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EVALUATING THE IMPACT OF META-COGNITIVE LEARNING IN TRADITIONAL CLASSROOMS THROUGH WEB-BASED INTERFACES

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ABSTRACT

Meta-cognitive prompts can be incorporated into a web-based learning environment to produce a reflective and analytical learning experience. The purpose of the research is to examine the impact of introducing meta-cognition in learning, through a web-based interface, on the problem-solving skills of students studying in a traditional Pakistani classroom. Mixed method design is used to evaluate perceptions of stakeholders and data is gathered using questionnaires, semi-structured interviews, and pre-post test results. Examination of pre-test and post-test results revealed significant differences between the control and experimental groups. The attitudes of students towards problem-solving were evaluated. This involved planning, monitoring, and evaluating learning whilst approaching the content and applying it to problems. The results indicated that the participants of the experiment group reported a change of approach towards problem-solving after the intervention. It is concluded that meta-cognitive strategies, embedded as cues in a web-based learning environment, had significant impact on overall problem-solving approach of students.

KEYWORDS: Meta-cognitive prompts, meta-cognition, meta-cognitive strategies, web-based learning.

1. INTRODUCTION

The sign of any developed nation is their eagerness to invest in the improvement of the quality and accessibility of their education system since it plays a pivotal role in the progress of any nation. As technology has transformed almost every aspect of our daily lives, it therefore follows those students get to experience technological facilitation in the educational realm as well. Following the technological revolution of the 21st century, it is quite clear that technology will certainly prove to be the way forth in every aspect of human life as it has intertwined almost every aspect of day-to-day life. This prediction serves to define the real role of a teacher as facilitator. Emerging technologies in education, hence serve to provide that facilitation, with web-based instruction playing a significant role. The use of web-based instruction, to aid learning beyond time and geographic constraints, has led to its popularity in the world of education (Aparicio et al., 2016).

Metacognition is the "awareness and management of one's own thought" (Lovett, 2013). This characterization incorporates the ability to organize, monitor, and regulate one's learning with the intention of achieving specific learning outcomes (Wolters & Pintrich, 2000). Meaningful web-based instruction combined with classroom-based instruction (CBI) has the potential to provide students with a diversity of options to facilitate learning. It is, therefore, imperative that schools should make informed decisions to facilitate web-based learning, in order to improve learning outcomes of the learners. On the other hand, the use of technology without a proper focus on pedagogy fails to create effective learning experiences for students and causes strain unnecessarily to the school budget. It is therefore imperative that the use of any form of technology in education must be accompanied by proper pedagogy.

This research demonstrated the effect of meta-cognitive cues, incorporated with web-based technologies, to encourage active learning in Geography, at secondary school level. The study provides:

(a) a comparison of student's learning achievement after incorporation of web-based metacognitive learning in the geographic inquiry,

(b) an observation of change in attitude of learners before and after exposure to web-based metacognitive environment, and

(c) perceptions of stakeholders (students and teachers) towards web-based learning designed on metacognitive pedagogy.

This research was carried out in order to demonstrate the potential of meta-cognitive cues incorporated in a web-enhanced learning environment and observing its impact in a traditional

Pakistani classroom setup. The incorporation of the aforementioned pedagogy stimulated students' mental processes and provided support for learning beyond the potential of inert learning resources.

2. REVIEW OF LITERATURE

2.1 Designing a "Meta-Learning" Web-Based Interface

Meta-cognitive prompts are commonly used to support the mental processes of learners during the learning process and to encourage active and conscious learning (Hartman, 2001). These prompts allow students to make connections, engage in problem-solving and focusing a student's attention and link to subject (Lee & Baylor, 2006; Opfermann et al., 2012). This in turn assists learners in constructing meaningful mental representations. As the learner becomes accustomed to the use of technology and its navigation, independent learning becomes inevitable and leads learning towards higher order thinking. Research conducted by Lofthouse and Leat (2006) and by Fatima (2016) revealed results related to the better performance amongst student groups who were engaged in learning using thinking skills in geography. It was concluded that planning was an important part of their learning process. It was found that these learners planned their learning, created the 'big picture' and then continuously adapted their plans as they came across new information. Students who performed better, paid attention to minute details and made sure that they did not neglect any information which was important for the solution. These students continued to build on their knowledge, thus giving rise to the constructivist approach. The learners also profited from collaborating with their peers with powerful visual memories.

Designing a 'meta-learning' web-based interface, which incorporates the major components of meta-cognition, provides an opportunity to address the use of critical thinking skills as well as the comprehension of content and its application. Henceforth, the pedagogical design of 'meta-learning.pk' was made consistent with the use of meta-cognitive processes in teaching and learning of geography. Elements from all three major components of meta-cognitive thinking (i.e., planning, monitoring and evaluating) were integrated to provide a stimulating and wholesome learning experience for the students. In essence, meta-learning.pk can be considered as an interactive geography notebook, which facilitates students in creating coherent connections and relationships between discrete facts. In resemblance to traditional geography workbooks, *Meta-Learning* provides students the opportunity (a) to gather, and exhibit observations (b) to demonstrate their understanding of the content. However, the Meta-Learning experience combined with web-based technology differs from traditional geography workbooks in a variety of fundamental ways.

First, Meta-Learning has been designed with the purposeful intent of increasing focus on comprehension of facts and their application to real-life in such a way that a student can track his or her own learning progress. Therefore, it was developed to incorporate the planning, monitoring and

evaluation of learning. Figure 1 represents general system design architecture, and Figure 2 provides further elaboration of the flow of the content.

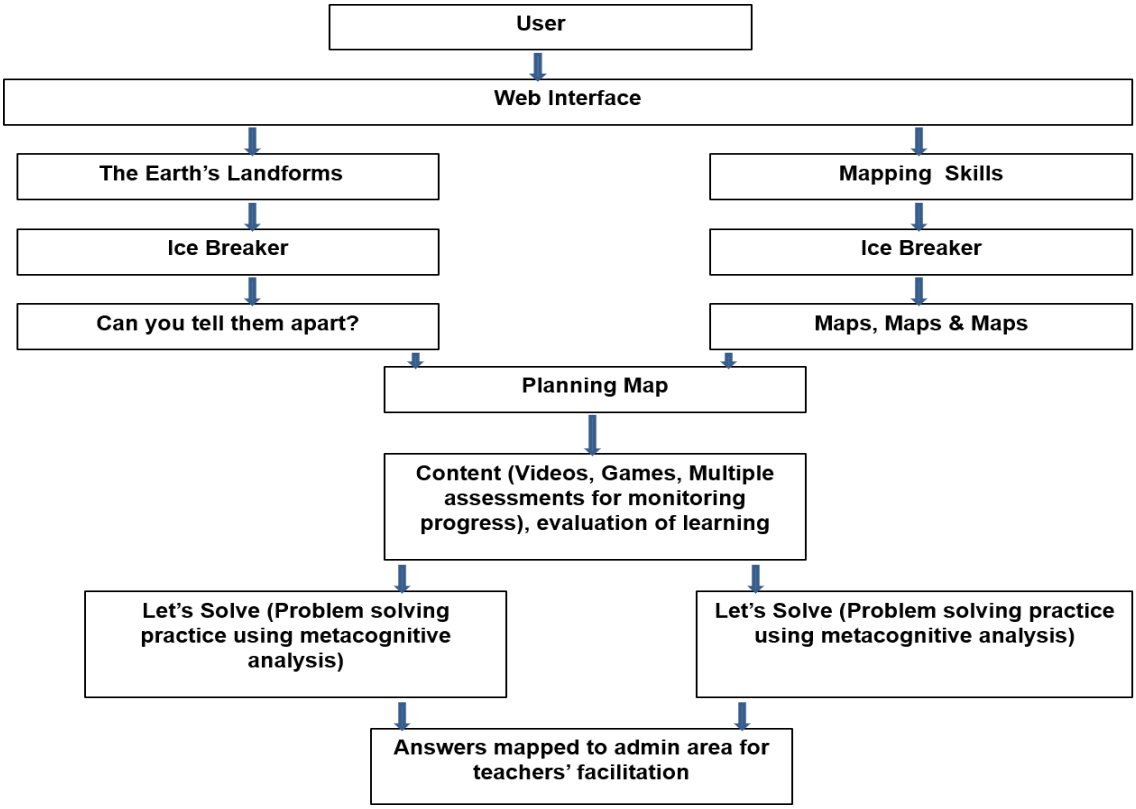

Figure 1. System Design Architecture

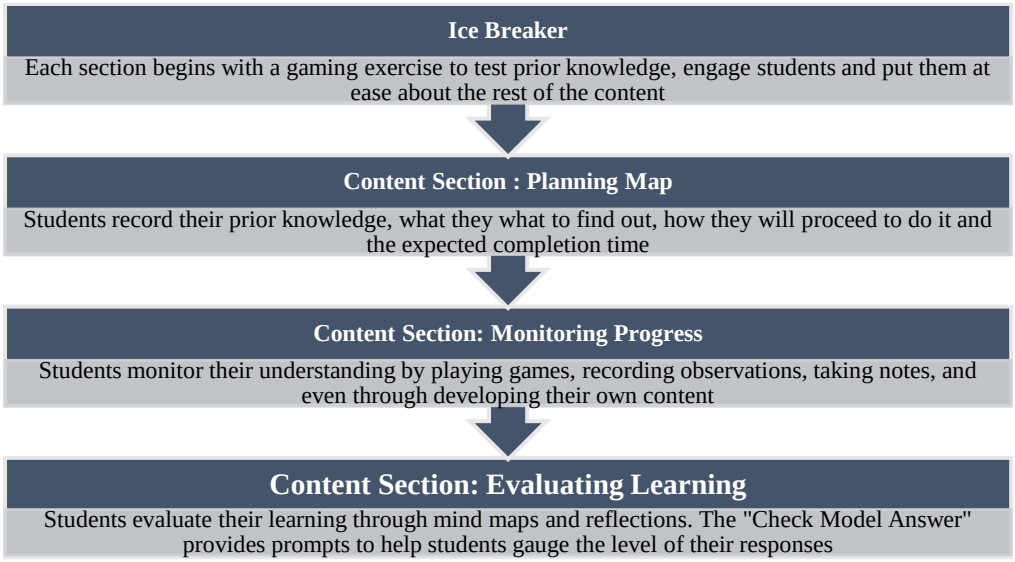

Figure 2. Content Flow

In meta-learning, planning, monitoring and evaluating one's own progress was facilitated through the use of a planning map, a local tracking map and a variety of note-taking, recording observations and mind-mapping activities. Additionally, the pedagogical aspect of the website allowed students to navigate through problem-solving steps in order to encourage them to apply their learning. Learners have a tendency to control the dimensions of learning. Consequently, they also select strategies which would apparently enhance learning (Kornell & Finn, 2016). The "Planning Map" feature facilitated the students with recording their prior knowledge, what they plan to find out, and their future course of action. Students are, therefore, prompted to plan their course of action before mindlessly proceeding. They were prompted to think about their learning progress by observing details about the topic, taking notes, producing mind-maps, play small games, watch related videos, and making connections between the discrete pieces of information. Students can use the "Check Model Answer" feature to ensure that their explanations feature all the necessary components for a coherent answer and evaluate their own learning through self-regulation. Furthermore, they are prompted to focus on the data provided in the text, make inferences and focus on appropriate geographical vocabulary to relate to problem-solving procedures. Moreover, students are encouraged to express their thinking through various formats such as typing out answers, uploading pictures and using mind-maps (Figure 3a & b). Teachers were provided with the facility of viewing the students' answers and developing an understanding regarding the student's concept of a particular topic (see Figure 4). It is incumbent to note here that some external resources such as Mind Map and Seterra were incorporated in the instructional design of Meta Learning. Mind Map was used as part of the evaluation feature and Seterra was used as an additional gaming resource.

3. RESEARCH METHODOLOGY

Design-based research methodology was employed for the progressive development of web enabled technologies. During this formative evaluation procedure, multiple cycles of design and implementation came about in order to make the end-product ready for implementation (Parker, 2011). The main purpose of the research was to verify whether the meta-learning approach and application of problem-solving strategies enhanced the usage of meta-cognitive skills by 7th grade students. Moreover, a mixed methods strategy was opted to explore the impact of the aforementioned pedagogy. Hence, the following research questions were explored: What is the effect on students' problem-solving skills and independent learning when meta-cognitive cues are provided for applying specific analytical strategies in a web-based learning environment?

The research areas explored to answer the general question were:

- RQ 1: Was there a difference in pre-test and post-test achievement in students after receiving meta-cognitive strategies embedded as cues in geography problem sets?

- RQ2. Was there any difference in students' attitudes, regarding problem-solving skills, for those who received meta-cognitive strategies as cues in geography problem sets before and after the intervention?
- RQ 3: Was there a difference in the perceptions of students regarding web-based learning as compared to the instruction they receive in the traditional classroom environment?
- RQ 4: What were the teachers' perceptions about meta-cognitive learning?

3.1 Designing a "Meta-Learning" Web-Based Interface

The data was collected from a private schooling setup in Karachi, Pakistan. The total number of student and teacher participants, selected through convenience sampling, was 68 and 15 respectively. It is a type of non-probability sampling wherein the sample is taken from the part of population or group of people that is easy to contact (Saunders et al., 2012). Hence, in this study it was adopted because the study depended upon permission from school authorities. Participants were distributed in two groups: a control group (34 participants) and a treatment group (34 participants), through simple random probability sampling. The total sample size was 68, which likely covers the minimum adequate sample size according to Nielson (2000).

3.2 Procedure

Prior to the actual research, a small base study survey was conducted in order to gauge students' attitudes and perceptions towards the teaching and learning of geography in a traditional classroom. It was revealed during the investigation that 69.4% of students indicated that they are interested in geography. Furthermore, web-based technology was indicated as the preferred learning resource by 35.71% of the students. Hence, it was used as a means to provide hands-on experience and build connections to real-life problems through application of meta-cognitive strategies.

Before implementation of Meta-Learning, usability testing of meta-learning.pk was carried out to determine any possible issues with the user interface design. Usability tests aid in identifying the discrepancy in use of the application in terms of navigation as well as in the understanding of content. A usability test is an essential part of the design process as "it has the potential to determine usability issues which may arise during the actual intervention or after the launch of a technical application" (Nielson, 1994). The participants selected for the usability test were representatives of real users (Dumas & Redish, 1999). It is important to note that testing with unrepresentative participants will be wastage of time and effort and it might also lead to the invalidation of results. Therefore, it is important to screen the participants carefully. According to Virzi (1992) a total of 4 to 5 participants are enough to reveal 80% of the usability problems. The research indicated that the most severe and critical issues were likely to be discovered by the first few participants. Moreover, for the usability test to prove fruitful, participants must be assigned with 'real tasks' (Dumas & Redish, 1999).

Nielson (2000) reinstated those five participants will discover 80% of the problems. However, according to Six and Macefield (2016) at least 10 participants should be employed for the purpose, as 5 participants might not tell the whole story. The first pilot was employed on 5 participants. For the second round, 15 participants were taken.

3.3 Pilot study

The pilot study was conducted twice. In the first study, a total of 5 participants from the age group 12- 14 were selected. The participants were selected in order to fit the same profile as those on whom the intervention was to be carried out. The study comprised of a brief introduction of the purpose of the website, followed by a small introduction of how the user interface is to be used. After this, each participant was provided the opportunity to explore and navigate through the website. The participants' feedback was taken through a usability survey. The System Usability Scale (SUS) was selected for this purpose. It was developed by John Brooke in 1986.The survey comprises 10 questions, which are analyzed on a Likert scale. The questions require the user to respond for a variety of aspects of system usability, ranging from ease of usage to requirement for extra help (Brooke, 1996). After the results of the usability testing were recorded, the total scores were converted to percentiles to obtain a better picture of the results. Unfortunately, the results of the first pilot were quite dismal. The total raw score was 50. After a discussion with pedagogy experts, the interface was re-designed and the pilot study was carried out again. However, this time a sample of 15 participants was taken (Six & Macefield, 2016). A total score of 73.8 was recorded and it was safely concluded that the web interface is good enough for the intervention. Table 1 shows the percentile ranks for this usability test.

Table 1. Usability Test Percentiles

	5	10	25	50	75	90	95
Weighted Average SUS Score	57.5	59	70	77.5	80	82.5	
Tukey's Hinges SUS Score			71.5	77.5	80		

Source: The Author

To answer RQ 1, we utilized the quasi-experimental non-equivalent design. A quasi-experiment is an experimental interventional study which is used to estimate the causal effect of an intervention on the target population without random assignment (White & Sabarwal, 2014). Students were divided into 'control' and 'experimental' groups. Each group had 34 participants.

To answer RQ2, an "Attitudes Test" known as "How do you Solve Problems?" was administered to the experimental group before and after the intervention. The test was based on a questionnaire

modeled by Hong et al. (2001). The instrument was adjusted to meet the goals of this study. The questionnaire examines the attitudes of the students towards planning, monitoring and evaluating their learning. Each of these areas has sub questions, which the students have to rate on a scale from 1-4. The test was conducted in order to examine any change in the way students approach problems before and after the intervention, as Meta-Learning systematically approaches these areas.

For RQ3, students in the experimental group were to fill out a survey which recorded their perceptions towards the web-based approach versus the traditional learning approach that they experience in class each day. Furthermore, their comments were also recorded to support the quantitative elements of the survey.

To answer RQ 4, semi-structured interviews were prepared to record teachers' perceptions about a non-traditional form of learning provided by the website. These interviews served to provide a qualitative angle to understand the quantitative results obtained considering contextual realities of the Pakistani school system.

3.4 Research instruments

3.4.1 Pre-test and post-test for the earth's landforms and mapping skills

The tests were developed using content from www.nationalgeographic.org. The questions that followed required students to apply problem-solving strategies through meta-cognitive engagement.

3.4.2 "How do you solve problems" survey

The inventory created for the research in question is modeled upon "How Do You Solve Problems" questionnaire by Hong et al. (2001). It should be noted, however, that the original inventory has been modified to meet the learning objectives for the students of geography at secondary level. The structure, however, retains generality and encompasses important factors related to meta-cognitive awareness.

3.4.3 Students' perceptions survey

The survey consisted of 12 questions in order to gauge the students' perceptions towards web-based learning versus the learning that they experience in a typical classroom. They were also required to record their comments.

3.4.4 Semi-structured interviews

An informal grouping of questions was done prior to the interviews to explore teachers' perceptions in these four groups: perceptions towards geography and meta-cognitive learning, effectiveness of the pedagogy utilized, best way to implement the software and the possible issues which can arise

during the implementation of this project. Teacher background characteristics were collected prior to the interview. This required recording years of teaching experience, years of teaching at the current grade level, years teaching geography, and the style of learning they feel is most effective.

4. ANALYSIS

4.1 Analysis of pre and post-test achievement in students

The research question for this analysis was as follows: RQ1. Was there a difference in pre-test and post-test achievement in students after receiving meta-cognitive strategies embedded as cues in geography problem sets?

H_0: There was no difference in pre-test and post-test achievement in students after receiving meta-cognitive strategies embedded as cues in geography problem sets.

4.1.1 First session – "The Earth's Landforms"

The first session was based on the topic 'The Earth's Landforms". The results from these tests were collected and examined to assess the level of conceptual understanding between the participants of the control and experiment groups. The participants of both groups were presented with the pre-test to test their level of problem-solving approach to questions. After the pre-test, the participants of the control group were handed over to their teacher for a traditional lesson. The experiment group was allowed to explore "The Earth's Landforms" on www.meta-learning.pk. After completion of the intervention, both groups were presented with the post-test for the concerned topic. The results of the first session are shown below. The graphs show the pre-test and post-test scores of control groups versus the experiment group in terms of mean, standard deviation and median.

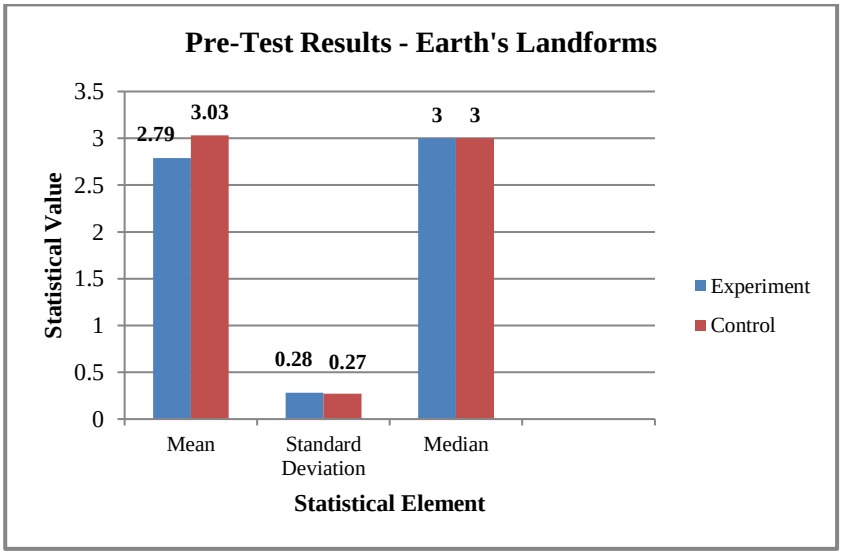

Figure 3. Pre-Test Results "The Earth's Landforms"

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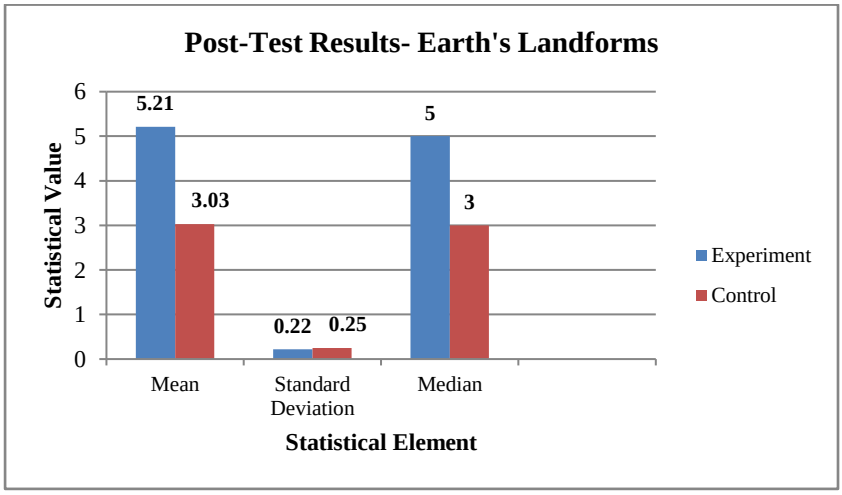

Figure 4. Post-Test Results "The Earth's Landforms"

Results indicate that the mean of pretest 1 scores was found to be slightly higher for the control group (M = 3.0294, SD = 1.585) as compared to the experimental group (M= 2.79, SD = 0.28). However, the median was the same for both groups (Mdn = 3.000). It can be observed that the mean scores in the post-test groups were found to be higher in the experiment group (M=5.2, SD=1.29) as compared to those of the control group (M=3.21, SD=1.29). The median for the control group was 3, whereas it was 5 for the experiment group. Next, appropriate statistical tests were to be selected in order to test the hypothesis. Parametric or non-parametric tests are usually used. Initial assumptions are made to test if the data distribution is normal or skewed. In order for parametric tests to be applicable, the data must be normally distributed. Normal distributions entail that the majority of scores lie around the center of the distribution. These are represented by a bell curve (Field, 2013). Table 2 depicts the results for normality tests for first session.

Table 2. Test of Normality – The Earth's Landforms

	Kolmogorov-Smirmov			Shapiro -Wilk		
Group	Statistic	df	Sig.	Statistic	df	Sig.
Pre-Test Control	0.184	34	0.005	0.944	34	0.080
Experiment	0.186	34	0.004	0.939	34	0.058
Post-Test Control	0.208	34	0.001	0.939	34	0.057
Experiment	0.210	34	0.001	0.937	34	0.052

Source: The Author

Considering the results of the pre- test and the post-test for both groups for the K-S and S-W, pre-test 1 scores show that the data is non-normal as $p<0.05$ or very close to it in one case. The same is

true for post-test scores. Hence, we reject the first assumption to conduct parametric tests. As a result, a non-parametric test had to be selected for data analysis. Non-parametric tests are called distribution-free tests as they do not require the data to follow a normal distribution. The Wilcoxon Rank-Sum test and the Mann-Whitney U test are the tests which are normally used. The Mann-Whitney U test looks for differences in groups in the ranked positions of the scores and it also allows us to compare the means of two independent groups (Field, 2013). In this case, the independent groups are the control and experiment groups. Table 3 shows the results of this test.

Table 3. Mann-Whitney Test Statistics -1

	Pre-Test	Post-Test
Mann-Whitney U	518.500	171.500
Wilcoxon W	1113.500	766.500
Z	-.746	-5.088
Asymp. Sig. (2-tailed)	.456	.000

Source: The Author

It can be concluded that the pre-test scores in the control group (Mdn = 3.000) did not differ from the pre-test scores of the experiment group (Mdn = 3.000) with U = 518, z = -0.746. However, the post-test scores of the treatment group differed significantly from those of the control group, U = 171.500, p = 0.000<0.05. Hence, the null hypothesis was rejected.

4.1.2 Second session - 'Mapping Skills"

The second session was based on the topic 'Mapping Skills". The data collection procedure was similar to the one used in the first session. The graphs show the pre-test and post-test scores of control groups versus the experiment group in terms of mean, standard deviation and median.

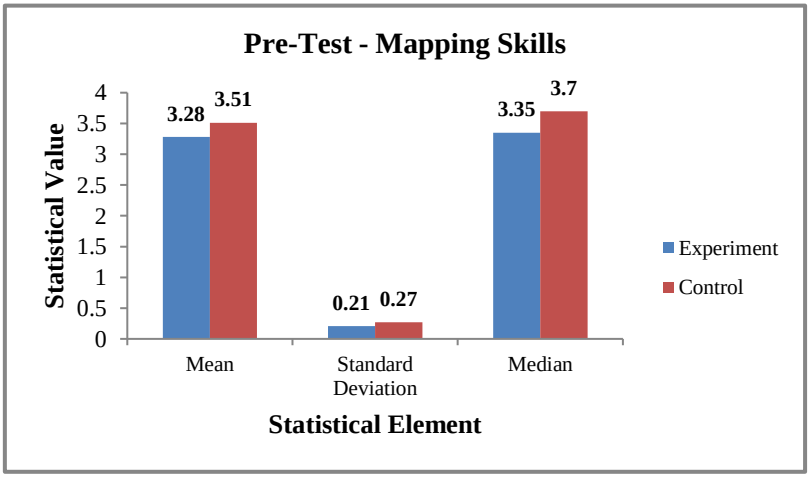

Figure 5. Pre-Test Results "Mapping Skills"

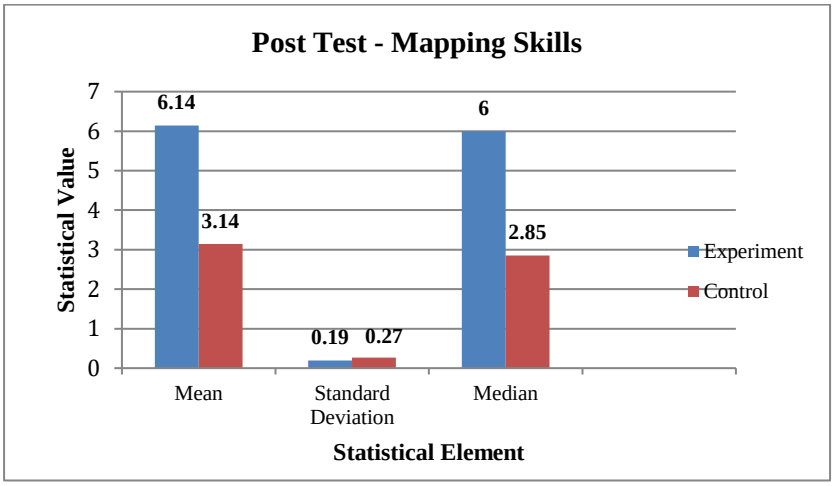

Figure 6. Post-Test Results "Mapping Skills"

The statistical results reveal that the mean of pretest 2 scores was found to be higher in the control group (M = 3.5, SD = 1.56) as compared to the treatment group (M = 3.28, SD = 1.24). The median was also shown greater in the control group (Mdn = 3.7) as compared to the treatment group (Mdn = 3.35). After observing the statistical results, it was concluded that the mean scores for the experiment group were higher (M = 6.14, SD = 1.135) as compared to the control group (M = 3.14, SD = 1.59). In fact, the median of the experiment group (Mdn = 6) was also higher than the median for the control group (Mdn = 2.85). Following the statistical descriptive analysis, as done for the first set of tests, normality tests were applied on the data to evaluate which statistical test would be appropriate. Table 4 shows the results of the tests.

Table 4. Tests of Normality-Mapping Skills

	Kolmogorov-Smirmov			**Shapiro -Wilk**		
Group	Statistic	df	Sig.	Statistic	df	Sig.
Pre-Test Control	0.112	34	0.200	0.959	34	0.225
Experiment	0.162	34	0.024	0.931	34	0.032
Post-Test Control	0.159	34	0.030	0.907	34	0.007
Experiment	0.167	34	0.018	0.920	34	0.016

The outcome of the normality tests for the pre-test 2, for control group, shows that the data is normally distributed ($p>0.05$). However, for experiment groups the data has a non-normal distribution ($p<0.05$). For the post-test, the data for both groups follow a non-normal distribution. Hence, non-parametric test was selected for data evaluation. Following this, the Mann-Whitney U test was carried out. The results are depicted in Table 5.

Table 5. Mann Whitney Test Statistics for Test 2

	Pre-Test	Post-Test
Mann-Whitney U	516.500	91.000
Wilcoxon W	1111.000	686.000
Z	-.768	-5.988
Asymp. Sig. (2-tailed)	.442	.000

The pre-test 2 scores in the control group (Mdn = 3.7) did not differ significantly from the pre-test 2 scores of the experiment group (Mdn = 3.35) with U = 516.000, z = -0.768. On the other hand, the post-test 2 scores of the experiment group fluctuated significantly from the post-test 2 scores of the control group with U = 91.000, p = 0.000. Hence, the null hypothesis was rejected for the second session as well.

4.2 "How do you solve problems" survey

The research question for this analysis was as follows: RQ1. Was there any difference in students' attitudes, regarding problem-solving skills, for those who received meta-cognitive strategies as cues in geography problem sets before and after the intervention?

H_0: There was no difference in students' attitudes, regarding problem-solving skills, for those who received meta-cognitive strategies as cues in geography problem sets before and after the intervention.

The "How Do You Solve Problems" survey was administered to the participants of the treatment group before and after the intervention, in order to determine if there has been a change in attitudes of the students towards employing problem-solving and meta-cognitive strategies. For each survey item, the participant was supposed to select between 4 choices on a Likert scale. The Likert scale ranks included "1" for **Rarely**, "2" for **Sometimes**, "3" for **Frequently** and "4" for **Almost Always**. The median was used as the tool of comparison for all three sections. A comparison was done for each question of each section and finally an overall comparison of median for each section was done. Figures 9,10 and 11 show the comparison of medians for each question and Figure 12 shows the overall comparison of medians for the planning section.

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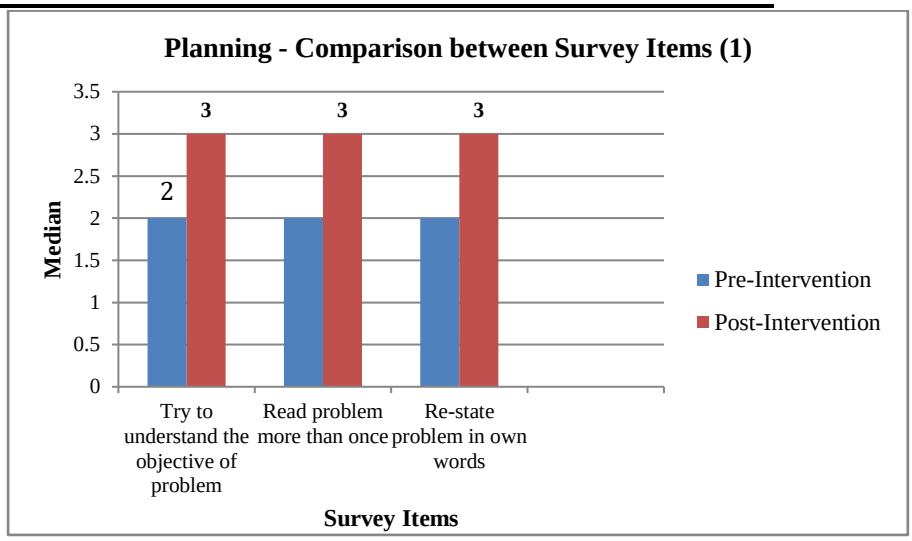

Figure 7. Planning – Comparison between Survey Items (1)

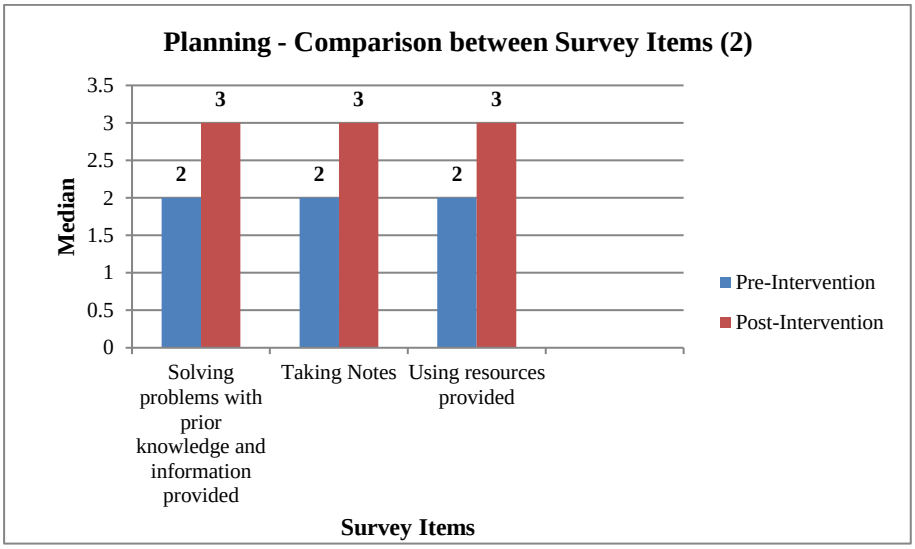

Figure 8. Planning – Comparison between Survey Items (2)

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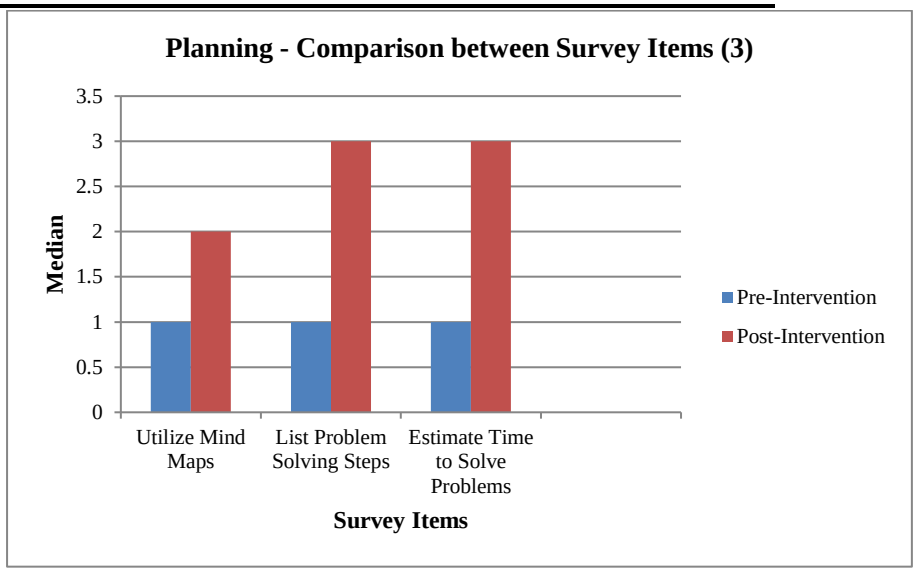

Figure 9. Planning – Comparison between Survey Items (3)

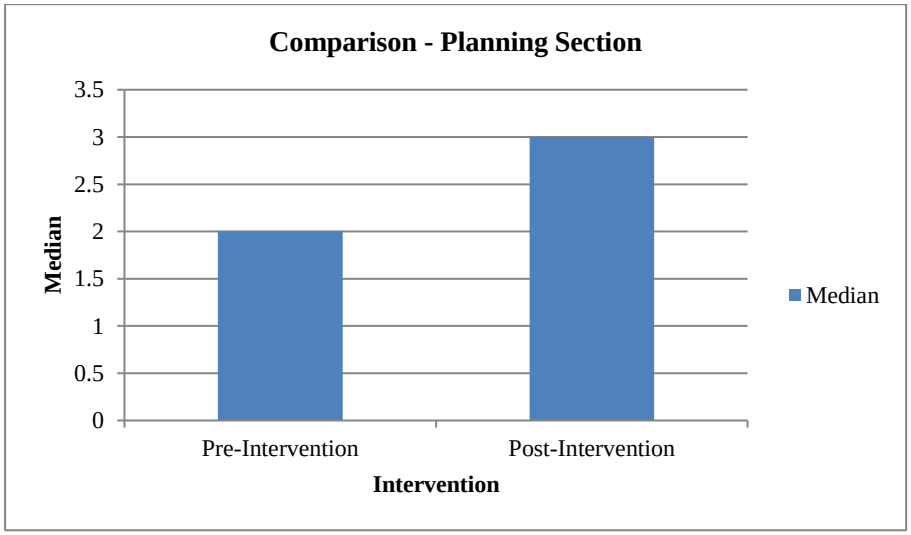

Figure 10. Planning - Overall Comparison

It is quite clear from the graphs that the median changed from 2 to 3 for the overall sections. Hence, there was an overall change in students' attitudes towards planning their own learning after the intervention. Figures 13 and 14 show the comparison of medians for each question and Figure 15 shows the overall comparison of medians for the monitoring section.

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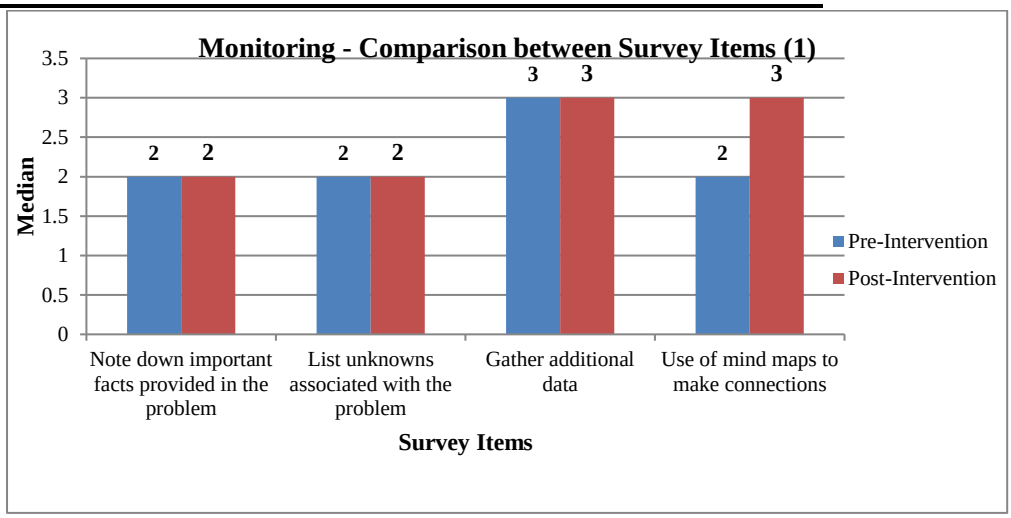

Figure 11. Monitoring – Comparison between Survey Items (1)

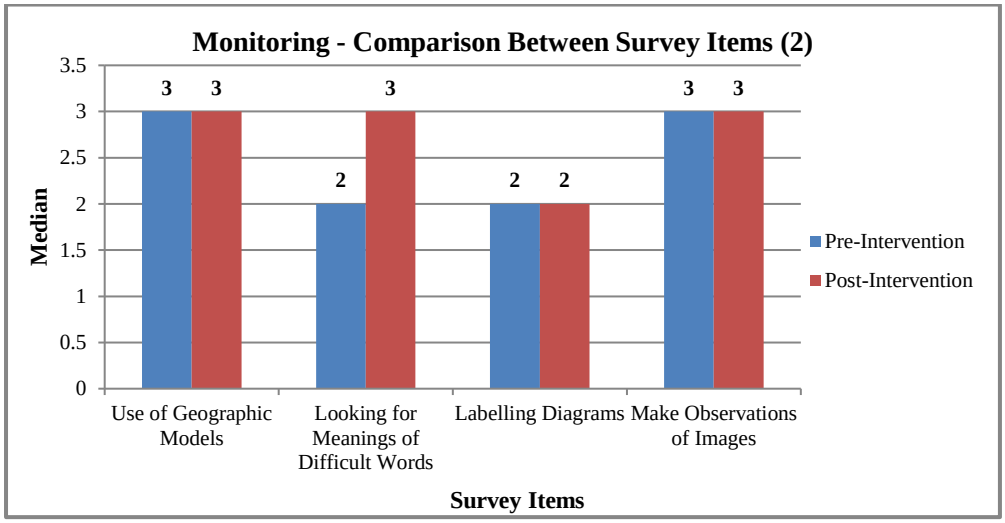

Figure 12. Monitoring – Comparison between Survey Items (2)

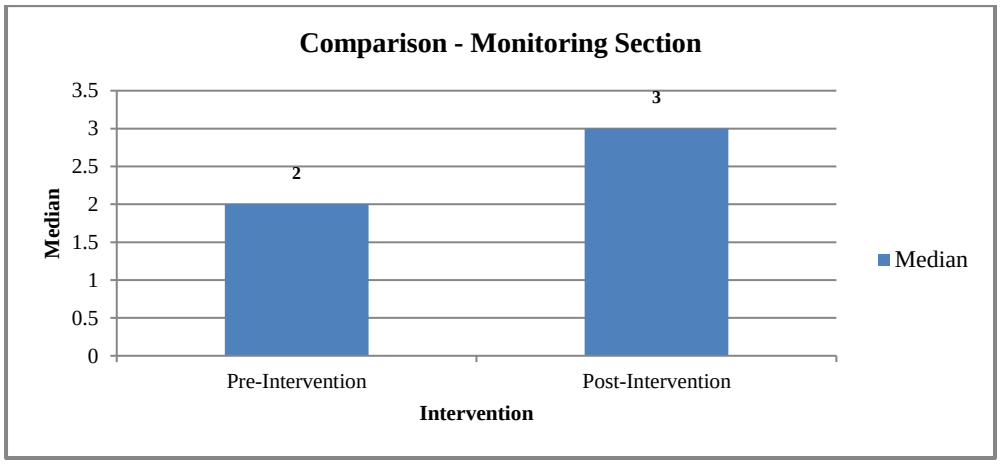

Figure 13. Monitoring – Overall Comparison

It is quite clear from the graphs that the median changed from 2 to 3 for the overall section. Hence, there was an overall change in students' attitudes towards monitoring their own learning after the intervention. Figure 16 shows the comparison of medians for each question and Figure 17 shows the overall comparison of medians for the evaluation section.

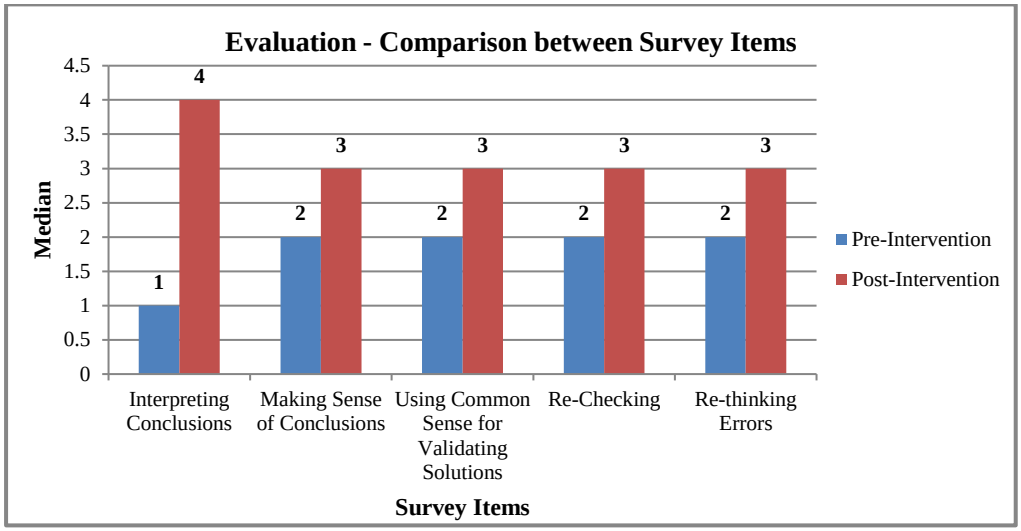

Figure 14. Evaluating – Comparison between Survey Items

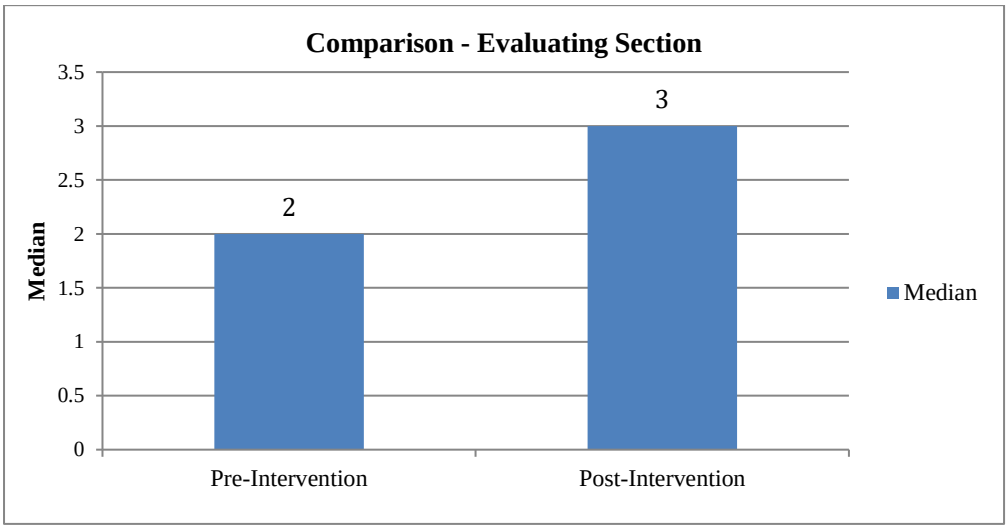

Figure 15. Evaluating – Overall Comparison

As the overall median has changed in all three sections after the intervention, therefore the null hypothesis can be rejected.

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4.3 Students' perceptions towards web-based learning

The research question for this section was: RQ3. Was there a difference in the perceptions of students regarding web-based learning as compared to the instruction they receive in the traditional classroom environment?

$H_{0:}$ There is no difference in perceptions of students regarding web-based learning as compared to the instruction they receive in the traditional schooling system.

The students of the experiment group filled out a Student Perception form which was based on a Likert scale. The form was examined for validity by senior educationists. The graphs shown below depict the results of the perceptions.

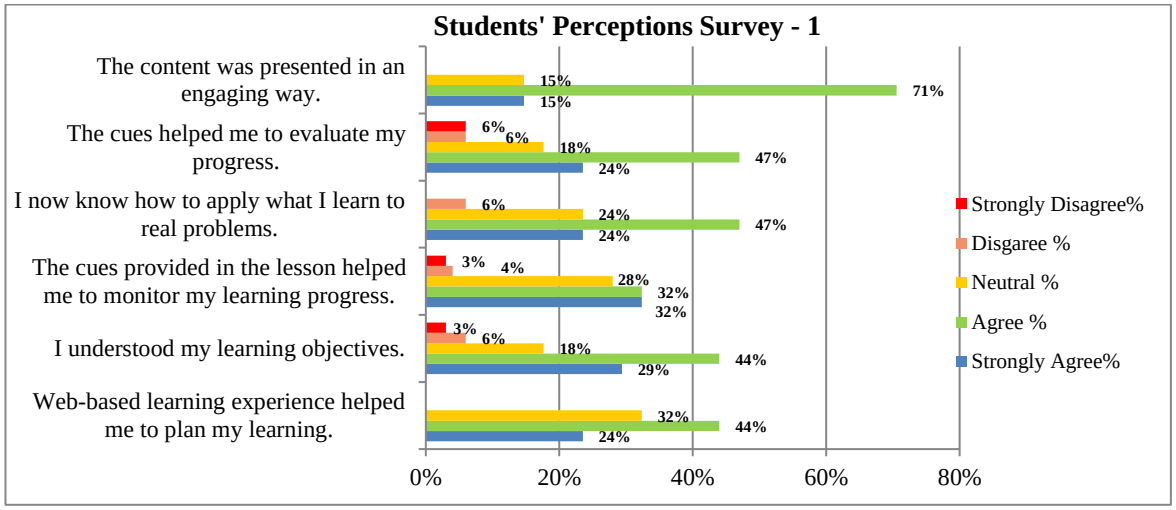

Figure 16. Results of the Students' Perceptions Survey

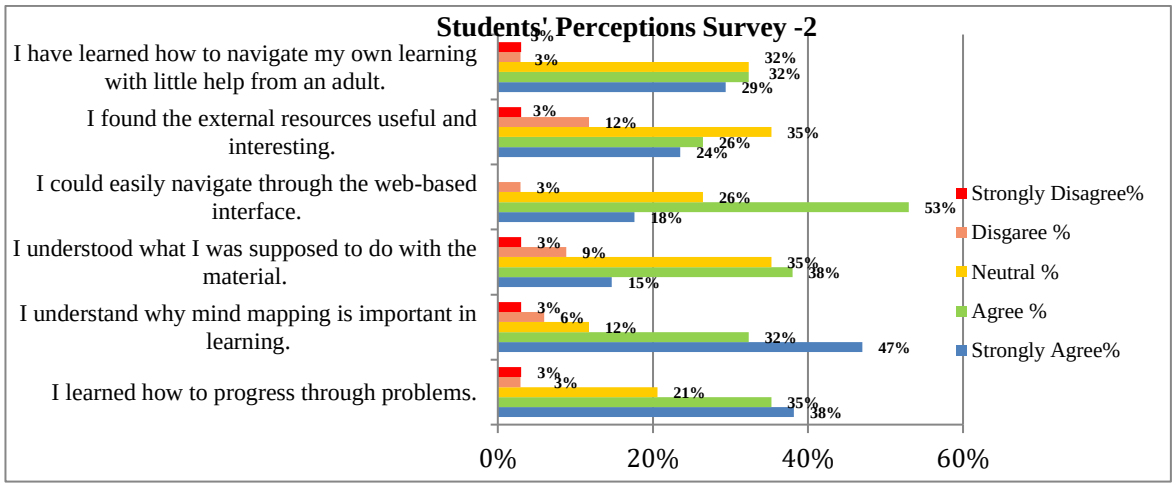

Figure 17. Results of the Students' Perceptions Survey

The results of the survey show that the majority of the students agree that the content of the website was engaging (71%). 53% of the students agreed that they could navigate the website easily with little help and 26% of the students remained indecisive. However, we also see that 18% of the students strongly agreed to this point. For the remaining points as well, the student response remained largely positive, depicting those students were generally satisfied with various aspects of the web-based, meta-cognitive learning experience. On the basis of the results, it can be concluded that students demonstrated more interest in web-based learning as it helped them to focus more on how to learn.

4.4 Thematic analysis of the teachers' perceptions

In order to gain further insights into the quantitative measures discussed above, semi-structured interviews were conducted to gain insights into various aspects of the software – such as effectiveness of the pedagogy employed, perceptions about the subject of geography, employing mea-cognitive thinking to solve problems and the kind of issues schools and students might face when adopting a new pedagogy. The qualitative study analysis helped in understanding phenomenon in its social settings i.e., in this case deeper insights were acquired regarding the teaching – learning phenomenon in schools when a new form of learning has been introduced. There was a total of 15 participants. The process of thematic analysis involved reading and re-reading the data multiple times, looking for common patterns and coding them throughout the process. These codes, analyzed using MS Excel, were combined into clusters to create meaningful concepts resulting in a theme (Braun & Clarke, 2006). The educationists interviewed for the purpose had 2 – 18 years of work experience in the field of education. The teachers were first given a demo of the website www.meta-learning.pk. Then, they were allowed to explore the software on their own. It was done to explore answers to RQ4: What were the teachers' perceptions about meta-cognitive learning? A word cloud was generated from the responses and common themes were extracted from the analysis.

Figure 18. Word Cloud

4.5 Common themes

4.5.1 Perceptions about geography and metacognition

The general opinion held by the educationists who were interviewed was that geography is basically perceived as a dry subject. Furthermore, the traditional teaching methods employed make it uninteresting for students.

The teachers were questioned about employing meta-cognitive strategies / reflective strategies in learning – particularly in geography as this was the subject chosen for this study. They unanimously believed that reflecting upon one's progress is important. However, as students are not really taught to employ these strategies at an early age, they struggle with these at later stages or end up not using them at all. Formative assessment tools were suggested to be used by teachers in order to help the students to develop awareness for their learning.

4.5.2 Effectiveness of web-based pedagogy

The general opinion held by the educationists was that a web-based learning experience – such as the one provided by www.meta-learning.pk – would be beneficial. According to them, the pedagogy offered by the website is inclusive and allows students to monitor their own progress. They felt that as the students are "gadget-smart", it will not take more than a month for them to adapt to the system. However, there was a difference in opinion amongst them regarding how this system should be implemented. Some felt that a few classes should be allocated for traditional learning and few for technology integrated learning, whereas some felt that notebooks should be removed altogether, and inquiry-based websites should be introduced as a whole for the subjects like Geography, History and Science.

4.5.3 Possible issues

Educationists agreed that since the teacher is the catalyst in the classroom, any kind of pedagogy – no matter how up to date it is – would fail if proper assistance is not provided to her. Technical assistance and guidance are essential to make pedagogical effort successful. Another possible issue highlighted was that students may not be interested in trying out something new. Hence, students would have to be phased into the new style of teaching.

4.5.4 Implementation of software

The participants were questioned regarding how the system can be introduced in schools. Some believed that the traditional method should be phased out completely but gradually. Others believed that a combination of traditional classroom teaching should be employed, with less emphasis on traditional methods and more on software-based learning.

5. RESULTS AND DISCUSSION

Previous literature on the effectiveness of practicing metacognitive learning demonstrates the challenges associated with working with Pakistani students to get them engaged in learning. However, the results of this investigation indicate that Meta-Learning was successful in promoting improved learning outcomes in the application of problem-solving skills in geography, as compared to the traditional rote' memorization techniques taught in a traditional classroom. It was successful in helping students to tap into their brain power and encourage students to work through problems in an organized manner. These findings are remarkable given that students used Meta-Learning for a period of only one week. Meta-Learning was designed in a manner to overcome passive learning, which is the norm in traditional Pakistani classrooms. It has a strong focus on reducing irrelevant construct barriers by providing interactive online contextual support to help them work through topics in an organized manner and evaluating themselves throughout. It is also incumbent to mention here, that the stress on interface design was to focus on providing contextual support in a manner which supported meta-cognitive thinking and learning. Hence, in light of these results, we can reject the null hypothesis for the overall research question and conclude that there is a significant effect on students' problem-solving capability and independent learning when meta-cognitive cues are provided for applying specific analytical strategies in a web-based learning environment.

6. CONCLUSION

The basic goal of this study was to explore the impact of using metacognitive prompts in a web-based environment on students' problem-solving capability and independent learning. Analyses of all the data revealed that a significant difference was found in the conceptual understanding and problem-solving skills of the students who participated in the intervention. Furthermore, the students benefited from the variety of resources and the embedded cues at appropriate instances. Additionally, the results of the qualitative study substantiated the quantitative results and provided a context to them. To conclude, the study demonstrated that metacognitive pedagogy and selection of resources which stimulate student interest in a variety of ways (such as the web-based interface) can help improve students' meta-cognitive processes and application of problem-solving skills.

The first phase of the study involved the design and development of the web-based application. The curriculum content used in the application has the same objectives as those of a traditional classroom and had been derived from the National Curriculum of Pakistan. The second phase of the study involved collecting and analyzing data in order to compare the results of the two groups as well as to study if the attitudes of the participants of the experimental group changed after experiencing metacognitive pedagogy. The results of the study indicate that the web-based interface improved student learning outcomes as well as students' approach towards problem-solving. It is quite clear

that metacognitive pedagogy is more beneficial for the students as compared to traditional classroom learning strategies.

Additional detailed studies may be conducted to draw more connections and explore more creative methods of improving problem-solving skills through the use of meta-cognitive strategies. Introducing creative and interactive learning methods in the classroom can greatly improve students' attitudes towards learning and help them to adapt to changes. The critical purpose is to prepare students to apply the knowledge they gain, apply it to actual situations and to facilitate their inquisitive nature.

Statements on open data, ethics policy and conflicts of interest

The identity of the participants was shielded by ensuring that their personal information was hidden during the research process. Their consent was ensured beforehand, and they were made aware that they could withdraw from the process at any time. There is no potential conflict of interest in this study; the data and the questionnaires can be obtained by sending request emails to the corresponding author.

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