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About the Journal

Founded in 2013, the Journal of Teacher Action Research (ISSN: 2332-2233) is a peer-reviewed online journal indexed with EBSCO that seeks practical research that can be implemented in Pre-Kindergarten through Post-Secondary classrooms. The primary function of this journal is to provide classroom teachers and researchers a means for sharing classroom practices.

The journal accepts articles for peer-review that describe classroom practice which positively impacts student learning. We define teacher action research as teachers (at all levels) studying their practice and/or their students' learning in a methodical way in order to inform classroom practice. Articles submitted to the journal should demonstrate an action research focus with intent to improve the author's practice.

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CANDIDATE TEACHERS EXPLORING ETHNOMATHEMATICS IN THEIR SOCIO-CULTURAL CONTEXTS

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Abstract This action research attempted to raise candidate teachers' (CTs) awareness about the links between mathematics, history, society and culture in Bahrain. It also tried to improve the quality of the researcher's teaching practices through drawing on ideas from the sociocultural and ethnomathematics theoretical frameworks, and the 'authentic ways of learning' teaching approach. This action research aimed to finding ways to integrate these theoretical ideas into actual practices through the development of a specific course curriculum design, and introducing new teaching techniques. The research was guided by the following question: How can the researcher improves the content and pedagogy of the 'Modern History of Bahrain" course in order to enhance the learning experiences of the mathematics CTs? The research followed a qualitative methodology and used personal observations and classroom activities as the data sources. The findings indicated that by the end of the research cycles, the CTs seemed to know more about the connection between mathematics and history and some other social and cultural activities. The quality of teaching has improved because of the changes that were implemented systematically and because the CTs and the researcher worked collaboratively to achieve these changes. The CTs developed a sense of ownership of their learning because they were encouraged to discuss the project's activities, negotiate their suggestions and give feedback during each step, and also locate connections between mathematics and their social and cultural contexts.

Keywords: teacher action research, mathematics education, elementary, pre-service teachers

Introduction

Many educational systems around the world are working to find ways for improving effective mathematics education through different reforms and initiatives (e.g. National Council of Teachers of Mathematics (NCTM) in the United States and Canada; National Centre for Excellence in the Teaching of Mathematics (NCETM) in the United Kingdom; and Enhancing Training of Mathematics and Science Teachers (ETMST) in Australia). These initiatives emphasise the need for making mathematics education more collaborative, connected to the real-world, contextualized, and related to the culture and ethnicity of the learners (Verner, Massarwe & Bshouty, 2019).

In addition, many researchers have recognized the importance of using action research in teachers' training and professional development. For instance, Mertler and Hartley (2017) noted that action research has been viewed as a good alternative to typical in-service teacher training (e.g. lectures or workshops) as it can help them to investigate their own practices in systematic ways, to reflect on their work, and find out more about their weaknesses and strengths. It also adds to their professional growth as it allows them to focus on specific aspects of their teaching practices and decide on ways for further improvement.

In this paper, I present an action research that focuses on finding ways to improve the quality of my teaching practices – as a university instructor - by introducing ideas from the sociocultural and ethnomathematics theoretical frameworks and drawing on concepts from the 'authentic learning' approach. This research aimed to integrate these theoretical ideas into actual practice in one classroom and to reflect on Bahraini mathematics candidate teachers' (CTs) views on using this new approach of learning. This action research also investigated how engaging the CTs in exploring their social and cultural contexts might improve the quality of teaching. The following section will provide a brief overview of the ethnomathematics framework and the sociocultural theory, followed by the research aims, questions, methodology and ethical issues. Then the research cycles will be explained and followed by the findings and conclusion.

Ethnomathematics and the Sociocultural Theory. Ethnomathematics is a pedagogical trend in education that emphasizes the centrality of culture and context in mathematics learning. This approach focuses on studying mathematical ideas of traditional people. These mathematical ideas involve number, logic, spatial configuration and ways of organizing these concepts into coherent structures (Ascher, 2017). The scholars of the ethnomathematics approach (e.g. Bishop, 1988; D'Ambrosio; 1997, Gavarrete, 2015, Gerdes, 1986) argued that mathematical knowledge is a cultural knowledge, which has been developed in all human cultures. Mathematics in this approach is conceived as a cultural product developed in particular ways under certain historical, social and cultural conditions in different cultures. This view challenges the traditional view of mathematics education as based on impersonal learning, technique-oriented curricula and Eurocentric knowledge. The traditional view can distance certain disadvantaged groups' learning through denying their personal cultural experiences, which can conflict with formal mathematics education in schools. Education according to the ethnomathematics approach should seek to develop mathematics as a cultural resource related to learners' experiences. Rosa & Gavarrete (2017) argued that the core of ethnomathematics research is to explore how mathematics is made in many historically rich, diverse and distinct traditions, and also on how mathematical thinking can be influenced by diverse types of human environments, which include language, religion, morals, economics, social and political activities.

Ethnomathematics can help students see the links between social and cultural contexts with the content and pedagogy of school mathematics, and to understand it in the context of ideas, procedures and practices used in everyday life activities. In addition, Palhares (2012) suggested that in order to improve mathematics education it is important to design

mathematical activities that are culturally contextualized and are grounded on the cultures, as this will help the students to associate meaning and ownership of the school curriculum. Another useful theoretical framework that supports ethnomathematics is the sociocultural theory (Vygotsky, 1978). According to this theory, learning cannot be separated from its social context; learning is not just a process that occurs internally in the individual learner, it rather occurs through the active participation of the individual in wider social practices mediated by social interactions and cultural tools. In other words, learning according to this theory is not just a mental process separated from its social context. Leaners according to this view learn through interacting with others, they communicate using language, signs and symbols. They also use different tools to organise and control their behaviours, all in which are tools created and developed in specific contexts of cultures and societies. Certain types of higher thinking abilities such as deliberative attention, verbal and conceptual thinking cannot develop without the constructive assistance of such social and cultural mediation (Ivic, 2000). Accordingly, by emphasizing the interrelations and strong dependence in learning and development, this theory supports the idea that learners' home environments are important in promoting learning; and other 'expert' people – such as parents, peers and teachers - can contribute greatly to the development of the 'novice' learning abilities (Tekin, 2011). Knowledge according to the sociocultural theory is shared and created among experts as they all engage in inquiry-based activities that serve to solve authentic and meaningful problems. Knowledge is also seen as a human creation process rather than a given fact and it is located in the cultural and social contexts of learning and not just in the mind of the learner (Eun, 2010).

In line with Vygotsky's ideas (e.g. zone of proximal development and the role of mediation in learning), Moll and his colleagues (Gonzalez, Moll & Amanti, 2005) regarded every household as an educational setting with important educational potential. The term 'funds of knowledge' was used to describe forms of knowledge and skills, which can be found in local households and "these historically accumulated and culturally developed bodies of knowledge and skills essential for households or individual functioning and wellbeing" (Moll et al., 1992: 133). All knowledge and skills attained are connected with authentic activities such as farming, construction, trade and business located in the learners' environments.

Looking at the Islamic, Arabic, and Bahraini history in context, we can see that ethnomathematics can have an interesting implications and applications for our classrooms. In the 13th and 14th centuries, Arab and Muslim scholars made seminal contributions to many scientific fields, especially mathematics. The development of mathematical ideas was often associated with social, cultural and economic needs such as solving problems related to navigation, astronomy and architecture. Islamic religious activities also involved mathematical aspects (e.g. calculating the time of praying, the direction of Mecca, the law of inheritance and the geometrical and engineering designs). Bahrain shares this Islamic history and culture. In the past, Bahraini people used different types of mathematics in their daily life activities; for example, in trading, traditional crafts, measuring the sizes of pearls, gold-smithing and jewellery design, ship building, games and architecture. Traditional crafts such as basket weaving, textile making and ornamenting are still practised in some villages in Bahrain and they include interesting mathematical concepts. An example of the use of mathematics in ancient Bahrain was highlighted by Serjeant (1968) who illustrated a star-

calendar system used by Bahraini fishermen. This ethnomathematics is embedded in real contexts and was developed for meaningful purposes. I think that this rich mathematical heritage and interesting ideas are still untapped in the Bahraini mathematics classroom. Recognizing and utilizing such ideas in the classroom can possibly help the CTs to see the social and cultural dimension of mathematics and to make them more aware that mathematics can be useful, interesting and essential not just for mathematicians, but also for common folk as well. Another study was conducted by Amit and Abu Qouder (2017), which attempted to address young Bedouin students' persistent difficulties with mathematics by integrating ethnomathematics into a standard curriculum. The researchers interviewed 35 Bedouin elders to identify mathematical aspects in their daily lives such as using traditional units of length and weight. Then the researchers combined these ideas with the standard school curriculum to design an integrated curriculum unit. Comparisons between the experimental group (75) and the control group (70) revealed that studying the integrated curriculum improved the students' self-perceptions and motivation but had no effect on achievement in school testing results that were conducted after the experiment. In addition, Gavarrete (2015) carried out a research project that was designed to train indigenous teachers in Costa Rica on incorporating cultural aspects of mathematics and to conduct action research projects as part of their professional development program. The finding of the research indicated that these projects helped the teachers to become more reflective about the connections between mathematics, culture, education and society. These experiences also helped the teachers to appreciate the valuable cultural and social resources that are connected with their students' indigenous identities. Through searching research databases, I found that there is a lack of studies related to ethnomathematics in the Arab world and especially in the Arabian Gulf states. Hopefully, this study will highlight the usefulness of employing ethnomathematics and the social and cultural contexts in classroom preparations conducted by the teachers themselves.

Context. The research was conducted in a relatively new teachers' college. The college offers different teacher preparation and professional development programmes. The strategic plan of the college emphasizes the importance of conducting research that would contribute to the educational reform agenda for teachers' professional development that includes: encouraging teachers and school leaders to conduct action research and to be open to the international educational developments.

In a previous year, I was assigned to teach a course called: The Modern History of Bahrain—a compulsory course that all university students have to take. My class consisted of a group of 18 CTs (12 males and 6 females) in their third year of the Bachelor Program in Primary Education—Mathematics specialization. Through my initial interaction with the CTs, two issues had emerged: The first issue being the CTs showed lack of interest and low motivation towards the course. Some of them said that they studied the same subject when they were in secondary school and they already have a good knowledge base about its content. Others said they preferred to study courses that are more relevant to their specialization and that they are more in need of scientific or mathematical content and skills. These views stimulated a discussion between us about two main topics: the importance of studying history in general, and the national history in particular, and the relationship between mathematics and history. In general, most of the CTs acknowledged

the importance of studying history, but at the same time they seemed unsure about the connection between mathematics and history. These two subjects seemed to them as quite distant from each other. The CTs generally thought that learning history is about knowing and memorizing facts that happened in the past. History can be interesting because it is full of stories. While learning mathematics requires different knowledge (e.g. symbols, numbers and equations); and it needs high thinking skills (e.g. understanding abstract ideas, analysis, reasoning and mental calculation).

The second issue was related to me as the course instructor. What follows are points explained with quotes from my course reflective notes. At the beginning of the project I sensed that I lacked experience and skills in teaching this course: "*although I had general knowledge about the history of Bahrain, I didn't have any previous experience in teaching this course – neither at school nor university levels – I felt that teaching this course would be different from the other educational courses that I used to teach and felt more comfortable with (e.g. educational foundations, citizenship education, study skills and professional development courses)".* I also had a sense of anxiety related to the best pedagogy which can be used to achieve my course objective: *"I was anxious that I would need to read and plan more and to be more innovative in order to make learning history more meaningful and enjoyable for my mathematics CTs".* I had two options for planning the course materials and teaching methods: *"the first option is to use a traditional teacher-centered approach where I will be delivering the course content through lecturing while the CTs will be listening most of the time in the class and then memorizing the historical facts at home for the exam. This seemed to be an easy option as it doesn't require me a lot of planning, saves my time and energy and it is always easier to manage a 'quite' classroom".* I always asked myself while planning the project about how the CTs will react to the new pedagogy: *"The CTs may feel bored but probably most of them would be happy as long as they 'follow the book' and don't have to worry about writing reflective assignment or feel burdened with confusing tasks".* Although it was tempting to choose the first option, I decided to explore an alternative approach which aimed to raise CTs awareness that there is a strong link between mathematics and history and it's important to work together to achieve a better understanding of mathematics, not as an abstract, pure, universal knowledge, but also as an everyday knowledge that is essential in every culture and every society: in the past, present and in the future.

It is generally accepted among educators that learning by doing is an effective way to learning as it can increase students' motivation through engaging them in real world problem solving, experimentation and action (Gavarrete, 2015; Lombardi, 2007; Mims 2003). It is also important to make learning more meaningful for the students by promoting the connections between what they learn and what they actually do in reality. One of the strategies that can be useful to achieve this type of learning is the authentic learning which "focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice" (Lombardi, 2007, p. 2). Authentic learning activities aim to move students' learning beyond content and to give them challenges that cannot be solved easily with open and multiple interpretations. These problems are complex and need to be investigated by students over a sustained period of time and require a variety of resources and perspectives. The authentic

learning tasks also require collaboration, reflection, and they allow for diverse interpretations and competing resources (Lombardi, 2007). Mims (2003) argued that authentic learning is different from traditional methods of teaching because learning is centred on authentic tasks that are of interest to the learners; students are engaged in exploration and inquiry; learning is interdisciplinary; learning is connected to the world beyond the walls of the classroom; students produce a product that can be shared with an audience outside the classroom; and students have opportunities for social discourse.

I found that the idea of authentic learning useful as it can be used as a teaching method, which will frame this action research especially that it is well aligned with the previously mentioned theoretical call for more recognition of the social and cultural resources in teaching and learning mathematics. In other words, I am personally interested in using these ideas because I think it is important for me as a university instructor to show my CTs – who will be primary mathematic teachers in the future – how important it is to move from the teacher-centered way of teaching, especially when teaching important subject such as mathematics, to a more learner-centered approach, which allows the CTs to investigate, talk, reflect, solve problems, share ideas and see how mathematics is relevant to the social and cultural context, instead of, excessive reliance on memorization, drill and rote practice. I also hope that their engagement in the action research would open new doors for them to see the connection between mathematics and other subjects, history especially.

Research Aims. Although many educational researchers considered acknowledging the social and cultural dimensions of mathematics as potentially key in mathematics education, as mentioned earlier, it seems that this issue is overlooked in classroom practices in the educational system in Bahrain and also in the current teacher training courses provided to the mathematics specialization in the college. Therefore, I believe it is important to introduce these theoretical ideas to the CTs and try to integrate it in the history course and see whether it would have an impact on CTs' understanding of mathematics as an abstract knowledge subject and also related to our everyday life activities and deep-rooted in our culture and history.

The overall aim of this action research (Coghlan & Brydon-Miller, 2014; Reason & Bradbury, 2001) is to improve the quality of my teaching practices through drawing on ideas from the sociocultural and ethnomathematics theoretical frameworks, and the authentic learning approach and finding ways to integrate these theoretical ideas into actual practices, mainly by the development of the history course curriculum design, and introducing new teaching techniques.

Research Questions. This action research tries to answer the following general question: How can I improve the content and pedagogy of the 'Modern History of Bahrain" course in order to enrich the learning experiences of the CTs?

Improving the content of this course was intended through introducing new insights that aim to enrich CTs' understanding about the social approaches in mathematics education and to see how this would reflect on their work in the class and in performing the required tasks. Improving the pedagogy is attained through utilizing the authentic learning approach as a

new teaching strategy that fits with the theoretical framework proposed earlier. By this approach I tried to move away from a traditional teacher-centered approach toward a more open and learner-centered approach.

Methodology

Data Collection. This research was based on a qualitative design. Two data collection methods were used in this action research: First, a reflective diary that contained my observations and comments about the research steps and cycles. These comments included information about how the research idea was developed, how well the action plan went, what kind of difficulties I encountered, what sort of unexpected issues emerged, how the CTs reacted to this new approach of teaching and how can I develop these ideas in future. The second source of data was the CTs' course work related to the following tasks:

> Task (1) – finding authentic problems: this task was implemented in the first cycle of the action research (which will be explained more in a following section). The CTs were asked to work individually or in small groups to find, analyse, discuss and present an authentic cultural or social activity related to an aspect of the history of Bahrain. This activity must demonstrate advanced mathematical concepts and practices. The CTs were required to submit a final written report of around 1500 words and should have illustrations and pictures if possible.
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> Task (2) – mathematical problems development: this task was implemented in the second cycle. The CTs were required to develop mathematical problems related to the topic chosen by them in the first task. These mathematical problems should have two levels: one that is suitable for the primary school students, and one that is suitable for the secondary or university level. For example, if the CT chose to investigate mathematical aspects in traditional sailing vessels building in the first task, better known as 'dhows' and were used in the past in wars, trading, fishing and pearl diving in Bahrain, then next, the CT should work on developing mathematical questions or problems related to the idea of vessel-building. Some of these questions should fit with one of the national primary 'basic' mathematics curriculum lessons and the others should be suitable for 'high' mathematics in secondary school or university levels.

The aim of these two tasks is to encourage the CTs to design mathematical problems that are connected to the cultural, historical or social contexts related to Bahrain. These problems can be used to support the formal curriculum which they study in the college or in the primary curriculum they will teach in schools. I hoped that the CTs would see the link between mathematics and history through their investigation, dialogue and reflection while working on the two tasks.

> Task (3) - CTs' presentation: after finishing the previous tasks, the CTs presented their work to their classmates at the end of each cycle. In these presentations they had the opportunity to engage in mathematical dialogue with each other where they presented their work and explained the link between mathematics and history with reference to certain historical events that were discussed in the course textbook.

The data analysis process was structured on three interconnected stages (Miles, Huberman & Saldana, 2014): (a) Data reduction: cutting down the data and condense it in a meaningful

way, (b) data display: summarizing, coding, organizing the data, and (c) drawing conclusions: reaching possible findings and conclusions. During the different stages of the data collection and data analysis I went back and forth and reviewed the different sets of data (e.g. the reflective diary and the CTs activities and tasks) to look for overarching themes that help in answering the research questions. The finding section is organized around the following dimensions that are related to the research question: CTs' views about their exploration of ethnomathematics, changes in the content element of the course, and changes associated with the pedagogical element of the course.

Ethical Issues. Participation in the research was voluntary and based on freely given consent. I gave the CTs sufficient information about the research, the data collection procedures, and how the data is going to be used. All of the CTs were happy to work with me on this action research and they even contributed with interesting ideas at the initial stages of the research design. However, once they accepted to take part, it was difficult to withdraw because the mathematical tasks, mentioned earlier, were part of their course assessment.

The Research Cycles. The first research cycle started in the first month of the academic year and it consisted of six teaching sessions. I mentioned earlier in a previous section how I began this research journey with the CTs and how they lacked interest and had low motivation towards the course, how they seemed uncertain about the connection between mathematics and history, and my lack of experience in teaching this course created mixed feelings. At this stage I planned to improve the quality of my teaching practice through drawing on ideas from the sociocultural and ethnomathematics theoretical frameworks and the 'authentic learning' approach in order to enhance the learning experiences of my CTs. I worked on planning my lessons for the following three weeks. In each week there were two sessions, each session was divided into two parts. The first part focused on teaching the normal history content of the textbook while the second part focused on the action research materials, which were as follows:

In the first week I focused on giving introductory information in regards to the course, encouraged the CTs to talk about their views and how we can work together on improving them, investigated CTs' previous experiences in studying history and their current experiences in studying mathematics subjects. We also discussed the research idea, their role and my role, the process of getting CTs' agreement about their participation in the research, exploring their perceptions about participating in the research and connecting this with the previous research skills course which they took a year before.

In the second week I tried to help the CTs to achieve better understanding about the idea of ethnomathematics. We talked about using mathematics in the Islamic religion (e.g. calculating the time or praying, the law of inheritance and the architecture designs). We also talked about the Islamic arts and some examples of traditional crafts, which, demonstrate interesting mathematical ideas. In another session we discussed the idea of authentic learning and the sociocultural approach to learning. The CTs were encouraged to work in groups to discuss their own examples of mathematics related to the cultural and social practices in Bahrain. They were asked to write a short summary of what they intended to do

in the first task (i.e. to find, analyse, discuss and present an authentic cultural or social activity related to an aspect of the history of Bahrain).

During the third week the CTs worked in groups under my supervision in discussing their first task and to explain how it is related to the historical content of the course. These discussions were interesting because it allowed the CTs to reflect on their understanding of ethnomathematical examples related to the social and cultural context in Bahrain. It also showed me how they demonstrated their understanding of the theoretical ideas through tangible examples. In another session they worked on presenting the final report of the first task. The final presentation encouraged a dialogue among the groups of CTs about why they chose this particular topic, what are the mathematical dimensions they found, how people in the past managed to achieve this level of complexity in mathematical thinking while they were illiterate or had lower levels of education, were there any links between mathematics and other subjects other than history in these topics, and most importantly, what they learned while carrying out this task.

The CTs were rewarded after finishing the first cycle with an invitation to visit a traditional cultural center where they saw traditional crafts such as textile weaving, pottery, basket weaving, traditional carpentry and artwork.

The second research cycle started in the second month of the academic year and consisted of around three weeks (six teaching sessions). In the first two weeks of the second cycle the CTs were required to reflect on what they learned and did in the last three weeks. They were encouraged to give their opinions about the first task and whether they found it useful or not and how we can continue our work in the same approach. Most of the CTs liked the first task, for instance, one of them said: "*doing this report was a wonderful experience to learn about a new science – the ethnomathematics – which showed us the relationship between mathematics and culture and heritage ... a relationship which I didn't know it's that strong ... it showed us how important mathematics is in our life, I also learned about our grandfathers' way of living and reminded me of the past*". It is important to say that some CTs showed good efforts in finding interesting ideas and worked hard on the tasks while others didn't understand the actual point of doing this task and used 'ready-made' ideas from the Internet. So, I decided to change my approach at that point and concentrated more on how the CTs can produce their own new mathematical problems that reflect their understanding of the relationship between culture, history and mathematics. These mathematical problems were supposed to have a rich mathematical content, and also related to meaningful social, cultural practices or everyday life experiences.

So afterward, the CTs brought their mathematics textbooks and worked together on developing new ethnomathematical problems. These mathematical problems had two levels: one that is suitable for the primary school students and the other for secondary school or university levels.

In the third week the CTs presented their mathematical problems and discussed their answers. At the same time, they were working on presentation sessions that were more related to the historical content of the course. Again, some of the CTs worked hard and

demonstrated an excellent understanding and provided interesting problems while others still preferred to give ordinary and simple problems – not really convinced about the link between mathematics and culture.

Findings

Looking back at the research question which guided this study: How can I improve the content and the pedagogy of the 'Modern History of Bahrain" course in order to enhance the learning experiences of the CTs? I am still not sure if the action research was successful in answering this question in full because one semester wouldn't be enough to cover the ethnomathematics ideas in depth. However, I will focus on three aspects that are relevant to the question, the first aspect is about CTs' views about their exploration of ethnomathematics, the second aspect is associated with changes in the content element of the course, and the third is changes associated with the pedagogical element of the course.

*CTs' views about their exploration of ethnomathematics. A*t the beginning of the project, the CTs talked about their past experiences as school students and how this reflected on their current position as mathematics CTs. For example, one the CTs said: "*When we were students in school, they only taught us how to calculate, we didn't learn how to use mathematics in real life. I like mathematics, but other students say what is the benefit of learning mathematics? Where can we use it in our life?"* Another CT said *"Mathematics is about three things: memorization, understanding and application. But in our schools application doesn't get much attention".* Another CT said: "*There are some exercises in the textbooks that require students to link their theoretical learning with everyday activities, but some teachers skip those exercises especially word problems which require problem solving skills, because they take long time and requires lots of feedback*." Some CTs emphasized teaching the basic mathematics skills and expect it to be transferred directly into real life contexts e.g. "*I think if the students learned well how to calculate and do school maths, then they can use it when shopping or when facing any everyday problems, the problem is that students already lack basic skills and that prevented them from solving problems*."

I noticed that the CTs tended to link their previous experiences as mathematics learners with their current practices as mathematics teachers. It seemed that these previous experiences guided them when they face difficulties in teaching mathematics in their classrooms. For example, they may focus more on memorizing mathematical calculations instead of understating and applying the basic underlying concepts. They may also overlook the importance of connecting school mathematics with everyday real mathematical problems or addressing how it is related to the social and cultural contexts of the learners. Therefore, it is important for the teachers to emphasize the connection between in school and out-of-school mathematics learning taking into consideration that it is not an easy straight, forward process. Creating these meaningful links require lots of efforts in planning, preparation and implementation. It also requires the teachers to move from a traditional teaching style to a one that appreciate the richness of their students' social and cultural contexts.

In the second phase of the project the CTs discussed their mathematical problems and worked on finding connection between ethnomathematical ideas and the school curricula. One of the CTs said: "*Mathematics seem to be everywhere, in games, in cars, in food, in time, etc. But this mathematics seems to be simple and common sense. Mathematics in school books needs the ability from the student to think logically, use symbols, use mental strategies … School mathematics and ethnomathematics, both are different and also similar*". Another CT said: "*The ethnomathematics seems to be good to support the existing curriculum with ideas relevant to the students in school; parents can also know through these activities how to link school work with what they do at home and to engage their children with more hands-on mathematical tasks*". Another CT said: "*If you look at the cultural heritage you will see that mathematics was used in such innovative ways, even in agriculture, fishing and sailing, but as a mathematics teacher I never thought I would use these examples in the classroom because children nowadays are digital citizens, they are more concerned with technology than what their grandparents do!*"

Although the CTs worked in groups on task 1, they submitted individual reports that each focused on a specific topic. Some examples of the CTs' work include:

- Mathematics in building traditional vessels: different types of vessels, the scientific concept of floating and mathematical concepts of volume, capacity, and dimensions.
- The traditional tools used in the past for measurement, and the different processes of calculating. For example, how traders measure the diameter of pearls and estimate their prices according to different characteristics.
- Mathematics in the 'Henna' design (dyeing hand skin): the geometrical shapes used in the henna design and the different prices for designs.
- Traditional games and their rules, which are based on some mathematical concepts related to numbers, counting and round taking (e.g. dominos, carom, cards, chess and marbles). These games also include mathematical probability and statistics.
- Mathematics in traditional textile weaving, palm tree leaves weaving and the traditional geometrical shapes, dimensions in handmade artefacts. These traditional crafts include various mathematical ideas such as measurement, patterns, and ratios.
- Mathematics in fishing: the different types and sizes of fishing tools and how they are used for catching different types of fish in different seasons. Traditional fishing traps that are made of weaved wired in a specific geometrical design and also include various mathematical ideas such as measurement, patterns, and ratios.
- There were other interesting examples relate to mathematics in Arabic calligraphy, faming, and carpentry, pearl diving and tassel.

In the second stage of the action research the CTs seemed to change their views gradually about linking mathematics to their students' social and cultural contexts. However, some of them still preferred to stick to the mathematics taught in their schools' curriculum firstly because it is clearly defined, sequenced, organized and can be assessed formally through standardized tests. Secondly, some of the CTs focused on an important point related to the nature of today's students who may not give much attention to the past and the history since they are more attracted to the present (e.g. using ICT in learning, video games, and

smart phone applications). Some of the CTs thought that their students can learn a lot through these attractive modern activities and they might feel uninterested in mathematical examples related to traditional crafts they might rarely see in their homes.

Changes in the content element of the course. The main change in the course content was enriching it with the ethnomathematical content and supporting it with a sociocultural framework in order to raise the cultural awareness among the CTs about the influence of history, social and cultural dimensions on mathematics learning. The two tasks that had been used in this research tried to follow what Bishop (1997) suggested helping CTs to develop more understanding about how and when to use mathematical ideas and techniques, why they work and how they are developed and to see mathematics as a reflective subject not just a set of mechanical procedures. For example, one of the CTs said: *"I think after learning about ethnomathematics and problem solving it is important for me as a training teacher to expand my students' understanding of mathematics. To let them see it in everything they do. Not just as word problems that are a bit detached from their childhood reality. They play games why not focus on mathematics in these games?"* I tried my best to provide good learning settings that encourage the CTs to develop their own personal meanings and to exchange ideas and opinions and have more opportunity to talk with each other about their understanding about mathematics and how they teach it. By the end of the action research the CTs seemed to know more about the connection between mathematics and other subjects, especially with history and science and the richness of mathematical ideas in cultural and social activities. For example, one of the CTs said: *"You can't teach mathematics in isolation. It is connected to science; in experiments they have to do the right calculations and check their results. Mathematics is also related to religion for example to know the direction of Mecca and the times of praying – sunset and sunrise times. I also think our students need to learn about money, who knows they might become entrepreneurs in the future? They also should be proud of their civilization and history. A Muslim scientist called Al Khwarizmi developed algebra. I hope my students will learn from that history".* The CTs gained more knowledge about the national history of Bahrain and about the interesting crafts and artefacts with meaningful mathematical ideas found in different communities. The CTs learned more about these aspects and the uses of mathematics as a useful cultural tool to solve real problems, not just as an abstract knowledge that is moved away from reality. For example, one of the CTs said: *"Our students should visit the museum one day and see how mathematics was part of our grandfathers' daily life. They needed mathematics to solve real problems not to just answer exam tests. Maybe they were illiterate but they know how to use mathematics in a smart way. Not all of them of course. But they learn mathematics according to their needs".*

At the same I cannot claim that this short action research was completely successful in raising CTs' awareness or it truly convinced all of them about the importance of the cultural and social aspects in mathematics learning. Some CTs were implicitly not happy with the new approach that I have used, maybe because these tasks were not really clear to them, they also needed a lot of reflection, discussion, accepting criticism from others, working with others in group, and refining the ideas again and again. This can be difficult for some students who got used to test-based learning. However, they did not object to work even to their minimum effort. I can generally say that the action research was successful in

challenging some of the dominant views of the CTs about learning mathematics in particular – e.g. mathematics as only pure and abstract knowledge – and I tried to attract the CTs' attention to a different perspective of learning and mathematics education which is more 'fallible'.

Changes associated with the pedagogical element of the course. The CTs feedback related to the ethnomathematics activities and the classroom discussions supported my feeling that I have gained better understanding about the ethnomathematics and sociocultural fields and gained more authentic pedagogical experience through teaching this course. This has influenced my performance positively in other courses especially in teaching research skills course. I used some examples of this research to show my CTs and other in-service teachers the usefulness of the action research approach. I also became more confident that CTs can change their views and beliefs if I acted as a role model for them and showed them how to connect theories into practice. In many occasions, educators teach their students important theories, but fail to provide practical hands-on examples and this might inhibit their students to implement these theories in their classrooms. In that case, the CTs will not see the benefits of using innovative ways of teaching when they go to the classroom and probably will duplicate their professor's teacher-centered methods.

Through conducting this research, I also began to test my understanding of the sociocultural theory through using it in the real settings of the classroom especially interaction and tools mediation. Some theories seem convincing in the textbooks but they are difficult to implement in reality. I found the sociocultural theory helpful in tapping a new source of understanding of how the CTs learn through exploring their social and cultural contexts. They were encouraged to build upon their previous experiences and exchange ideas with each other through collaboration and dialogue, and they utilized the cultural and social tools and ideas to mediate both their learning and their teaching with each other.

I felt that the quality of my performance has improved through doing this action research. First, because I implemented change in a systematic way, and I worked with others in achieving these changes. I encouraged the CTs to speak about their suggestions and gave them consistent feedback about what we were doing at that stage and what we would be doing in the next stages. As a result, the CTs developed a sense of ownership of their learning because they felt the importance of their contributions and ideas to the research. Secondly, I felt throughout this process that I myself was a learner more than a teacher. I didn't always have ready answers to my CTs' questions, so I needed to reflect on my own understanding about ethnomathematics and authentic learning and to be always well prepared before each session. Finally, I hope this action research would be useful for other college instructors who are interested in using this approach to learn more about the valuable knowledge and skills that exists in the social and cultural contexts of their students. I also hope that mathematics school teachers would think about other action research ideas and implement them in their classrooms as this would help them develop their professional skills, and would also help their students to be active learners. The findings of this small-scale action research are aligned with Abu Qouder and Amit (2017) research recommendations that highlighted the importance of integrating cultural dimensions in mathematics teaching and in teaching materials; and to train teachers to enhance their

cultural knowledge as this would help them to support and enrich their students' learning. More so, I hope that this research would raise awareness in regards to acknowledging the social and cultural dimensions of mathematics in Bahraini mathematics education, and in teacher preparation and professional development courses provided to mathematics teachers.

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