Role of ICT for Managing Diversity of Mathematics Classes: Experiences of Teachers

https://doi.org/10.3126/tej.v12i1.64923

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Article History

Received	Revised	Accepted
17th December, 2023	26th December, 2023	2nd Janauary, 2024

Abstract

Diversity issue in the present context is a global issue of socialization. It has not yet been materialized into the education system in Nepal. The education system of a country should prepare students to function in today's diverse society. There are issues emerging in the effectiveness of the diversity management and the concerns how to better shape the diverse classroom in Nepal. This paper focuses on issues such as teacher's experiences in diverse classes, classroom management, and role of ICT integrated pedagogy to manage diverse classroom context. It also discusses the context, and experiences of teachers that can bring the diverse classroom situation into the right track. For this purpose, I apply narrative inquiry of two mathematics teachers (one male and one female) of University campus Kirtipur with more than ten years' of teaching experience. In depth interview related to the experiences of teachers managing diverse in higher mathematics classes were conducted and found that there are different types of diversity in the context of Nepalese mathematics classroom viz. cognitive diversity and social diversity. However, the management of diversity is a great job for teachers, the use of ICT tools plays vital role in this direction. Although, teachers are little familiar to the diversity management skill they try to manage such type of diversity by supporting their students personally through ICT tools. Diversity works with social constructivist approach in educational field is trying to discuss in this paper. It also presents the role of ICT integrated pedagogy to manage the diverse classes by respecting student's personal feelings.

Keywords: Constructivism, Diverse classes, Diversity management, ICT integrated pedagogy, Narrative inquiry.

Background of the Study

One of the global common phenomena in the large educational institutions is the diversity of students in the classroom, which is being characterized by individuals with various characteristic like age, gender, nationality, religion, tribal affiliations, logical, doctrinal or political affiliation, learning capacity, problem solving skill, pre-requisite knowledge, etc. In this context, Cox (2001) defines "diversity as the variation of social and cultural identities among people existing together in a defined employment or market setting" (p. 3). Cox and Smolinski (1994) define diversity as "the representation of people of different group identities in the same organization social system"(p. 12). Generally defined, "diversity is

multidimensional, but the key to diversity is the valuing and managing of differences in such a way that the results lead to inclusion"(Plummer, 2003, p. 10).

When educational leaders became aware of the demographic changes in the classroom and students base, it became apparent that a focus on classroom diversity was critical. As a result of legislation mandating Equal Learning Opportunity and Affirmative Action, institution and teachers began to examine the students' demographics within their own institutions. Within an organizational framework, diversity refers to "making use of and leveraging human differences toward institutional effectiveness and productive educational goals" that maintain a high performing workforce (p. 13). A potential benefit of diversity will be to promote institutional effectiveness in creativity, learning, problem-solving, and quality of participating in classroom activities by being conscious of individual identities.

> When identifying individual diversity, it is suggested one distinguishes between the primary and secondary dimensions. Loden and Rosener (1991) defined "primary dimensions of diversity as those unchallengeable human differences that are inborn and/or that exert an important impact on our early socialization and ongoing impact throughout our lives" (p. 18) such as age, ethnicity, gender, physical abilities/qualities, race, and sexual orientation. Secondary dimensions contain elements of control and are things that can be changed such as: educational background, geographic location, parent's socio economic status, peer group, parental status, religious belief and work experience. Both are extremely important because they influence learners' identity, how they define themselves in the world, and how others react to them (Loden and Rosener, 1991).

It is stated that the use of Information and Communication Technologies in learning and teaching mathematical concepts has made a positive contribution to students' learning and their motivation (Baki, 2000). As is specified in "Technology Principle" which ranks among principles of school mathematics published by National Council of Teachers of Mathematics (NCTM) in 2000, how to use technology in classes and the yield of such use are bound to teachers. In future, it is expected that teachers will use ICT to enrich learning opportunities and enable its continuity. It can be said that this process is decisive in effectiveness of both integration and teaching process. However, when the literature is examined, it has been seen that most of the teachers do not feel well-prepared while using technology and they need more knowledge and skills about the use of technology (Glazer, Hannafin & Song, 2005). Studies have shown that pre service teachers' competence in ICT-based instruction also increases teachers' increasing knowledge and experience in the use of ICT (Yurdakul, 2011). It has been set forth in studies that pre service teachers will learn ICT integration better and convey it to their teaching processes when they find an opportunity to integrate ICT with their observations and experience during their own learning processes (Glazer, Hannafin & Song, 2005).

At present, Information Communication Technologies (ICTs) have been the

inevitable parts of any human activities. This has impact on all aspects of human life. ICTs have become within a very short time, one of the basic building blocks of modern society (Daniels, 2002). Therefore, the field of social sciences and pure science too cannot be an exception of it. More specifically, our teaching learning procedures, the learner attitudes, activities and motivation also have to impacts of ICT integrated pedagogy. With these changes, we also need to adjust and adapt ourselves. We cannot drag our students with the same traditional means that we followed continuously. Further, if we observe our student's activities into the classroom such as in our universities, yet there is low participation of the students in ICT integrated pedagogy. More noticeably, there is the tendency of greater dependence up on the teachers and the limited information that they provide. This leads to the lower confidence on the part of the learners. ICT integrated pedagogy in the mathematics class have the potential to innovate, accelerate, enrich, and deepen skills, to motivate and engage students, to help relate school experience to work practices… (Davis and Tearle,1999).

Observing above situations it is better to discuss about what are the best pedagogical practices for improving students' achievement? What type of pedagogical practices can address the problem of multicultural classroom? How a teacher can manage the student's interest from different perspectives? How can a teacher treat varieties of students (i.e. students from different culture, different socioeconomic status, different gender, different learning capacity, problem solving skill, pre-requisite knowledge etc.) on the basis of their performance in a single class? How can a teacher experiences with their diverse students in their mathematics classroom using ICT?

Statement of the Problem

Basically, the learning is not only the result of the instruction. It is rather the result of the unhampered participation in a meaningful setting (Frere, 1968). Are teachers able to create such a meaningful environment? Are teachers providing such a situation so that the students are able to learn according to their pace and capacities? Are teachers able to address the interest and learning capacity of students from different culture, different socioeconomic status, different pre-requisite knowledge and different gender? These are today's questions and challenges for the teachers. The purpose of this study is to explore the teachers experience in teaching mathematics on diverse mathematics class (i.e. students from different culture, different socioeconomic status and different gender) taught by ICT integrated pedagogy. If ICT integrated pedagogy works as expected the student who do not get chance to attain their regular classes will not miss their mathematics classes as well as each students will have opportunity to understand any concepts at their own pace. In this regards, this research answered the following research questions:

1. How a teacher experience in teaching mathematics on diverse classes (i.e. students from different culture, different socioeconomic status, different pre-requisite knowledge, different interest and different gender) using ICT integrated pedagogy?

2. Are the students from different culture, different socioeconomic status, different pre-requisite knowledge, different interest and different gender learning mathematics equally?
3. What type of pedagogical practices does a mathematics teacher can apply to manage diversity of students in their classroom?

Objectives of the Study

The main objective of this study was to analyze the experiences of mathematics teachers on diverse mathematics class by applying information communication technology integrated pedagogy. More specifically, it aimed to explore the teachers' strategies on mathematics classroom with students from different culture, different socioeconomic status, different pre-requisite knowledge, different interest and different gender. Similarly, this study also tried to describe the role of ICT to manage diversity of students.

Methods

The Research Design

This study adopted qualitative research design in order to explore the experiences of mathematics teachers in diverse classes since it would be possible to obtain rich and in-depth data. The generalization was not the main aim of the study as it was confined to two mathematics teachers of University Campus TU, Kirtipur.

I adopted narrative inquiry research design of qualitative research approach in this study. According to Webster & Mertov (2007, p.1),"narrative inquiry provides researchers with a rich framework through which they can investigate the ways humans experience the world depicted through their stories". Similarly, Khanal (2009, p.241) said, "Narrative inquiry is the process of gathering information for the purpose of research through story telling ". Thus, I employed narrative inquiry to collect the experiences of mathematics teachers to teach mathematics in diverse mathematics classes.

Informants

The informants of the study include a total of two mathematics teachers (1 female, 1 male) of University Campus, TU Kirtipur, who were practicing ICT integrated pedagogy in their classroom since couple of years. They were selected following a purposive and convenience sampling technique. The informants had more than 10 years of teaching experience and all voluntarily participated in this research (Cakmak, 2013). To ensure anonymity, alpha-numeric identity (T_1& T_2) had been used for the participants involved in this study (Ambler, 2016).

Data Collection

Interview technique was used to collect data in this study. The interview, being the most common and powerful research method, enables participants to speak for

themselves. The semi-structured interview was used in order to elicit in depth data from the mathematics teachers on their perception, practice and beliefs experiencing diverse mathematics classes using ICT tools at Central Department of Education TU.

Data Analysis

Content analysis (Strauss and Corbin, 1990; Miles and Huberman, 1994) was used in the analysis of the data in this study based on interviews. All interviews were first audio-recorded by taking the informants' permission. Secondly, data was transcribed and translated for analyzing process. Thirdly, content analysis was utilized based on the assigned codes, basic themes, organizing themes and global themes on the text. Finally, the global themes were analyzed in terms of the basic themes, organizing themes and codes given (as cited in Cakmak, 2013, p.57). The data obtain from interview was interpret by using general inductive method as described by Thomas (2006).

Theoretical Understanding

A number of scholars have provided theoretical insight about the management of diverse mathematics classes by using ICT tools and teachers experience, children's struggles and underachievement in a multicultural classes on their real teaching. In this research, I review some literatures and discussed some theories that support to manage diversity in mathematics classes from teacher's point of view as well as learning style of students from different culture and select three major theories in my study. The theories that I discussed are theory of social constructivism and connectivism theory.

The first theory that I discussed here is Constructivism. Constructivism is a theory of knowledge (epistemology) that argues that human generates knowledge from integration between their experiences and ideas (Swan, 2011). The feature of constructivism suggest that knowledge is actively constructed and its application has emphasis on process, collaborated learning and teaching for understanding (Crotty, 2012). Constructivist is based on a 'relativist' (as opposed to realist) ontology and 'subjectivist' (as opposed to an objectivist) epistemology. In other words, in constructivism, the true meaning of knowledge (epistemology) is internally constructed (subjectivism) (Scotland, 2012).

In the constructivist view, learner has active role in the process of knowledge construction and child learn through the interaction with the friends. According to social constructivist view student learn by experiencing the successful completion of the challenging tasks. They gain the confidence and motivation by challenging complex task. This theory assumes teacher as a facilitator at the process of teaching and learning.

In my study the constructivism is applied in two ways: one of them is knowledge is actively constructed and its application has emphasis on process, collaborated learning and teaching for understanding. So, the diversity can manage by the active participation of students by experiencing the successful completion of the challenging tasks. The second is the role of teacher as a facilitator at the process of teaching and learning.

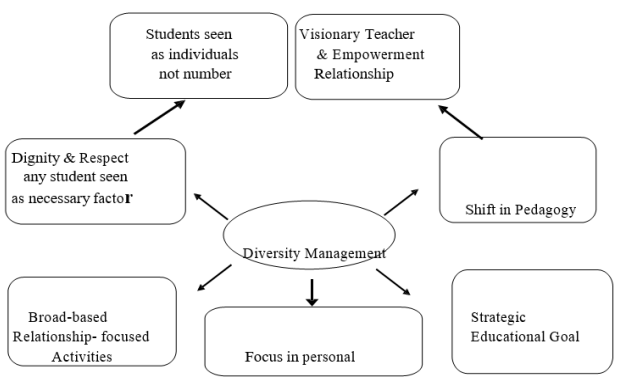
Similarly, the second theory applied in this study is connectivism. Connectivism also offers the specific technological opportunities for the learner to be actively involved in the presentation of a body of knowledge. Siemens (2004) proposed connectivism as an alternative learning which states that learner attempt to foster understanding connection between specialized communities (Duke, Harper and Johnoton, 2006).

Connectivism could be a learning theory for the following reasons: First, connectivism is characterized as the enhancement of how a student learns with the knowledge and perception gained through the addition of a personal network (Siemens, 2004). Being able to tap into huge databases of knowledge in an instant empowers a learner to seek further knowledge. Such a capacity to acquire knowledge can facilitate research and assist in interpreting patterns. Second, explaining learning by means of traditional learning theories is severely limited by the rapid change brought about by technology. Connectivism is defined as actionable knowledge, where an understanding of where to find knowledge may be more important than answering how or what that knowledge encompasses.

In this study the Connectivism is applied in two ways: one of them is teacher will empower learner and facilitate them by interpreting patterns. Second, use ICT based pedagogy to address diversity in mathematics teaching.

Diversity and Diversity Management

Diversity management means to explore these differences under an environment characterized by safety, positivity and care. It also means understanding each other and being tolerant and simply expanding the natural dimensions in each individual, while celebrating the differences and approaching the individuals with equally positive actions (Tomas, 1990). The following picture presents the principle of diversity management by the mathematics teachers in diverse mathematics classes.



& classroom culture

Figure 1*: Principles of Diversity Management*

This diagram/figure shows the process of managing diversity in classroom. There are different techniques of diversity management in mathematics classroom. To manage the diversity, mathematics teachers focus in personal and

classroom culture that helps in pedagogical shifting. Also, the teachers should respect the students interest such that each students seen as individuals but not number. The knowledge was constructed by student through their active base learning that's why teacher plays the role of facilitator at the process of knowledge construction.

Results and Discussions

In this part of the study, findings and discussions are given under several subtitles with the following sequence: Teachers experiences in teaching diverse classes and diversity management through ICT integrated pedagogy.

Teachers experiences in teaching diverse classes

Teaching mathematics with the students from different pre-requisite knowledge, different socioeconomic background, different community and different interest groups is exciting because there is new environment and all circumstances are different for the teachers. When the teachers enter the class to teach, they reflect on what they experienced in their previous classes. The different type of diversity in mathematics classroom and its management is a great job for teachers. The teachers were always experiences different diversity in their daily job. In this regard T_1, one of my informants, said;

> There are many challenges for teaching culturally diverse classrooms. Firstly, the differences in culture are an aspect of personality, which needs to be crossed in order to be an effective teacher. This, however, takes effort from the teacher and creates additional work in extension. I, as a teacher always try to manage students from different culture and different intellectual level but due to large class size and time constraints we are not completely satisfied for our purpose. Secondly, the students have different individual interest, learning style and poor prerequisite knowledge on the subject matter.
>
> As the remarks expressed by T_1 what I feel that teaching a diverse classroom requires a lot of additional effort from the teacher, since he or she has to pay attention more carefully that everyone is able to follow the classroom instruction. Even though cultural awareness is important for teachers but how can it possible for a single teacher? Also, different students have different interest due to individual difference and the teacher must choose the best strategies to manage such problem. Regarding this matter, Duke, Harper and Johnoton (2006) asserted Connectivism offers the specific technological opportunities for the learner to be actively involved in the presentation of a body of knowledge and it will be an alternative learning strategy which states that learner attempt to foster understanding connecting between specialized communities. On the other hand, many students in the mathematics class have very poor prerequisite knowledge that creates problem to run the class smoothly. The large class size and time constraints for teachers as well as students also creates problem for effective mathematics teaching. But, after listening to the opinion of my first participant what I realize that the large class size and time constraints for teachers as well as students also creates problem for effective mathematics

teaching In the same issue, T_2 expressed the experience as;

> Every teacher has a strong commitment and willpower to manage the diverse classes. I always pay attention for the individual difference of students. I encourage all the students to participate in their classes actively and provide extra guidance as their necessity. Many of my students request me for the supportive materials through my personal email, Viber and personal phone contact. I provide available materials for them without any hesitation. This type of individual support helps to manage the diversity of students in my classroom. We need training of diversity management such that we can make our class effective.

As the remarks expressed by T_2 what I feel that teacher should manage good classroom environment by providing equal opportunity to their students. Regarding these views, Guba and Lincoln (2001) stated "learner has active role in the process of knowledge construction and child learn through the interaction with the friends. They learn by experiencing the successful completion of the challenging tasks". The account expressed by my second participant above indicated that the teacher must respect the individual differences of students and engage them in class work as well as project works. Teacher's commitment and effort make mathematics class more interactive as well as productive. As my second participant, constructivism theory also assumes teacher as a facilitator at the process of teaching and learning. The personal support of teachers helps to reduce individual differences of the class.

The above view of teachers indicate that the provision of technological aspect of course content about the diversity in master's level course on TU is not sufficient. The strategies that are managed in the course is not appropriate and practical for the students from different sectors because it is not sufficient to provide knowledge to the students. Teachers have bitter experiences and reflection on the management of diversity by using modern technology on their classroom in the sense that they don't know how to use modern technology in the classroom. Many teachers do not have an opportunity to participate on any orientation and training.

Diversity management through ICT integrated pedagogy

In the context of Nepal, there are three type dimensions in mathematics classroom; the primary dimension, secondary/psycho-social dimension and tertiary (third) dimension (Plummer, 2003). The primary dimension includes Age, Gender, and Ethnicity, Sexual orientation, Race, Physical Abilities/disabilities Region, Ethno-linguistic region, Demographic, Immigration and Citizenship status. Whereas the secondary dimension includes Educational background, Income levels, Work experiences, marital/parental status, Religious beliefs, Value system and ethics, and Historical influences. Similarly, the tertiary dimension encompasses: Government policies and political factors, Communication, Society-traditionally dominant/weak, and legal factors. The better management of such types of diversity make the teaching learning unbiased and trustworthy. Every teacher wants to manage the diversity and made his teaching learning productive but most of them fail to manage it. In this regard

one of my participants, T_2 says;

> The most effective way to manage diverse mathematics classes is the use of ICT integrated pedagogy in teaching learning process. There is misconception about the use of ICT tools on students as well as teachers due to lack of knowledge even though it is very effective to address the individual difference of students and easy to handle. The visionary teacher can manage the diversity by respecting each student's interest and treated them as individual but not a number. Teach-student collaboration to focus the classroom culture helps in pedagogical shifting and diversity management.

This characteristics told by my participant announced that teachers have strong belief on ICT integrate pedagogy to manage diverse classes. The ICT can support each individual students to learn mathematics differently. As concerning on this fact, Ghosh,Hattangdi and Atonu, (2007) said "ICT increases the flexibility of delivering of education so that the learner can access knowledge anytime and from everywhere". The best ways to manage the diverse class are; a) Ask about your students' interests and experiences so you can know them as individuals rather than merely the members of a group. b) Encourage students to respond to each other's questions and comments, not just your own, to foster a sense of community. c) Don't make assumptions about students based on what you perceive as their majority experiences and needs. d) Provide guidelines for group discussions so as to create an environment where students will feel safe voicing their opinions. e) Don't ignore or single out students and never ask a student to act as a spokesperson for his/her group. In the same concept T_1 expressed their ideas as;

> "We face many problems to teach students in a diverse class such as; language problem, content problem, level of understanding. Basically, the problems arises due to classroom diversity. There are two type of diversity in our classes they are social diversity, and cognitive diversity. We can manage the diversity by managing cognitive model of difference to increase the level of understanding. The ICT tools can support the students in multiple perspectives but due to time constraints and geographical difficulties it is not effectively implemented in our classroom."

To realizing the importance of using ICT in mathematics class, teachers tries to use ICT tools in the classroom. But they feel two type of problems for the effective implementations of ICT. One of them is all the students who enroll in mathematics class are not familiar and practiced with ICT tools and techniques. The second is, students and teachers have little knowledge as well as misconception about use of ICT tools regarding as time constraints. ICT can enhance the greater collaboration between the pupils as it helps to increase students' motivation towards the teaching. Due to geographical difficulties and resource constraints, Nepalese educational institutions are unable to manage appropriate learning resources in classroom. This leads to demotivate students as well as teachers towards new dimension in teaching learning. Teachers and students are very much curious and optimist towards the use of ICT in mathematics

classes but the limited resources is the main huddle for the effective implementations. In the support of teachers views, Ghosh,Hattangdi and Atonu, 2007, Becta, 2014 says, ICT can enhance the greater collaboration between the pupils as it helps to increase students' motivation towards the teaching. The similar idea was present by the participant T_1 as;

We can manage the classroom diversity by supporting students from different cultures and society differently in the classroom. Also, the individual differences of students can be address by integrating ICT in pedagogical practices to increase the level of understanding. The ICT tools and technological skill can support the students in multiple perspectives but due to time constraints and geographical difficulties it is not effectively implemented in our classroom.

The view of my research participant informs me that to realizing the importance of using ICT in mathematics class, teachers try to use such tools and techniques in the classroom. But they feel two types of problems for the effective implementations of ICT. One of them is all the students who enroll in mathematics class are not familiar and practiced with ICT tools and techniques. The second is students and their parents have misconception about use of ICT tools regarding as time consuming and expensive. ICT integrated pedagogy can enhance the greater collaboration between the pupils as it helps to increase students' motivation towards their learning. Due to geographical difficulties and resource constraints, Nepalese educational institutions are unable to manage appropriate learning resources in classroom. This leads to demotivate students as well as teachers towards new dimension in teaching learning. The prime purposes to introduce ICT in education are the pedagogical aspect where the pedagogical rationales are to utilize technology in enhancing learning, flexibility and efficiency in curriculum delivery.

Conclusion

In the context of Nepal, there are many types of diversity in mathematics classroom. They are: Age, Gender, Ethnicity, Sexual orientation, Race, Physical Abilities/disabilities, Geographical dimension, Educational background, Income levels, Marital/parental status, Religious beliefs, Value system, pre-requisite knowledge, socioeconomic background and ethics. Different teachers have different experiences in diverse class. The experience of teachers indicate that they are unable to include the voices and experiences of all students to prepare them for an intercultural society and job market that helps to create opportunities to utilize project based learning. In case of heterogeneous classroom, it is especially important to emphasize multiculturalism because the only exposure our students may get to other cultures is through the activities, books and lessons that we provide them with.The best ways to manage the diverse class are; Ask about your students' interests and experiences so you can know them as individuals rather than merely the members of a group, Encourage students to respond to each other's questions and comments, not just your own, to foster a sense of community, Don't make assumptions about students based on what you perceive as

their majority experiences and needs, Provide guidelines for group discussions so as to create an environment where students will feel safe voicing their opinions, Don't ignore or single out students and never ask a student to act as a spokesperson for his/her group and Use ICT integrated pedagogy. The ICT integrated pedagogy can enhance the greater collaboration between the pupils as it helps to increase students' motivation towards their learning.

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