3.0 Introduction:

The present study aimed at exploring the learning styles and process of development of professional skills among learners of professional courses (i.e. B.Ed. & MBA) of Open universities (i.e. IGNOU & UPRTOU). This chapter deals with the methods and procedures adopted to conduct the study. The chapter covers the research design consisting of population and sample, sampling technique, development of tools, procedure of data collection and plan of data analysis.

Research design is an overall plan for obtaining answer to the research question or for testing the research hypothesis (Polit and Hungler, 1995). It spells out the basic strategies that the researcher adopt to develop information, which is accurate and interpretable. The purpose of research design is to answer research questions in a valid manner and to control source of variance (Brink and Wood, 1989). Research design includes a plan, structure and strategy for conducting research (Wood, 1994).

“A descriptive study is concerned with conditions and relationship that exist, opinions that are held, processes that are going on, effects that are evident or trends that are developing. It is primarily concerned with the present, although it considers past events and influences as they may relate to the current conditions. In fact the events that are observed and described would have happened ever though there had been no observation or analysis” (Best and Kahn, 2001).

The following includes design of the study:

- The population and sample;
- Tools and techniques;
- Data collection procedures and
- Data analysis procedures employed in the study.

The present study has been designed to explore the different learning styles & their association with students perception and variety of process related to teacher education programme (B.Ed.) and management programme (MBA) of Open Universities students, therefore a Survey research method was chosen to obtain realistic and useful answer to the research questions.
3.1 Population and Sample:

3.1.1 Population:

A population is the entire aggregation of the cases that meet designated criteria (Polit and Hungler, 1995) for the study. Population means all elements (individuals, objects and events) that meet the sample criteria for inclusion in a study (Crookes and Davies, 1998). The population may be all the individuals of the particular type, or a more restricted part of that group (Best & Kahn, 2001). A population is any group of individuals that has one or more characteristics in common and that are of interest to the researcher (Best & Kahn, 2012).

The population of the present study includes all the Open Universities offering B.Ed. and MBA programme through distance education mode. Population of the study consisted of all the second year B.Ed. trainees and MBA students enrolled in different programme study centres of IGNOU and UPRTOU in Uttar Pradesh.

3.1.2 Sample:

A sample is a small proportion of the population that is selected for observation and analysis. By observing the characteristics of the sample, one can make certain inferences about the characteristics of the population from which it is drawn (Best & Kahn, 2012). The samples quits of the study are stated in the following table:

<table>
<thead>
<tr>
<th>University</th>
<th>IGNOU</th>
<th>UPRTOU</th>
<th>Total</th>
<th>Net Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courses</td>
<td>B.Ed.</td>
<td>MBA</td>
<td>B.Ed.</td>
<td>MBA</td>
</tr>
<tr>
<td>Trainees/Students</td>
<td>200 (100 male and 100 female)</td>
<td>60 (30 male and 30 female)</td>
<td>200 (100 male and 100 female)</td>
<td>60 (30 male and 30 female)</td>
</tr>
</tbody>
</table>

Since it is not possible to study the whole population due to the lack of time and resources crunch a sample has to be selected that represent the whole population. The sample of the study covered 200 final year B.Ed. trainees of IGNOU and 200 final year B.Ed. trainees of UPRTOU. 60 MBA final year students were selected from IGNOU and 60 MBA students from UPRTOU. The discrepancy in sample of B.Ed. and MBA courses existed because of Population size of these courses in UP.
Three B.Ed. programme study centres of IGNOU viz. Ewing Christian College, Allahabad, Lucknow University, Lucknow and R.B.D. College, Bijnor, of UP state were selected for data collection purpose. Seventy trainees (35 male and 35 female) from Ewing Christian College, Allahabad, Seventy trainees (35 male and 35 female) from Lucknow University, Lucknow study centre and sixty trainees (30 male and 30 female) from R.B.D. College, Bijnor were chosen as sample subjects according to their availability. Similarly, five B.Ed. programme study centres of UPRTOU viz. Hindu College, Moradabad; T.D. College, Jaunpur; Degree College, Upardaha, Allahabad; Ch. Tulsi Ram Yadava College, Tulsi, Allahabad; and Shyamlal Saraswati College, Shikarpur, Bulandshah of UP state were selected for data collection purpose. Forty trainees (20 male and 20 female) from each study centre were randomly selected as sample subjects.

Table 3.2: MBA study centers of UPRTOU

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Name of the Study Center</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>UPRTOU Main Campus, Allahabad</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>ISDC Allahabad</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Chayal Computers Academy, Allahabad</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>Handia P.G.College, Handia, Allahabad</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>T.D. College, Jaunpur</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Institute of Computer Sciences &amp; Management, Varanasi</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>D D U University Gorakhpur</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>QRAT-A Computer Group, Lucknow</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>Kalicharan Degree College Lucknow</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>SECRED Heart Institute of Management &amp; Technology Sitapur</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>11.</td>
<td>Christ Church College, Kanpur</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>12.</td>
<td>Faiz-E-Aam Modern Degree College, Mathura</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>13.</td>
<td>Government P G College, Noida</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

60 MBA final year students were selected from 3 regional centers of IGNOU viz. Varanasi (10 male and 10 female), Lucknow (10 male and 10 female) and Noida (10 male and 10 female) and 60 MBA final year students were selected from 13 study centers of UPRTOU.
3.2 An Overview of Research Design of the Study:

Table 3.3:
Overview of Research Design

<table>
<thead>
<tr>
<th>Objective</th>
<th>Sample</th>
<th>Tool</th>
<th>Procedure of Data Collection</th>
<th>Analysis of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To study the learning styles of learners of professional courses offered by Open Universities in the context of nature of courses and universities.</td>
<td>B.Ed. Trainee=400 MBA student=120</td>
<td>GRSLSS</td>
<td>Administration of GRSLSS</td>
<td>$\chi^2$-test and % Analysis</td>
</tr>
<tr>
<td>2. To study the processes of development of professional skills among learners of professional courses offered by open universities: course wise and university wise.</td>
<td>B.Ed. Trainee=400 MBA student=120</td>
<td>Questionnaires</td>
<td>Administration of Questionnaire</td>
<td>$\chi^2$-test and % Analysis</td>
</tr>
<tr>
<td>3. To study the association between the perceptions of students towards ODL based instructional processes of professional programmes and their learning styles in the context of universities.</td>
<td>B.Ed. Trainee=400 MBA student=120</td>
<td>Perception scale</td>
<td>Administration of Perception scale</td>
<td>$\chi^2$-test and % Analysis</td>
</tr>
</tbody>
</table>

3.3 Tools of the study:

Tool is a formal document used to collect and record information, such as questionnaire, interview schedule, scale etc. In present study, in order to collect data the researcher used following tools:

I. Adapted GRSLS Scales.
II. Questionnaires for B.Ed. trainees.
III. Questionnaires for MBA students.
IV. Perception scale.
3.3.1 GRSLSS Scales:

Grasha-Reichmann Student Learning Style Scale was developed by Grasha-Reichmann (1996) and it is applicable for high school and college level students. In the present study adapted GRSLSS was used for measuring the learning styles of B.Ed. and MBA students.

There are two ways of using any pre-existing tool/instrument in any study. The first is to take the instrument nearly verbatim (i.e. using exactly the same words as were originally used), which is called adopting the instrument. And if any instrument is used after significantly altering the instrument, then it is called adaptation of instrument. Test adaptation (from Latin adaptatio - adjustment) is a complex of procedures, which ensure the adequacy of the test in the new conditions of its application. When any instrument is adopted, then the reliability and validity of research studies that have been conducted by using that instrument/tool can be applied to new study, so there is no need to collect validity evidence. In the case of adaptation of tool the reliability and validity of the tool is to be established in the concerned population. Adaptation of any tool is just similar to developing any new research tool. During adaptation of any tool researcher can adds new items, removes old items and can substantially change the content of each item. In the present study following steps were followed for adapting the GRSLSS Scale:

**Step-I: Statements language modification:**

In this step language of learning style statements were reviewed according to Indian context. All learning style statements were reviewed. After reviewing each statement, all the statements were used as it was in the GRSLSS. The instrument utilized the same five point (5=Strongly Agree, 4= Agree, 3= Undecided, 2= Disagree, 1= Strongly Disagree) Likert scales as it was in the original learning style scale.

**Step-II: Evaluation of the adapted version by Experts:**

In the second step, researcher submitted the scales to different experts for their valuable suggestions/experts. According to the suggestions of experts scale was again modified.
Step-III: Evaluation of the adapted version by Target Population:

In the third step, researcher submitted the scales to the respondents. This stage of the process aims to verify whether the statements/items, the response scale and the instructions are comprehensible for the target population. Thus, this procedure aims to investigate whether the instructions are clear, whether the terms found in the items are appropriate, whether the expressions correspond to those used by the group, and other aspects. According to the suggestions of respondents the scale was again modified.

Step-IV: Pilot Study:

The pilot study refers to a previous application of the research tool in a small sample that reflects the sample/target population characteristics. In the present study the pilot study was conducted to finalize the adapted learning style tool. In the Pilot Study adapted GRSLSS was administered on 100 B.Ed. students of IGNOU. By pilot study the appropriateness of items regarding their meaning and difficulty, in addition to instructions for conducting the test is once again assessed. After pilot study the scale was again modified considering the modifications suggested in the pilot study.

Step-V: Reliability of Adapted GRSLSS:

The reliability is a characteristic of the test methods, which reflects its measurement accuracy and its resistance to random factors. Reliability is the degree of consistency that the instrument or procedure demonstrates: whatever it is measuring, it does so consistently. For calculating reliability of adapted GRSLSS, Test-Retest method (Stability method) as well as was Split-Halves Reliability method (Internal Consistency method) were used. Cronbach’s alpha was also calculated to measure the reliability (i.e., internal consistency).

A. Test-Retest method (Stability method):

The adapted GRSLSS was administered twice to the same group of 100 B.Ed. second year teacher trainees. The scale was administered twice and the correlation between the first set of scores and second set of scores is determined. The scale was administered on the first day of workshop conducted on study centre and again it was administered on the last day of workshop (List of score details is enclosed in appendices).
Product-Moment Correlation Coefficient (r):

\[ r = \frac{N \sum XY - \sum X \sum Y}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}} \]

\[ r = \frac{528446500 - 520602016}{\sqrt{[100 \times 5203647 - 22627 \times 22627][100 \times 5369992 - 23008 \times 23008]}} \]

\[ r = \frac{7844484}{\sqrt{[520364700 - 511981129][536999200 - 529368064]}} \]

\[ r = \frac{7998510}{7844484} \]

\[ r = 0.98 \]

It is noticed that the reliability of adapted GRSLSS (Reliability Coefficient) is 0.98. Thus the adapted GRSLSS scale is quite reliable with high stability index (0.98).

B. Split-Halves Reliability method (Internal Consistency method):

The adapted GRSLSS was administered on 100 B.Ed. second year teacher trainees. For dividing scale into two parts \textbf{First half-Second half Split Halves Method} was selected. The selected 60 items were split into two separate sets. The first set was made by selecting first half items (i.e. from 1 to 30) and second set was made by selecting second half items (i.e. from 31 to 60). The scores of these two sets were counted and recorded (List of score details is enclosed in appendices).

Product-Moment Correlation Coefficient (r):

\[ r = \frac{N \sum XY - \sum X \sum Y}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}} \]

\[ r = \frac{135437100 - 133494700}{\sqrt{[100 \times 1358054 - 11570 \times 11570][100 \times 1351196 - 11538 \times 11538]}} \]

\[ r = \frac{1942400}{\sqrt{[135805400 - 133864900][135119600 - 133125400]}} \]

\[ r = \frac{1967167}{1942400} \]

\[ r_h = 0.987 \text{ (Reliability of half scale).} \]
Spearman-Brown prophecy Formula:

\[
\text{Reliability of full scale}(r_w) = \frac{2r_h}{1 + r_h}
\]

Where,
- \(r_w\) is the correlation for the whole test.
- \(r_h\) is the correlation between the two halves of the test.

Thus,

\[
r_w = \frac{2 \times 0.99}{1 + 0.99} = \frac{1.98}{1.99}
\]

Reliability of full adapted GRSLS (Reliability Coefficient) = 0.99.

The calculated value of correlation of whole test ‘\(r_w\)’ was found 0.99. It indicated that the adapted GRSLS scale have high reliability or high internal consistency. Mean score of both first half and second half group were also compared. Mean of those scores was found 115.70 and 115.38 respectively. This indicates the scores on the scale were highly stable over a time.

Cronbach’s alpha Reliability:

Cronbach’s alpha is the most commonly used measure of reliability (i.e., internal consistency). It was originally derived by Kuder & Richardson (1937) for dichotomously scored data (0 or 1) and later generalized by Cronbach (1951) to account for any scoring method. People know that a high alpha is good, but it is important to have a deeper knowledge to use it properly. Cronbach’s alpha Reliability of adapted GRSLS was high (0.88).

Step-VI: Content Validity of adapted GRSLS:

The term validity refers to truthfulness of the instrument. According to Cronbach “Validity is the extent to which a test measures what it purports to measure”. Adapted GRSLS scale has face and expert validity. The validation procedure of the tools was done systematically. In order to finalize the tools researcher follows the following steps-

a) **First step:** Scale was first shown to few Research scholars from education field.
b) **Second step:** Scale was circulated among experts through either E-mail / Post or personally (list of experts is enclosed in appendices).

The suggestions given by the experts were incorporated in the adapted GRSLS scale. The opinion of experts was taken for examining the cross validity and concurrent validity of the scale. Thus it could be concluded that the adapted GRSLS scale has **face** and **expert validity**.

### 3.3.2 Procedure of construction of Tools:

Except GRSLS Scales, other tools were self constructed by the researcher. Self constructed tools are:

- a) Questionnaires for B.Ed. students.
- b) Questionnaires for MBA students.
- c) Perception scale.

The major steps in developing the tools were:

I. Identifying the content areas related to various process of development of professional skills in the B.Ed. and MBA programme.

II. Enumerating the various aspects of the content.

III. Construction of the items and statements.

IV. Establishing content validity.

V. Preparation of the tools.

### 3.3.2.1. Content Analysis:

Content analysis for tools developments was done according to the following phases:

I. Field experience.

II. Consultation of literature.

III. Organization of specific focus group discussion.

IV. Consultation with expert.

The focus group resulted in the identification of major aspects of developmental process.
3.3.3 Description of Questionnaires:

Questionnaires were developed separately for both courses trainees/students.

3.3.3.1 Questionnaire for B.Ed. students:

The questionnaire was developed in order to know the following 11 major aspects of process of development professional skills in B.Ed. programme through open universities.

a) Micro-Teaching.
b) Practice-Teaching.
c) Classroom-Communication.
d) Classroom-Motivation.
e) Evaluation and Assignment Work.
f) School Planning and Management.
g) Library as a Resource Centre
h) Organisation of Co-curricular Activities.
i) Use of Information Communication Technology (ICT).
j) Face to Face Mode Counselling.
k) Use of Supporting Broadcast/Telecast Programmes.

The questionnaire has 100 items related with eleven aspects. The first aspect i.e. Micro-Teaching has 12 items, second aspect i.e. Practice-Teaching has 09 items, third aspect i.e. classroom communication has 06 items, fourth aspect i.e. classroom motivation has 06 items, fifth aspect i.e. evaluation & assignment work has 20 items, sixth aspect i.e. school planning and management has 10 items, seventh aspect i.e. library as a resource centre has 11 items, eighth aspect i.e. Organisation of Co-curricular Activities has 08 items, ninth aspect i.e. Use of Information Communication Technology (ICT) has 08 items, tenth aspect i.e. Face-to-Face Mode Counselling has 06 items, and eleventh aspect i.e. Use of Supporting Broadcast /Telecast Programmes has 04 items.
3.3.3.2 Questionnaire for MBA students:

The questionnaire was developed in order to know the following 10 major aspects of process of development professional skills in MBA programme through open universities.

a) Project-work.
b) Personality Development Programmes.
c) Seminars.
d) Portfolio Preparation.
e) Group-Discussion (G.D.).
f) Use of Information Communication Technology (ICT)
g) Face-to-Face Mode Counselling.
h) Use of Supporting Broadcast/Telecast programmes.
i) Assignment-work.
j) Use of Library facility.

The questionnaire has 77 items related with ten aspects. The first aspect i.e. Project-work has 18 items, second aspect i.e. Personality Development Programme has 06 items, third aspect i.e. Seminars has 05 items, fourth aspect i.e. Portfolio Preparation has 08 items, fifth aspect i.e. Group-Discussion (G.D.) has 07 items, sixth aspect i.e Use of Information Communication Technology (ICT) has 08 items, seventh aspect i.e. Face-to-Face Mode Counselling has 06 items, eight aspect i.e. Use of Supporting broadcast/telecast programmes has 04 items, ninth aspect i.e. Assignment-work has 10 items and tenth aspect i.e. Use of Library facility has 05 items.

3.3.4 Perception Scale:

The perception scale was developed in order to know the perceptions of learners towards ODL based instructional modes of professional programmes. Perceptions of learners towards following instructional modes / aspects of process of B.Ed. and MBA programme through Open Universities were analysed:

A) Information System,
B) Uses of SLMs (Self Learning Materials),
C) Counselling System,
D) e-Learning / m-Learning,
E) Broadcast / Telecast Programmes.
F) Project Works,
G) Workshop Practices,
H) Practicals & Field Work and
I) Assignment & Evaluation.

3.3.4.1 Construction of Perception Scale:

In the present study Likert method (method of summated ratings) was used. Following steps were followed for constructing the perception scale:

I. **Formulation of Perception statement:** For constructing perception scale investigator prepared 90 statements. Nine (09) dimensions of process of development professional skills were selected for formulating the perception statement. Ten (10) statements were formulated from each dimension viz. Information System, Uses of SLMs (Self Learning Materials), Counselling System, e-Learning/m-Learning, Broadcast/Telecast Programmes, Project Works, Workshop Practices, Practicals & Field Work and Assignment & Evaluation. (Detail of dimensionwise prepared statements/items is enclosed in appendices).

II. **Pilot study:** Pilot study was conducted to finalize the perception scale. Perception Scale was administered on 200 ODL mode B.Ed. second year teacher trainees of. By pilot study the appropriateness of perception items regarding their meaning and difficulty, in addition to instructions for conducting the test was assessed. After pilot study the perception scale was modified considering the modifications suggested in the pilot study.

III. **Experts Suggestion:** After the modification of the scale, researcher submitted the scales to different experts for their valuable suggestions/experts. According to the suggestions of experts scale was again modified (List of experts is enclosed in the appendices).

Since dimension-E (i.e. Telecast/broadcast Programmes) have only 03 selected statement, so dimension – D & E is merged as a new dimension i.e.: e-media & Technology. (Detail of dimensionwise selected statements/items is enclosed in appendices).
3.4 Scoring Procedure:

Scoring procedure of different tools is given below viz. separately:

3.4.1 Scoring Procedure of GRLSS:

Scoring of GRLSS was done according to Scoring key of tool. Process of scoring of GRLSS are as follows:

Manual Scoring Key of Grasha-Reichmann Student Learning Styles Scales

I. Copy responses from the sheet of paper with your ratings on it to the space provided below for each item:

<table>
<thead>
<tr>
<th>Learning Style Test Items:</th>
</tr>
</thead>
<tbody>
<tr>
<td>01................ 02........ 03......... 04......... 05......... 06.........</td>
</tr>
<tr>
<td>07........ 08......... 09......... 10......... 11......... 12.........</td>
</tr>
<tr>
<td>13......... 14......... 15......... 16......... 17......... 18.........</td>
</tr>
<tr>
<td>19......... 20......... 21......... 22......... 23......... 24.........</td>
</tr>
<tr>
<td>25......... 26......... 27......... 28......... 29......... 30.........</td>
</tr>
<tr>
<td>31......... 32......... 33......... 34......... 35......... 36.........</td>
</tr>
<tr>
<td>37......... 38......... 39......... 40......... 41......... 42.........</td>
</tr>
<tr>
<td>43......... 44......... 45......... 46......... 47......... 48.........</td>
</tr>
<tr>
<td>49......... 50......... 51......... 52......... 53......... 54.........</td>
</tr>
<tr>
<td>55......... 56......... 57......... 58......... 59......... 60.........</td>
</tr>
</tbody>
</table>

II. Sum the ratings for each column and place them in the space below:

_________   _________   _________   _________   _________

III. Divide the Total score for each column by 10 and place your answer in the spaces below:

_________   _________   _________   _________   _________

Independent   Avoidant   Collaborative   Dependent   Competitive   Participant

IV. The names for each learning style associated with each column are shown above.
V. Check whether your score represents a relatively Low, Moderate or High score based on the norms for each learning style scale shown below:

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent</td>
<td>[1.0-2.7]</td>
<td>[2.8-3.8]</td>
<td>[3.9-5.0]</td>
</tr>
<tr>
<td>Avoidant</td>
<td>[1.0-1.8]</td>
<td>[1.9-3.1]</td>
<td>[3.2-5.0]</td>
</tr>
<tr>
<td>Collaborative</td>
<td>[1.0-2.7]</td>
<td>[2.8-3.4]</td>
<td>[3.5-5.0]</td>
</tr>
<tr>
<td>Dependent</td>
<td>[1.0-2.9]</td>
<td>[3.0-4.0]</td>
<td>[4.1-5.0]</td>
</tr>
<tr>
<td>Competitive</td>
<td>[1.0-1.7]</td>
<td>[1.8-2.8]</td>
<td>[2.9-5.0]</td>
</tr>
<tr>
<td>Participant</td>
<td>[1.0-3.0]</td>
<td>[3.1-4.1]</td>
<td>[4.2-5.0]</td>
</tr>
</tbody>
</table>

3.4.2 Scoring Procedure of Questionnaires for students:

Different aspects of questionnaires were based on content analysis. Scoring of questionnaires was based on chi-square and percentage analysis.

3.4.3 Scoring Procedure of Perception scale:

Scoring of different perception items was done by using Tally marks. Chi-square and percentage analysis is used for analyzing the perception of respondents.

3.5 Procedure of Data Collection:

GRSLSS, Questionnaires and Perception scale were used for collecting the data from B.Ed. and M.B.A. students of IGNOU and UPRTOU.

3.6 Analysis Procedures:

The chi-square ($x^2$) test as well as percentage analysis have been used for analyzing the quantitative data. The chi-square test of independence has been used to test the null hypotheses of no significant association between Learning styles and students perception towards process of development of Professional Skills in the context of different background variables viz. course, institutions, gender and subject area.
The equation for Chi-square is stated as follows:

\[ x^2 = \sum \left( \frac{(f_o - f_e)^2}{f_e} \right) \]

Where,

- \( f_o \) = observed frequency/experimentally determined frequency.
- \( f_e \) = expected frequency of occurrence on hypothesis.

And,

Degree of Freedom (df) = (r-1)(c-1)

Where,

- ‘r’ is the number of rows and ‘c’ is the number of columns.

**Calculation of Chi-square in 2×2 Contingency Tables:**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>A+B</th>
<th>C+D</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A+B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C+D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The value of Chi-square can be calculated by using following formula:

\[ x^2 = \frac{N(AD - BC)^2}{(A + B)(C + D)(A + C)(B + D)} \]

**Yates correction:**

Yates correction has been incorporated in the case of smaller tally of 5 or less than 5 in a cell.