Computer Based Self-Pacing Instructional Design Approach in Learning with Respect to Gender as a Variable

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Abstract Interactive individualized learning technologies and applications are probably one of the most significant innovations in the age of information revolution. However, Gender-based differences have not been considered as major variable in teaching-learning. Motivated by the gender differences this article reports the findings of the study that analyzed students' gender differences in learning using interactive computer based instructional technology compared with traditional lecture based method of learning of Secondary students. The sample consisted of 120 students from different schools of West-Bengal (Eastern part of India). Each student completed a GIS (general information schedule), computer proficiency test, a prior knowledge test and post-test on geography. The finding of MANOVA result shows significant gender differences in different learning methods. This study also investigated gender differences in various learning objectives (factual, conceptual, and rules and principles knowledge). The MANOVA result shows significant difference in identification test which measured factual knowledge where female student performed better than male. In comprehension test which measured rules and principal, male student performed better than females. However, no significant difference were found in male and female student and they performed equally well in terminology test which measured the conceptual knowledge.

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1 Introduction

Teaching learning process has changed tremendously due to the modern scientific revolution. The main aim of modern scientific teaching learning process in education is all round development of the student without discriminating cast, race, religion and gender. However gender difference is one of the major factors affecting achievement. Thus, Researchers have perceived the need to recognize gender difference in learning and find out the impartial method to minimize the gender gap providing gender-equitable education for student learning. Much research has focused on gender differences in various areas of learning objective [1]. Gender differentiation has been found in different aspects of teaching-learning. For example, differences in behavior and information processing [2], learning environment [3], student teacher interaction in classroom [4], Performance of different learning objective [5], and presentation of learning material [6]. Although, each and every individual have the right to perform differently, but when this differentiation and gap effect our national socio cultural development, then there may be the need to minimize/diminish the gap [7]. Researchers suggested that in order to avoid imbalance in social development it may be required to minimize the gender differences in academic achievement [8].

In order to minimize the gender differentiation it is important to explore and understand the underlying causes for the occurrence of this gender gap in student learning [7]. Progressively researchers have been exploring different factors as causes for gender differentiation. Nevertheless, in this area different additional issues have yet to be unveiled. To explore this gulf is the pivotal factor in this article.

Previous researchers have found that intra class environment viz: biased behavior of the teacher, sitting arrangement amidst the classroom may all act as factors for gender differentiation [7]. But what would happen if we provide the computer based collaborative learning environment to minimize the key gender differentiation factor in conventional teaching approach as suggested by the previous researchers. This is one of the base line in this article (Sects. 8 and 9).

Different researcher emphasized the need of "gender appropriate software" which will increase the likelihood that both the gender develops equal feelings and might reduce the gender gap [9]. In this paper an attempt has been made to design a gender appropriate learning module software by controlling the effect of various cognitive and extraneous factors e.g. color, tropology, manipulation etc. (Sects. 6, 8 and 9). This attempt is relatively new in this area more specifically in developing countries like India where the present research has been conducted.

Previous research has revealed gender differentiation in their research outcomes and affirmed that both male and female student performed differently in achieving their learning objective. Surprisingly, till now it is unrevealed specifically in which knowledge domain gender difference occur such as factual, conceptual and rules and principal knowledge of student.

2 Factors Effecting Gender Differentiation: Research Overview

Significant gender differences were found in the way both the gender retrieve information through their sensory system from the environments [6]. Sax [6] in his research found that male student likely preferred cool color such as silver, black, blue, and grey etc. while girls prefers texture and warmer colors like red, yellow, and orange [10]. Researchers pointed out that boys are mostly interested in moving object while females tend to draw detail visuals. These may have significant implication in the way instructions should be imparted through visualization in a computer based instruction (CAI) which has the flexibility to provide instructions with this specificity in a more personalize and flexible way so that both the genders will be equally interested and engaged in learning and achievement.

Brain size and autonomy difference present significant differences across gender. Research found that man possess on average more than six times grey matter related to general intelligence, while women possess nearly ten times more white matter related to specific intelligence than males [11]. It is also found that differences in the brain areas correlate with IQ between the sexes found that girls perform better than boys in the area of verbal and written ability due to the left side of brain which develops earlier among the girls than boys [11]. Moreover, the development of brain is influenced by the environmental factors [12]. Traditional teacher dominating class rooms encourage development of lower quality memory structures for males than for females which may lead to more differences in performance related to gender [7]. Researchers indicate that traditional class room environment and learning method influence brain based gender differences [8]. Hence one of the urgent needs of the hour for the teacher, educator/instructional designer would be to provide the learning material to the students in such a way in order to use both the hemispheres so that to minimize the gender differences.

3 Teaching Learning Environment and Presentation of Learning Material

Various strategies of Teaching-learning, classroom environment and presentation of learning material may also lead to gender differentiation. Different research established the fact that teacher student relationship, presentation of learning material, teacher biased behavior between male and female student, and teaching resource material may cause gender differentiation [13]. Some of the researcher also came with findings that gender difference may cause due to teachers' authoritarian behavior and negative attention [14]. Researchers found a significant relationship between gender and the ways in which male and female accessed and utilized information [15, 16].

Interactive visualization is the recent innovation in instructional process and quite new in the developing countries. It has different characteristic like manipulation, control, simulation which helps the student to match content material in a real life settings. Researchers establish greater advantages over traditional method of teaching-learning showing improvement in attention and self-pacing which increase student interaction with the use of interactive visualization [7].

4 Objective of the Study

(a) To investigate the effect of gender on learning of various educational objectives (factual, conceptual, and rules and principles knowledge) through traditional method of learning.
(b) To investigate the effect of gender on learning of various educational objectives (factual, conceptual, and rules and principles knowledge) through instructional visualization.

5 Research Tools

5.1 General Information Schedule

General Information Schedule comprised of student's demographic information.

5.2 Computer Proficiency Test

Computer proficiency test was prepared for initial screening of students to assess students' computer proficiency on three dimensions namely; basic knowledge about computer, usability of computer and use of computer. Cronbach's alpha reliability of the test was 0.65.

5.3 Computer Based Interactive Instructional Module

The instructional module was developed on the topic—Solar System consisting of different sub units namely (i) the solar system, (ii) the sun, (iii) eight planets, (iv) the moon and (v) the earth.

5.4 Prior Knowledge Test

The Prior Knowledge test was developed by the researchers consisting of 10 multiple-choice questions on the subject Geography, on the topic Solar System. The Cronbach's alpha reliability of the test was 0.65.

5.5 Criterion Measures Test

The three criterion tests used in this study was developed by the researchers to measure different learning objectives (namely factual knowledge, conceptual knowledge and knowledge of rules and principal). The Cronbach alpha result indicated high reliability for all the three criterion tests (0.65 for Identification test, 0.69 for Terminology test and 0.77 for Comprehension test). In all the three criterion tests, the test reliabilities were all above 0.60, which is a satisfactory level of reliability.

6 Development and Designing of an Interactive Instructional Material

Previous research has emphasized to develop a "Gender Appropriate Software" following the gender specific characteristics.

For the present research a computer based interactive instructional material was developed by the researcher following all guidelines scientifically as proposed by the previous researchers.

- Previous research has established the fact that preference of color in instructional material varied for male and female student. This module combined different color in every frame as research suggested that females preferred reds, yellow, and oranges and males preferred silver, black, blue, and gray [6].
- A special attention has been taken in consideration specifying attributes of instructional material. The module has been kept to some extent action based and picture based as by nature male most likely preferred games and competition type target oriented materials and girls are more likely to prefer picture based animation [11].
- Another important factor taken into consideration while developing this module is the "Mode of presentation". Previous research findings has established the fact that males benefitted from a dual mode presentation of text (text with redundant speech), whereas females benefit from a single mode presentation (text only). This instructional module has an option button. Students can select only text or text with narration as per their preference [17].

Fig. 1 Nature of Sample
(N = 120)
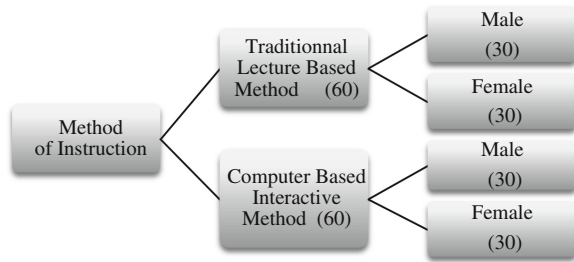
- This instructional module has also taken into consideration the scientific way in presentation of features like typography, graphical images presentation, manipulation process into consideration.

7 Sample

The data was collected from 120 students through purposive sampling selected from various schools in and around Kolkata (Eastern part of India). All of these students were matched by computer proficiency test and prior knowledge test (Fig. 1).

8 Results Analyses and Interpretation

A variance of analysis was conducted on the solar system prior knowledge test scores to determine if there was a significant difference among the treatment groups (traditional and interactive).

The result indicated no significant differences among the treatment groups on the prior knowledge test score F (6/119) = 1.58, $\rho = 0.17$. Result indicated that the participants were approximately equal in their prior knowledge on the content material used in the study and therefore any results of treatment effects would not be attributed to the difference in participants' prior knowledge.

After the prior knowledge test, the gender differences were noted in the two type of treatment materials. Multivariate analysis of variance (MANOVA) was conducted to analyze the effect of gender in performance through instructional visualization and traditional instruction method on students' learning of educational objectives (factual, conceptual, and knowledge of rules and principles).

Before conducting MANOVA for Traditional method of Instruction and gender effect, three statistical procedures was checked namely; (a) Correlation between dependent variables, (b) Normality of dependent variables, and (c) Homogeneity of variance among dependent variables [18].

Findings of the correlation among the three criterion tests on traditional method of instruction and interactive visualization instruction were significant at the 0.01 and 0.05 level of significance. Descriptive statistics tested the normality of dependent variables which found the Skewness being 0.06 (<1) with kurtosis of 0.69 (<10) in the identification test; skewness 0.29 (<1) with kurtosis of 0.62 (<10) in the terminology test; skewness is 0.17 (<1) with kurtosis of 0.74 (<10) in the comprehension test. And in interactive instruction skewness being 0.39 (<1) with kurtosis of 0.30 (<10) in the identification test; skewness 0.21 (<1) with kurtosis of 0.17 (<10) in the terminology test; skewness is 0.30 (<1) with kurtosis of 0.28 (<10) in the comprehension test. Finally the homogeneity of variance among criterion tests (i.e. three criterion tests) was tested by Levene's test of equality of error variances. The results found that significant values in each test are higher than $p > 0.05$.

After conducting MANOVA assumption check the following statistical analyses were conducted (1) one-way MANCOVA; (2) follow-up tests of the between-subjects effects. The multivariate effect for traditional method of instruction was significant.

The overall MANCOVA Pillai's Trace F value and Wilks' Λ value (see Table 1) was statistically significant at the 0.05 alpha level ($\rho < 0.5$), in traditional method of instruction so we conclude that male and female student performed differently in criterion test but in the interactive instruction method no significant difference were noted, so from this result we conclude that male and female student performed equally on three criterion test. In the traditional method significance difference were noted [19] subsequently exploratory analysis was conducted to further examine the differences. Subsequent univariate tests or exploratory follow-up analysis using MANCOVA for traditional method of instruction (Table 2) indicated that in traditional lecture based instruction significant gender differences have been found on three Criterion tests (Identification test F (1/119) = 12.05, $\rho = 0.00 < 0.05$, with $\eta p^2 = 0.17$, Terminology test F (1/119) = 9.78, $\rho = 0.00 < 0.05$, $\eta p^2 = 0.014$, Comprehension test F (1/119) = 4.71, $\rho = 0.03 < 0.05$, $\eta p^2 = 0.07$).

Table 1 MANCOVA results using Pallai's Trace F

Method	DV	Df	F	Sig.	ηp^2
Traditional	0.51	4	14.47	0.00	0.51
Interactive	0.70	4	1.03	0.39	0.07

Table 2 Tests of between-subjects effects in traditional method of instruction (N = 120)

Method	DV	Df	F	Sig.	ηp^2
Traditional	Identification	1	12.05	0.00	0.17
	Terminology	1	9.78	0.00	0.14
	Comprehension	1	4.71	0.03	0.07

Table 3 Follow-up univariate pairwise comparison results by methods of learning on the identification, terminology and comprehension test in traditional method of instruction (N = 120)

Dependent variable	Mean (Gender)	Mean differ. (I − J)	Std. eror	Sig.	95 % confidence interval	
					Lower	Upper
Identification	Female = 7.53 (M)	−1.13	0.32	0.00	1.78	−0.48
	Male = 6.40 (M)	1.13	0.32	0.00	0.48	1.78
Terminology	Female = 7.46 (F)	1.00	0.32	0.00	0.36	1.64
	Male = 6.46 (M)	−1.00	0.32	0.00	1.64	−0.36
Comprehension	Female = 7.60 (F)	0.80	0.36	0.03	0.06	−1.53
	Male = 6.80 (M)	−0.80	0.36	0.03	1.53	0.06

Pairwise comparisons results (Table 3) showed the differences among students who received traditional method of instruction. The mean difference was significant at the 0.05 alpha level. It is found that in traditional method of instruction male student performed better than female with mean of male (7.53) > female (6.40) in identification test which measure factual knowledge. In terminology test female student performed better than male with male (6.46) < female (7.46) which measure conceptual knowledge and in comprehension test which measured rules and principal knowledge also female student performed better than male.

9 Discussion

From the findings, it can be concluded that in traditional method of learning environment male and female student performed significantly different in three criterion tests. Hence momentous gender difference may be found due to sitting arrangement in a class room or teacher different behaviour towards students teaching techniques or the nature of the environment of the given class as established by earlier researcher in previous study [13]. It has been found from various previous researches that not only sitting arrangement influence teacher attention but also active participation of the students within the class and the class activities, consequently may influence gender differentiation in class room environment [7]. This finding has been substantiated by previous research that found that female recipient are more attentive than males as well as there were differences noted in responses and non-verbal cues in traditional classroom [14]. On the contrary male student were less accurate in interpreting nonverbal cues in classroom from their concerned teacher which may precisely effect gender equity.

Findings clearly depicts that male and female student both equally performed in interactive instructional environment as no significant differences were found in the three criterion tests. This result is similar to previous studies which found that interactive and cooperative learning environment reduces gender differences [20]. Different screen design principles may also have affected the results as different scientific principles were taken into consideration to develop interactive instructional material. Previous research proposes that appropriate designing software would be helpful in insuring a positive computer experience for females there by reducing the gender gap [9, 21]. Researchers established the fact that "girls like colors" and "boys like action" thus the present instructional module was designed with different color principles having the preference of male and female both so that to catch on their attention and motivation [21, 22]. In this instructional module not only different color coding was done keeping the female specific characteristics but also simulation, manipulation, drag and drop characteristic followed as preferred by males student as also strongly supported by previous research [23]. However the results were also contradictory with few previous findings [24] which might have happened as they used instructional material in traditional classroom environment and more research is needed to explore these facts.

10 Conclusion

The outcome of this research empirically establish the fact that properly designed interactive visualization help to minimizing gender gap simultaneously explaining the reasons for gender differentiation. The result of the research has focused on sitting arrangement and scientific presentation of learning material that can effect in reducing the problem of gender differentiation.

11 Further Applicability of the Findings

- Teacher may use this study result for implementing new strategies viz classroom arrangement, presentation of learning material in various ways following the basic principles. Apart from this they can also use graphical image, typography and color principles as pointed out in the paper while presenting any material.
- Teacher trainer can use the findings effectively for training new teachers. From this research instructional designer will get an overall picture on how to design a learning material, which principal should be followed for minimizing gender gap.
- Most importantly different national and International bodies can use these results for decision making in education and for diminishing the gender gap.

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