing this, we identify various elements of the investigation that are novel, original or creative which may constitute production of original knowledge or an original interpretation of existing knowledge? The research design is completely holistic in its approach with mixed or multiple methodologies. The study combines the qualitative and quantitative methods of approach. Although, the study could best be described as a mix method approach with a strong positivist paradigm, hence my earlier understanding of the differentiation of the students, student – teacher body and the various elements of indicators that is being measured which will require an attenuated description of individual research subjects. The design strategy involves five key stages which are; literature review and document analysis, the survey, interview, and observation; then finally the analysis of data set, all

encapsulated in a four phase design strategy. The research identified the need for triangulation with Reid's (1992) phases of data management providing scaffold for the study [42]. The SPSS software was used in the identification and manipulation of data set, enabling researcher to develop outcomes from the synthesis of data collected from the surveys, interviews and observation reports. This product became valuable in responding to the initial research questions.

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