PROBLEMS FACED BY STUDENTS IN EXISTING FURNITURE AND DESIGNING A PROTOTYPE OF CHAIR AND ADJUSTABLE TABLE FOR SELECTED PRACTICAL ROOM OF DEPARTMENT OF FAMILY AND COMMUNITY RESOURCE MANAGEMENT

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The Degree of Masters in Family and Community Sciences

(Interior Design)

By

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Ethical Compliance Certificate 2022-2023

This is to certify that **Ms. Shruti Chaudhari's** study titled, **Problems faced by students in existing furniture and designing a prototype of Chair and Adjustable Table for selected practical room of Department of Family and Community Resource Management** has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number **IECHR/FCSc/M.Sc./2022/09.**

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CERTIFICATE

This is to certify that the thesis entitled **"PROBLEMS FACED BY STUDENTS IN EXISTING FURNITURE AND DESIGNING A PROTOTYPE OF CHAIR AND ADJUSTABLE TABLE FOR SELECTED PRACTICAL ROOM OF DEPARTMENT OF FAMILY AND COMMUNITY RESOURCE MANAGEMENT"** submitted for partial of the requirement for the Degree of Masters in the Faculty of Family and Community Sciences (Family and Community Resource Management) to The Maharaja Sayajirao University of Baroda, carried out by Ms. Shruti Chaudhari, is her original bonafide work.

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INTRODUCTION

CHAPTER - I

INTRODUCTION

The human spends a large fraction of their life inside the interior building spaces formulated by the aid of the elements, structures and walls. These spaces create an environment wherein many daily activities occur. Furniture as one of the most important of these elements results in the shaping of the interior spaces. The comfort, well-being and performance of people can be increased by designing furniture according to the needs of the human body. (Tunay and Melemez, 2008). The criteria that are commonly important in achieving a successful match for the product include functional efficiency, ease of use, comfort, health and safety and quality of working life. The aim was to accomplish the best possible match between product and the user for whom the product is designed [1].

Rates of growth follow certain patterns, but physical development from birth to adulthood does not show same proportional growth of all parts of the body. So, one has body parts of different proportions and it does not follow the same proportion always (Chakrabarti, 1997). Due to the progress of civilization and innovations in life styles, man consciously and unconsciously adapts himself to new ways, while using the same body and physical capabilities. The basic structure and shape of the human body are identical among humans over the world, but sizes differ. Being aware of the basic structural mechanisms and various in-built facilities and limitations in shape, size and range of movements that the human structure provides (without going into specialized anatomical details of medical importance), these can be applied in various design concepts. It is necessary that these innovations should be compatible with the human body.

1.1. FURNITURE

Nowadays furniture is become part of the lifestyle around the world. For many people furniture means more than just as furniture. More special the furniture, means more expensive and exclusive [2]. Furniture is the first piece of attraction, where everyone wants to sit comfortably and feel relaxed. Choosing the right furniture for office, school or home not only

decorates but it also has an overall impact on our physical and mental comfort [3]. In-office employees need to feel stimulated while working and in-home, everyone needs a peaceful place to relax and in school, students sit comfortably to concentrate on their studies [4].

Furniture has changed a lot throughout the years until becoming what we know today. Knowing its path is important to design furniture suitable for our society nowadays and understand the needs that can emerge in the future [5]. Furniture design in the last years has been closely related to the advent of technology. Knowledge and easy access to information enabled pieces to become more practical and useful.

1.2. CLASSROOM FURNITURE

The classroom is a formal learning environment that helps students learn about different aspects of the world. A conducive and comfortable classroom environment motivates the students to perform better and encourage the learning process (Kekre, 2015). Furniture used in university classroom is one of the factors that affect the learning of students. Inappropriate furniture continues to be an issue and the use of appropriate furniture is critical to healthy child development.

In early 1900s, Classroom furniture was fixed facing the same direction for control and to enable students to focus on the teacher at the front of the classroom. Classroom furniture also needs to be durable, affordable and qualities which can be provided whereas creating stimulating contemporary spaces. Classroom furniture may need to be versatile to cope with different age groups requirements. For example, in some locations, Classroom furniture needs to be stacked and moved quickly for a multi-purpose space, while performing a special role, such as allowing for musical instruments to be played [5]. Similarly, designing students spend considerable amount of time working on the drawing boards, learning and practicing. Therefore, the provision of proper study facilities should be provided. Furniture not only affects education, but it also pays attention to the physical comfort of a student as well. Hence, furniture plays a vital role in shaping the career of an individual. Every student

deserves an ideal desk and chair for reading and writing [3]. One solution to such problem which all universities with designing subjects can follow is to provide with adjustable furniture. Such furniture will accommodate everyone in question and students can easily adjust and use the furniture comfortably.

The classroom is like other work environment because there is interplay of both “static work” and “force” (Odunaiya, 2014). Static work refers to the musculoskeletal exertion required to maintain a certain position. For example, sitting and keeping the head and torso upright requires static work; while force refers to the amount of tension generated in the muscles in order to move or keep the body in a particular posture (Odunaiya, 2014). When anything is designed for specific group, the data used should be specific and standard for that group of country so that all people are accommodated (Datar, 2003).

It is important to have furniture that helps students to sit comfortably for longer periods, so they can concentrate on learning. Grimes and Legg (2004) indicated that there was a need for ergonomically designed interventions to make classrooms suitable places for long periods of sitting for study. Furniture facilitates the functioning of students in a classroom. It should permit space for flexible movements of the body, provide place for all the education activities and must possess adequate storage for their personal belongings used by them in classroom.

Furniture is the main interface between the user (students) and the building. Two major functions of furniture are to support the student when attending to the teacher, and when writing or drawing on the working surface; these activities require adoption of quite different physical positions by the students (Knight and Noyes, 1999). Good seating design can improve anatomical performance by lessening ergonomic stresses on the body. As students spend the major time on the bench and desk during college hours, it is necessary that the classroom furniture should suit the requirements of students (Savanaur et al., 2004).

According to Muley, there are 4 different types of furniture generally used in classrooms in India:

1. **Stand-alone:** This is movable furniture. They can be rearranged and carried to other rooms. However, unless the piece is custom-made, it comes in standard dimensions.

2. **Modular:** Modular furniture offers great flexibility, allowing one to combine components to fit the child's exact needs. Many of the units' stack or about to form larger composites. The components can be packed up when they are moved and rearranged in a new room. Some modular systems require assembly.

3. **Furniture collections:** This refers to collection of furniture that coordinate in style and finishes.

4. **Built-in:** Built-in furniture is type of furniture that fits an area precisely. They are designed according to the requirements of the specific space. This kind of furniture can be built into nooks or under windows (Muley, 2018).

1.3. PROBLEMS

Students relatively must experience the inconvenience mostly due to the uniform furniture design for a large population. Such furniture is indirectly related with the health and performance issue of many students. Without proper design, sitting will require greater muscular force and control to maintain stability and equilibrium. This in turn, results in greater fatigue and discomfort and is likely to lead to poor postural habits as well as neck or back complaints (Sharma et.al., 2014). Such problems forced the orthopaedists and other scientists to concentrate on the furniture, which could promote a good posture and reduce discomfort at work or rest. No matter, how unaware of such scientific facts, a layman also accepts that the furniture must be suitable to the physiological needs of the rest, sleep, work and leisure activities. The improvement of the design of university furniture in developing countries has been a recent concern.

Students usually attend class for a long period of time (about 5 h/day) in a sitting posture with ill-designed classroom furniture [6]. Fatigue may be caused by sitting for long periods of time in the classroom. Incorrectly designed furniture induces improper posture, leading to operational uneasiness, musculoskeletal and some physiological disorders among

students. Studies have shown that any deviation in dimensions of furniture from the anthropometric dimensions may cause physiological and bio-mechanical load on the musculoskeletal system [7]. This may also lead to quick changes of posture because of the imbalance and discomfort of the student's bodies while using the furniture.

Literature points to various consequences like; back pain prevalence among the students, musculoskeletal discomfort and low back pain, biomechanical problems, awkward postures adopted for long periods of time affecting academic performance of students etc. The prime factor affecting students' posture is related to the furniture used, but other factors are just as important as students' anthropometric dimensions and furniture design. Studies have also shown that being confined in awkward postures for specific task demand at a given situation or as influenced by bad designed furniture for a long duration provokes psychological stress and imposes ill effects on human performance (Qutubbudin et.al., 2012). Appropriate design of classroom furniture with consideration of the body dimensions of the students may be helpful for reducing health complaints and improving the posture of the college students in the classroom [6].

JUSTIFCATION OF THE STUDY

Student is a learner in Colleges and Universities. It is a known fact that the physical facilities which we use in our everyday life should have some relationship to our basic physical features and dimensions because the comfort and the performance of people can be influenced by poor facilities. Since students are the ones who use classroom facilities for a considerable amount of time, the provision for good classroom furniture should be at higher priority. Student's sitting posture is influenced by mismatched tables and chairs as one of the factors, so they need suitable tables and chairs to prevent Musculoskeletal Disorders (MSDs). The use of inappropriate dimensions of tables and chairs has several detrimental effects. Thus, the idea to adjust university furniture periodically might be reconsidered.

During the review of literature, the researcher come across various researches conducted on topics related to Work posture analysis, Musculoskeletal problems, Anthropometric Measurements, Designing Students seats,

designing for pre-primary schools and opinions of students related to classroom Furniture. It was inferred that most of the researches were undertaken in schools and keeping in mind the school children. Hardly any studies have focused on the problems faced by the students while using the classroom furniture and designing a furniture which is comfortable for the students of the universities.

Courses such as “Furniture Design” and “Ergonomics in Interiors are among trust areas of the field of Family and Community Resource Management. Hence, the information gathered through the present research would widen the data base and will help in strengthening the curriculum by making modifications for designing furniture. The study will be beneficial to the department students who can work on comfortable furniture without any problem. The study is also beneficial to the department as the design of prototype can be used to develop furniture for students in future. It will also be useful for those designers who are willing to design adjustable furniture in future.

Therefore, the present research attempts to study the problems that are faced by the students while using furniture in selected Practical Classroom and to design a prototype of Chair and Adjustable Table which is suitable for designing students. From the present study, a criterion is determined for Chair and Adjustable Table which can be used in Practical Classroom of the Universities where designing is done.

STATEMENT OF PROBLEM

The present study aims to analyse the problems faced by students in existing furniture of selected practical room and to design a Prototype of the Chair and Adjustable Table.

OBJECTIVES OF THE STUDY

1. To find out the problems faced by the students in existing furniture of the selected practical room of Department of Family and Community Resource Management.
2. To collect the measurements of existing furniture of table and chair.

3. To design a prototype of the chair and adjustable table for the selected practical room of Department of Family and Community Resource Management.
4. To prepare a testing tool for testing the prototype designed to solve the problems faced by the students while working existing furniture of selected practical room of Department of Family and Community Resource Management.

DELIMITATIONS OF THE STUDY

1. The practical room will be delimited to Room no. 205 of the Department of Family and Community Resource Management.
2. The Design is delimited to designing of Chair and Adjustable Table only.
3. The Study will be delimited to second- and third-year students of the Department of Family and Community Resource Management.
4. The Study will be delimited to 80 students for data collection and 17 students for Prototype testing.

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

The major areas of related literature, survey, scholarly articles, books and other sources relevant to particular issues, area of research, or theory, providing a description, summary and critical evolution of each work are presented here. In order to make the review clear and understanding the present chapter was divided into the following sections:

2.1. Theoretical Orientation

2.1.1. Classroom Furniture

2.1.1.1. Importance of Classroom Furniture

2.1.1.2. Materials of Classroom Furniture

2.1.1.3. Standard Dimensions of Classroom Furniture

2.1.1.4. Market Survey

2.1.2. Problems faced by students while using classroom furniture

2.2. Related Researches

2.2.1. Researches conducted outside India

2.2.2. Researches conducted within India

2.2.3. Researches Related to design and development

2.3. Conclusion

2.1 Theoretical Orientation

Theoretical orientation is the section which describes about the theoretical content related to the topic of the study. These are discussed independently in the succeeding description.

2.1.1. Classroom Furniture

Education is the most effective means to ensure economic growth and national development in countries. University is one of the educational settings in training of students. Effective training can be achieved in a safe and stress-free space in classrooms. Physical environments of classrooms have a vital role in student's satisfaction and a higher level of satisfaction can increase the level of skills, mentality and knowledge of students. University is the workplace of many students around the world and Classroom furniture have become an important physical element of the classroom and learning environment (Ansari, 2018).

2.1.1.1. Importance of Classroom Furniture

Classroom furniture is an important facility that helps to provide a conducive, comfortable and functional classroom environment for students in educational institutions. The comfort and functional utility of classroom furniture depends on its physical design in relation to the physical structure and biomechanics of the human body (Boampong, 2016). Students spend a major part of their time sitting on this furniture in classrooms. Therefore, they are exposed to risks associated with prolonged sitting in a static and awkward posture. These risk factors are generally created with inappropriate furniture (Ansari, 2018).

Furniture transforms educational institute into an extraordinary place. While buying or upgrading your classroom furniture, one should see that students are comfortable while sitting. Since kids have limited attention spans, it is crucial to adjust to their comfort levels. In the past, a classroom might be created with just a few modest desks and benches. The furniture in classrooms is changing as well, making them more dynamic. There is now adaptable classroom furniture that can handle different group sizes. These furniture pieces are easily flexible and mobile, which promotes a cooperative environment. The learning

experience is improved by the ability to adapt to various teaching and learning approaches. In that age range, biological changes happen quickly. Thus, when purchasing classroom furniture, their height and weight should be considered. More they feel comfortable, the more they will be able to pay more attention to their studies [8].

Additionally allowing for movement and promoting excellent posture, comfortable and well-fitting classroom furniture. These components have a crucial role in encouraging youngsters to learn and enhancing their academic achievement. Although it was once thought that excessive movement impaired concentration, it has now been discovered that flexible furniture enhances the body's desire to change postures and move around. By allowing for that natural occurrence, we can help children learn in a way that is pleasant for them. So, it's safe to argue that having comfortable and conducive classroom furniture is essential for fostering learning [8].

According to Pheasant (1986), the purpose of seating furniture is to provide stable body support in a posture that is comfortable over a period of time, physiologically satisfactory and is appropriate to the task or activity being considered. Workplace furniture design and user anthropometry have become an important consideration in designing ergonomically appropriate furniture (Harris et al. 2005). Furniture used in institutes is one of the factors that affect the sitting posture (Panagiotopoulou et.al., 2004). Students are often exposed to fixed-dimension furniture with little opportunity for adjustability to suit their own changing anthropometry. This concern is rendered clear by the large number of studies published worldwide in which a clear mismatch between anthropometric characteristics and the dimensions of the furniture under study has been identified to avoid the mismatch problem, one of the best possible solutions is adjustability (Singh, 2017).

Yeats (1997) argued that it is difficult to encourage proper posture early in life without the support of adjustable chairs, desks and tables in the

classroom. This has been recognized by the fact that classroom furniture dimensions are usually based on findings not correlated with the students' requirements. Students are growing and changing in dimensions. This results in high variability in body dimensions in the same grade (Assiri et.al., 2019).

2.1.1.2. Materials of Classroom Furniture

When choosing the best furniture, there are several things to take into consideration. When choosing the best materials for furniture, there are several things to take into account. The most important factor is for what purpose is the furniture being used. If the furniture is for indoor use, then one should choose a material that is durable and easy to clean. On the other hand, if the furniture is for outdoor use, then it is recommended to choose a durable material that is weather-resistant [9]. Another factor to consider is the style of the furniture. For modern style, a stylish and fashionable material should be chosen whereas for classic style, one should choose a material that is robust and traditional. Finally, it is advisable to consider the cost of the material. Some materials are more expensive than others, so it is important to decide a budget and then find a material that meets all the requirements [9].

Some of the most common materials for furniture are Wood, Metal, Plastic and Fabric.

- **Wood**

The longest-lasting materials have been made of wood. It doesn't matter if it's Teak, Redwood, Mahogany, or even Composite Wood; these are among the most often utilised types of materials in the production of furniture. It is also one of the most sought-after materials in the world, and it still is [10]. In addition to solid wood, there are other varieties of wood available on the market, including plywood, particle board, MDF, and HDF. Each of these materials has unique qualities that set them apart. They can be used in several ways [11].

- **Metal**

Metal, known as a popular raw material for furniture making, are found in many designs, styles, unique colours, and pattern combinations. You can find metal material in chairs, tables, double-seater, triple-seater sofas, etc. Instead, the structure of furniture items proffered metals such as brass, steel, and aluminium. For example, chairs and tables have aluminium legs and edge designs. Furthermore, metal materials are a great and popular choice as it can be used for outdoor furniture, it is light in weight, easy to clean and withstand the extreme weather condition [12].

- **Plastic**

Plastic is an artificial material that was created in 1862 in London. The material was originally called Parkesine was an organic material derived from cellulose that once heated could be moulded and retained its shape when cooled. The ability to mould plastic into any form has made it a very popular material for mass produced furniture but also for modern bespoke furniture where any shape or form is possible [13].

- **Fabric**

Another popular fabric, fabric furniture is often seen as a luxury and sophisticated material that is used in many upholstered furniture. Some recommended fabrics include leather, linen, silk, velvet, jute and cotton [10].

2.1.1.3. Standard Dimensions of Classroom Furniture

Ellis (1951) has set a thumb rule, when seated as much as when standing, that the hands are at their best in both power and precision when the elbows are at the sides and bent at right angles. When the height of the seat is 40-42 cm the elbow height above the floor of a woman is about 63-65 cm and of a man is 64-66 cm. If we allow for a necessary 2 cm clearance between the arms and the table top, a table height of 61-63 cm is ideal for women and 62-64 cm for men. On the other hand, women require knee room of 63 cm beneath the table, that for men being 66 cm. With top 2 cm thick, the lowest possible height for the table therefore becomes 65-68 cm, a little higher than the ideal

height (Datar, 2003). Certain recommendations for design and construction of work seats were found:

- The work seat must permit any movement of the arms required by the users.
- The works seat must be considered as one with the work bench or desk, so that the distance from the seat to the upper edge of the desk, is 27-30 cm and the distance from the seat to the underside of the desk at least 19 cm.
- The seat should be flat or slightly concave, with the front half tilted backwards to about 3-5°, and the rear third bulging slightly upwards. The front edge of the seat should be rounded off.
- A high backrest, 55-60 cm vertically above the point of contact with the seat, with a slightly convex lumbar pad and slightly concave at chest height is recommended so that the back muscles can be rested periodically.
- If a traditional type of work seat with a lumbar support is preferred, then this should have as much adjustment as possible and have light springing. The lumbar support should be 20-30 cm high and 30-37 cm broad.
- The following rules are given for the height of the seat:
  - for a non-adjustable seat without foot rests: 38-40 cm
  - for a non-adjustable seat with foot rests: 45-48 cm
  - range of adjustment for the seats concerned: 38-53 cm

  The work seat can be upholstered on both seat and backrest in such a way that the body does not sink in more than 2 to 3 cm. The upholstery should be covered with a material that has good permeability to sweat (Datar, 2003).

Joseph et.al., (2014) gave standard dimensions of different furniture items in book named “Time-Saver standards for Interior Design and Space Planning”. which are used in India for furniture design. According them the standard dimensions of Table, Chair and Stool are as follows:

Table 1: Recommendations Standard Dimension for Table, Chair and Stool

Furniture Item	Chair	Table	Stool
Height	23”- 25”	20”-22”	18”
Width	14”-16”	24” -30”	18”
Depth	16”-17”	24”-25”	18”

The recommendations for fine and precision work (Ayoub, 1973) are somewhat at odds with the second general principle of placing working heights at elbow height. Specially, the recommendations would place the working surface upon which fine and precision work is done at 6 and 2 in (15 and 5 cm) above elbow height respectively. In such instances there should be a provision for arms to rest on the work surface. The higher surfaces are recommended so that the work is within close visual range which would be important for such work (Datar, 2003).

Recommended chair characteristics (Akerblom 1954, Anon 1974, Faulkner 1967, 1968, 1970, Floyd and Roberts 1958 and Grandjean 1980) :

- Seat width: 43 cm (17 in.)
- Distance from seat to footrest: 46 cm (18 in.)
- Back rest width: 30-36 cm (12-14 in.)
- Adjustable range for seat height: 15 cm (6 in.)
- Seat depth: 41 cm (16 in.)
- Back rest height: 15-23 cm (6-9 in.)
- Back rest height above adjustable seat: 18-25 cm (7-10 in.)
- Angle: 3-5° (Datar, 2003).

Chakarabti (1997) also stated that, one should consider appropriate anthropometrical requirements for sitting, for seat and work surface dimensions, legroom and clearances for getting in and out. The surrounding free movement space is important too. Thus arose the

ergonomist's need to treat the issue of furniture design for students, as a necessity and educational institutes should treat the selection of right kind of furniture as social responsibility towards the student community.

Pandya (1983) in her study concluded that the existing physical facilities in the hostel rooms were not of suitable measurements and thus, students were not satisfied and felt discomfort in thighs and back. The observations emphasized on the need for the suitable dimensions and design of the physical facilities in the hostels.

Table 2: Recommendations given for the Furniture for all the Three Stature

SR. NO	FURNITURE	STATURE		
		SHORT	MEDIUM	TALL
1	**Chair:**			
	Seat	40 cm	44 cm	46 cm
	Back rest	40 cm	45 cm	48 cm
	Angle between seat and back	98°	98°	98°
	Arm rest from the seat	15 cm	16 cm	18 cm
	Depth of arm rest	30 cm	35 cm	38 cm
	Width of the arm rest	8 cm	8 cm	8 cm
	Foot rest from the floor	10 cm	10 cm	7.5 cm
	Depth of the foot rest	7 cm	7 cm	7 cm
2	**Table:**			
	Total Height	71 cm	71 cm	76 cm
	Length	122 cm	122 cm	122 cm
	Width	61 cm	62 cm	62 cm
	Thickness	5 cm	5 cm	5 cm

Reference: Pandya, 1983

Working height is of critical importance in the design of workplace. If the work surface is raised too high the shoulders must frequently be lifted up to compensate, which may lead to painful cramps in the neck and shoulders. If the working height is too low the back must be excessively bowed, which again often causes backache.

Table 3: A range of Recommendations for Chair Integrated from number of Sources

Component	Recommended Dimensional Range	Comment
Seat height	38-57 cm	When the knee angel is 90° the thighs should be horizontal.
Seat pan angle	8° back, 15° forward	Should support weight at the thighs and the buttocks.
Seat pan depth	33-47 cm	Depth should be less than the length of the thighs to maximize support and movement.
Seat pan width	46 cm	Wide enough to support the buttocks and allow for position adjustment.
Seat cushioning	4-5 cm thick	Firm foam with porous fabric to prevent sliding.
Backrest height	50 cm	Should be adjustable and support the lumber region
Lumber support	10-24 cm	Above seat pan
Back rest contour	5 cm deep	Should be vertically convex and horizontally concave.
Backrest width	30-48 cm	Wide enough to permit operator movement and various working posture
Backrest angle	90^o-120^o	Should be adjustable
Base	5 Castors	Base should be stable and swivel.
Footrest area	30 by 40 cm	Made of non-slide surface and used when the operator cannot put feet firmly on the floor
Footrest angle	Less than 30^o	

Reference: ANSI, 1988

In 1983, Reinhold, recommended standing work place height. The optimal working height of the hands is determined by compromise based on analysis of the total work sequence such as:

- For light assembly, writing, packing tasks, the optimal working height of the hands is 107 cm.
- For tasks requiring large downward or sideward forces, such as causing operations and packing, the working height of the hands should by 91 cm. In case of very heavy force exertions, lower heights to about 76 cm may be approximate.
- When jobs require handling of articles of different sizes at the same work place, either an adjustable height workbench should be used or the height should be based on the most frequently used items.

2.1.1.4. Market Survey

A market survey conducted by the researcher for materials that are used in Classroom Furniture, Readily Available Classroom Furniture and Different types of Adjustable Furniture available in Market. It was conducted in different areas of Vadodara city, namely Alkapuri, Raopura, Gotri, Fatehgunj and Pratap Nagar from December 2022 to January 2023.

Table 4: Market Survey of Materials used to make Classroom Furniture

Sr. No	Name of the Material	Details of the Material
1	 **Plate 1: Teak Wood**	**Shop Name:** Patel Soumil **Shop Address:** Near Gurudwara, Lakadpitha, Vadodara **Cost:** ₹ 2500 – ₹ 3000 for per cu.ft
2	 **Plate 2: Junglee Wood**	**Shop Name:** Patel Soumil **Shop Address:** Near Gurudwara, Lakadpitha, Vadodara **Cost:** ₹ 900 per cu.ft

Sr. No	Name of the Material	Details of the Material
3	 **Plate 3: Pine Wood**	**Shop Name:** Akshar Randha Machine **Shop Address:** Akshar randha Machine Sun complex, R. V desai road, Navapura masjid ni same, Vadodara **Cost:** ₹ 700 to ₹ 900 per cu.ft
4	 **Plate 4: Plywood**	**Size:** 8’-0” x 4’-0” **Thickness:** 6mm - 25.5mm **Shop Name:** Sayaji Plywood **Shop Address:** Sayaji Ply, Road no.2, Sardar Industrial Estate, Vadodara **Cost:** ₹ 40 onwards for per sq. ft (Prices varies according to the thickness of Plywood)
5	 **Plate 5: Medium Density Fibre (MDF)**	**Size:** 8’-0” x 4’-0” **Thickness:** 2mm - 32mm. **Shop Name:** Sayaji Plywood **Shop Address:** Sayaji Ply, Road no.2, Sardar Industrial Estate, Vadodara **Cost:** ₹ 8 onwards for per sq. ft (Prices varies according to the thickness of plywood)
6	 **Plate 6: Particle Board**	**Size:** 8’-0” x 4’-0” **Thickness:** 6mm - 38mm **Shop Name:** Sayaji Plywood **Shop Address:** Sayaji Ply, Road no.2, Sardar Industrial Estate, Vadodara **Cost:** ₹ 20 onward for Per sq. ft (Prices varies according to the thickness of particle board)

Sr. No	Name of the Material	Details of the Material
7	 **Plate 7: Laminate sheets**	**Size:** 8’-0” x 4’-0” **Thickness:** 0.8mm, 1.0mm and 1.5mm **Shop Name:** Sayaji Plywood **Shop Address:** Sayaji Ply, Road no.2, Sardar Industrial Estate, Vadodara **Cost:** ₹ 75 onwards for per sq. ft
8	 **Plate 8: Mild Steel**	**Shop Name:** Krishna Steel **Shop Address:** Pratham Avenue, Akota, Vadodara, Gujarat 390020 **Cost:** ₹ 60 onwards for per kg (Cost vary according to company)
9	 **Plate 9: Fabric**	**Shop Name:** My Home Decor **Shop Address:** Opposite siyapura police chowky Raopura tower, Vadodara, Gujarat 390001 **Cost:** ₹ 50 onwards for per meter

Table 5: Market Survey of Readily Available Classroom Furniture in Vadodara

Sr. No.	Readily Available Classroom Furniture	About Classroom Furniture	Cost per Piece (Bulk Quantity)	Cost per Piece (Single Piece)
1	 **Plate 10: Mild Steel Ms. School Bench and Desk**	• **Table top:** MDF with Laminate • **Frame:** Mild Steel with Colour Coating • **Capacity:** 2-Seater • **Shop Name:** Nisha Display System, Vadodara • **Manufacturer:** Maa Fabrication Works	₹ 2348 per Bench	₹ 3500 per Bench
2	 **Plate 11: Institutional Bench**	• **Table top Material:** Wood • **Appearance:** Modern • **Capacity:** 2-Seater • **Shop Name:** Anish Corporation • **Manufacturer:** Shantinath Furniture, Ahmedabad	₹ 3200 per Bench	₹ 5000 per Bench
3	 **Plate 12: Brown Wooden Dual Desk**	• **Table top Material:** Thick Particle Board with pre-laminated Particle Board • **Capacity:** 2-seater • **Shop Name:** Ravi Steel Furniture • **Manufacturer:** HHW Care Products	₹ 4500 per Bench	₹ 7580 per Bench

Sr. No.	Readily Available Classroom Furniture	About Classroom Furniture	Cost per Piece (Bulk Quantity)	Cost per Piece (Single Piece)
4	 **Plate 13: Dual Desk Bench**	• **Table top Material:** Wood • **Frame:** Mild Steel with Black Coating • **Capacity:** 2-Seater • **Shop Name:** Ravi Steel Furniture • **Manufacturer:** HHW Care Products	₹ 6500 per Bench	₹ 8570 per Bench
5	 **Plate 14: Mild Steel Wooden School Benches**	• **Table top Material:** Plywood with Laminate finish • **Capacity:** 3-Seater • **Shop Name:** Ravi Steel Furniture • **Manufacturer:** HHW Care Products	₹ 7500 per Bench	₹ 10,000 per Bench
6	 **Plate 15: Wooden School Desk with Tubular Steel Structure**	• **Table top Material:** MDF/PB Tops • **Capacity:** 2-Seater • **Shop Name:** Anish Corporation • **Shop Name:** Anish Corporation • **Manufacturer:** Shantinath Furniture, Ahmedabad	₹ 5000 per Bench	₹ 9460 per Bench

Sr. No.	Readily Available Classroom Furniture	About Classroom Furniture	Cost per Piece (Bulk Quantity)	Cost per Piece (Single Piece)
7	 **Plate 16: Wood & Metal School Classroom Desk**	• **Table Top Material:** Wood • **Frame:** Metal with Black Coating • **Capacity:** 2-Seater • **Manufacturer:** MRK Furniture and Interior Private Ltd	₹ 6500 per Bench	₹ 7500 per Bench
8	 **Plate 17: Cushion College Bench**	• **Seating Material:** Leather Cushion • **Frame:** Mild Steel with Colour Coating • **Capacity:** 3-Seater • **Shop Name:** Ravi Steel Furniture. Vadodara • **Manufacturer:** HHW Care Products	₹ 5700 per Bench	₹ 9459 per Bench
9	 **Plate 18: Bench and Desk**	• **Table top Material:** Wood • **Frame:** Iron Rod with Black Coating • **Capacity:** 2-Seater • **Shop Name:** Baroda Texway Enterprise, Vadodara • **Manufacturer:** Baroda Texway Enterprise, Vadodara	₹ 2750 per Bench	₹ 4500 per Bench

Sr. No.	Readily Available Classroom Furniture	About Classroom Furniture	Cost per Piece (Bulk Quantity)	Cost per Piece (Single Piece)
10	 **Plate 19: Work Station**	• **Bench Size:** 2'-5" Height • **Table top Material:** Plywood • **Capacity:** Single Person • **Shop Name:** Shri Hari Interior, Vadodara • **Manufacturer:** Pridiyos, Nasik	₹ 1500 Per Station	₹ 3500 per Station
11	 **Plate 20: Office and Institutional Chair**	• **Seat Material:** Leather • **Frame Material:** Stainless Steel • **Shop Name:** Vaibhavi Furniture & Fabrication • **Manufacturer:** Vaibhavi Engineer, Vadodara	₹ 3000 per Chair	₹ 5500 per Chair
12	 **Plate 21: Black Mild Steel School & College Chair**	• **Table top Material:** Wood • **Capacity:** Single Seater • **Shop Name:** Vishwakarma Enterprise • **Manufacturer:** Vishwakarma Furniture, Vadodara	₹ 1500 per Chair	₹ 3500 per Chair

Sr. No.	Readily Available Classroom Furniture	About Classroom Furniture	Cost per Piece (Bulk Quantity)	Cost per Piece (Single Piece)
13	 **Plate 22: Student Fabric Writing Pad Chair**	• **Seat Material:** Fabric • **Capacity:** Single Person • **Shop Name:** Vishwakarma Enterprise • **Manufacturer:** Vishwakarma Furniture, Vadodara	₹ 2300 per Chair	₹ 4800 per Chair
14	 **Plate 23: Black Writing Pad Chair**	• **Seat Material:** Polyester • **Capacity:** Single Person • **Shop Name:** Vishwakarma Enterprise • **Manufacturer:** Vishwakarma Furniture, Vadodara	₹ 1500 per Chair	₹ 3500 per Chair
15	 **Plate 24: School Bench**	• **Table top :**MDF with PVC Patti • **Frame:** Metal with Black Coating • **Capacity:** 2-Seater • **Shop Name:** Baroda Texway Enterprise, Vadodara • **Manufacturer:** Baroda Texway Enterprise, Vadodara	₹ 2499 per Bench	₹ 6000 per Bench

Table 6: Market Survey of Readily Available Adjustable Table in Vadodara

Sr. No.	Readily Available Adjustable Table	About the Classroom Furniture	Cost per Piece
1	 **Plate 25: Height Adjustable Portable Table**	• **Table top:** Wood • **Frame:** Internal Pipe structure • **Features:** Height Adjustable and Movable • **Shop Name:** Kaya (Branch in Vadodara) • **Manufacturer:** Kaya, Surat	₹ 600 per Table
2	 **Plate 26: Variable Height Table**	• **Material:** Mild Steel Frame with H.D.P.E. Top • **Features:** Height Adjustable and can be locked at 4 different heights • **Shop Name:** Young India Implex (Branch in Vadodara) • **Manufacturer:** Young India Implex, Surat	₹ 2800 per Table
3	 **Plate 27: Height Adjustable Table**	• **Table Top Material**: Blow moulded plastic • **Frame Material**: Powder coated square cum round tubular mild steel frame • **Manufacturer:** Radiant Plastic, Vadodara	₹ 2800 per Table

Sr. No.	Readily Available Adjustable Table	About the Classroom Furniture	Cost per Piece
4	 **Plate 28: Manual Adjustable Bedside Pressed Top Table**	• **Material**: Wood and Mild Steel • **Features:** Adjustable, light in weight and easy to operate • **Shop Name:** Tvadartham Industries (Branch in Vadodara) • **Manufacturer:** Tvadartham Industries, Surat	₹ 5656 per Table
5	 **Plate 29: Food Trolley Height Adjustment Level Gear**	• **Material**: Metal • **Features:** Lever for adjusting height • **Manufacturer:** Digital Company, Vadodara	₹ 5500 per trolley
6	 **Plate 30: Mild Steel Adjustable Height Tables**	**Material**: Mild Steel with White Colour Coating • **Capacity:** up to 100kg • **Features:** Digital Memory Controller with 3 height timer settings • **Shop Name:** Tech Centric Group of Companies (Branch in Vadodara) • **Manufacturer:** Tech Centric Group of Companies, Mumbai	₹ 22,500 per piece

Sr. No.	Readily Available Adjustable Table	About the Classroom Furniture	Cost per Piece
7	 **Plate 31: Manual Height Adjustable Table Stand**	• **Material**: Metal with white powder coating • **Capacity:** up to 60kg • **Features:** handle provided for Adjusting Height which can folded when not in use • **Shop Name:** Tech Centric Group of Companies (Branch in Vadodara) • **Manufacturer:** Tech Centric Group of Companies, Mumbai	₹ 11,500 per piece
8	 **Plate 32: Tabletop Height Adjustable Table**	• **Product Type:** Tabletop Height Adjustable Table • **Material**: Aluminium • **Capacity:** up to 60kg • **Features:** Ergo standing Desk Frame with Electric Rising Desk frame kit • **Shop Name:** Ergologic Private Limited • **Manufacturer:** Tech Centric Group of Company, Mumbai	₹ 20,000 per piece

2.1.2. Problems faced by students while using classroom furniture

Efficiency of a person depends strongly on the fact that how comfortable a person is with the work environment and also the suitability of workstation with the user. Therefore, it is very important to make the classrooms in colleges comfortable and suitable for the students, so that they can concentrate and evolve as talented individuals. Students spends majority of time on the chair and desk during college hours.

Hence, it is necessary that the college furniture should fit the requirements of the students. Therefore, the college furniture should be made based on anthropometric dimensions of the user (Qutubuddin et.al., 2012). Inappropriately designed furniture results in back pain, eyestrain, and poor student morale (Gouvali and Boudolos, 2006). The prevalence of musculoskeletal symptoms among school children is increasing. Amitabha et.al., (2001) who studied on Indian classrooms, observed that there is need to focus on seating design for student in classroom as majority of students felt that there is insufficient space and lack of storage provision to keep their belongings.

Students are especially predisposed of negative health impacts from inadequately designed and mismatched furniture, due to prolonged periods of sitting. Furthermore, improper classroom furniture may also be accountable for poor sitting posture. Improper students' posture, while using classroom furniture, is considered one of the factors that may increase the possibility of developing back pain. Back pain among students is a highly prevalent problem, which could influence their learning capabilities and substantially impact their adulthood quality of life. The reasons for the development of back pain remains debatable. The use of ergonomically matched school furniture may reduce student's fatigue and back pain (Assiri et.al., 2019).

Excessively stretching a muscle can led to a strain. A strain is an injury to a tendon or muscle resulting in swelling and pain. When a group of fibres get torn apart, a more serious injury occurs. If the obstruction occurs over an extended period of time, it can lead to complete deterioration of the muscle (McCauley, 2011).

A comprehensive review of epidemiological studies was performed to assess the risk factors associated with Work-related Musculoskeletal Disorders (Musculoskeletal Disorders and Workplace Factors, NIOSH, 1997). The degree of impact is synergistic when two or more factors exist. A large number of studies, worldwide, have shown a mismatch between students' anthropometric characteristics and dimensions of classroom furniture. The review categorized Work-related

Musculoskeletal Disorders (WMSDs) by the body part impacted including:

1. Neck and Neck Shoulder
2. Shoulder
3. Elbow
4. Hand Wrist
5. Back (McCauley, 2011)

The key to good posture is the position of the spine. The spine has three natural curves - at your neck, middle back, and lower back. Correct posture should maintain these curves, but not increase them. In recent decades, the upright posture forced on students has required their sitting with the joints of their hips, knees and ankles at right angles. However, a ‘normal’ child can maintain this posture for no longer than 1-2 min (Mandal 1981). Additionally, this posture can cause some biomechanical problems because a seated person has a hip joint flexion of approximately 60° and the pelvis has a sloping axis; therefore, the lumbar curve changes from a lordosis (standing position) to a kyphosis (sitting position) (Mandal 1994). Murphy et.al., (2004), observed an average 60° hip flexion and 30° lumbar flexion from X-ray examinations of 25 people sitting upright. Many researchers have attempted to improve the sitting position by modifying some aspects of classroom furniture.

The seat base also represents an important element of school furniture because the base carries approximately 80% of the trunk weight (Mandal, 1994). Seat height (SH) is important because increasing SH in addition to the forward-sloping seat tended to increase lordosis (Freivalds, 2004). Furthermore, the backrest or lumbar support will have a beneficial effect only if the chair presents a negative seat or a backward-sloping seat (Mandal, 1994). However, in practice the backrest may facilitate the forward movement of the buttocks and kyphosis of the lumbar spine to stabilise the trunk against the backrest

(Bendix et al., 1996). Any incompatibility of Classroom furniture with intended use presents a danger of injury of the pupil.

At this stage, it is important to eliminate the possibility of injury to student by rounding the edges and corners, adequately placing fittings and elements, as well as carefully selecting materials. One must also remember to use such structural components for which the designer has certificates of their complete non-toxicity.

2.2. Related Researches

2.2.1. Researches conducted outside India

Aminiam and Romli (2012) conducted a study on "Mismatch between Anthropometric Body Dimensions and Classroom Furniture in Malaysian Universities". The main objective of the study was to highlight possible mismatch between the student's body dimensions and the dimensions of classroom furniture used in most Malaysian universities. 500 students from five different universities: University Putra Malaysia (UPM), University Kebangsaan Malaysia (UKM), University Tenaga Nasional (UNITEN), Lim Kok Wing University and University Malaya (UM) were selected and survey was conducted with the help of case study. Several mismatches have been found and highlighted for a better planning and design of classroom furniture.

Bendak (2013) carried a survey on "Ergonomic assessment of primary school furniture in United Arab Emirates". The purpose of the study was to ergonomically assess classroom furniture dimensions in United Arab Emirates and compare it to students' anthropometric measures. Relevant anthropometric dimensions of a sample of 200 students from grade 6 were measured in two large schools in Dubai and Sharjah. Dimensions of furniture used by these students were also measured and compared to their anthropometric measurements. As a result, it was seen that there was a major mismatch between many anthropometric measures and classroom furniture dimensions. To ensure postural comfort, a new set of furniture dimensions for grade 6 classrooms was suggested based on anthropometric dimensions of students.

A study conducted by **Biswas (2014)** was on “Mismatch between classroom furniture and anthropometric measurements of Bangladeshi primary school students” that evaluated the mismatch between classroom furniture dimension with anthropometric measurement of primary school students to examine proper ergonomic-oriented classroom furniture dimension. A sample of 300 primary school students were randomly selected in which equal number of boys and girls were taken with no physical disabilities from three primary schools (Police Line School, Badsha Foysal School, Churamonkathi Government Primary School) located in the city of Jessore, Bangladesh. Fifteen anthropometric measurements and five dimensions from the existing classroom furniture were taken and then compared together to identify any potential mismatch between them. The results indicated a considerable mismatch between body dimensions of the students and the existing classroom furniture. For both boys and girls seat heights and desktop heights of the classroom furniture were too high, which may result in pain on the posterior surface of the knee and shoulder region, discomfort respectively and tend to increase the risk for developing Musculoskeletal Problems amongst school students. The study also concluded that it is difficult to select the proper furniture for a large number of students, so, to design the furniture dimension’s adjustable range design would be preferable.

Ajayeoba et.al., (2016) carried research on “Ergonomic Evaluation and establishment of suitable Classroom Furniture Design specifications for Secondary School Children in South-Western Nigeria”. This research work compared the anthropometric dimensions of secondary school students to the design dimensions of their chairs and desks to assess whether the furniture was appropriate for students or not. A total of 840 students, with their chairs and desks, from fourteen secondary schools in seven states in south-western Nigeria, were measured. It has been established that no dimensions of chair and desk can comfortably fit all students. Likewise, no student would be comfortable with the same size of chairs and desk for his or her six-year programme. Hence, to avoid

Musculoskeletal Problems and other associated workplace hazards, three different chairs and tables were proposed which were comfortable for at least 95% of students.

An Ergonomic Study was carried out on “Analysis of Secondary School Furniture’s based on Ergonomic Considerations” by **Farooqui (2016)**. The main purpose of the study was to conduct survey amongst the school students to examine the musculoskeletal pain and estimating the adequacy of classroom furniture in relation to anthropometric characteristics. The sample size of this study was 200 students, aged between 13 to 16 years belonging to class 8th, 9th and 10th respectively. From the responses obtained it was been observed that the existing furniture design has many short-comings. Majority of the students stated that their discomfort was first noticed recently. In total, 63% of students believed that their pains are related to the school furniture design. 71% of students did not feel comfortable while using existing furniture setup. 62% of students reported injuries due to existing setup. 75% and 84% of students stated that their existing school furniture does not have proper back-rest and arm-rest respectively.

Kahya (2018) conducted a study on “Evaluation of the Classroom Furniture for University Students”. The purpose of the study was to examine whether school furniture dimensions match student’s anthropometric measurements. Eleven anthropometric measurements are taken from 225 respondents among which 68 were female and 157 were male students from nine departments at the Faculty of Engineering and Architecture of Eskisehir Osmangazi University using a specially designed measurement tool. The existing classroom furniture dimensions and the anthropometric measurements of the students were compared in order to determine the match between them. The results indicated that the existing furniture were comprehensively adequate suitable for the students.

Parvez (2018) carried a survey on “Design of Ergonomically Fit Classroom Furniture for Primary Schools of Bangladesh”. The main

objective of this study was to determine the potential mismatch between student anthropometric measurements and classroom furniture dimensions and reduce mismatch percentages by designing classroom furniture based on student anthropometric data that fit most of the students. The survey was conducted in 10 primary schools in Khulna, Bangladesh. Anthropometric measurements were accumulated from 300 students of these primary schools. A significant degree of mismatch was found between furniture and student anthropometric measurements. The results highlighted that desktop height and seat height were found too high and seat width was too small for all of the students. The paper also proposes furniture dimensions, which reduce mismatch percentage of students ranging from 90% to 10%.

Gosende (2019) carried research on “Evaluation of Classroom Furniture Design for Ecuadorian University Students: An Anthropometry-Based Approach”. The first aim was to define the classroom furniture design parameters' dimensions for university students according to relevant anthropometric information. The second aim was to conduct a preliminary diagnostic of the appropriateness of classroom furniture currently used to students' anthropometric characteristics. Among the 13 functional universities in Guayaquil, 5 were randomly selected. Then, in each institution, five classrooms were selected through a simple random sampling. For each identified furniture model, ten measurements were made of each of the ten design parameters considered relevant by the study authors. Sample size of 601 students was considered for the study. The findings supported the need to extend the research immediately to a national level to identify the real prevalence of MDS in the Ecuadorian university students, provide the required medical rehabilitation if necessary, and establish a strategy that allows the gradual acquisition of safer and appropriate classroom furniture that matches students' anthropometric characteristics.

A study conducted by **Abdullah and Ahmad (2020)** was on “Evaluation of Ergonomic design of Desk and Chair for Primary Schools in Erbil city”. This study evaluates the existing school furniture ergonomically as

compared to students' anthropometric measures, i.e., examining if dimensions of primary school furniture agree with pupils' anthropometric measurements for first to sixth graders. Anthropometric dimensions in eight schools for 487 students of grades 1-6 were measured, and their data were analysed via IBM®SPSS Statistical Package and MS Excel®. The results showed that group of grades 1-3 pupils have major mismatch accordance to the anthropometric measures (sitting elbow height, stature, sitting shoulder height, popliteal height, knee height, buttock-popliteal length, shoulder breadth, hip breadth, and upper limb length) and classroom furniture dimensions more than group of grades 4-6. The research suggests designing two different sizes of classroom chairs and desks for each grade groups pupils 1-3 and 4-6 should be made based on anthropometric measurements of the pupils to avoid discomfort, pain, decrease the occurrence of musculoskeletal disorder, in addition to ensuring comfort for pupils.

Haqi (2020) conducted research on "Designing School Tables and Chairs based on Anthropometry of Elementary School Students in Surabaya". The purpose of this study was to design school table and chair sizes in accordance with anthropometry of elementary school students, so the tables and chairs do not cause health problems for children. The population used in this study was 72 students of elementary school in Surabaya. The sampling method used in this research was random sampling. The results of the research show that the sizes of existing tables and chairs are mismatched with student anthropometry. There are 7 dimensions of proposed table and chair sizes which are based on anthropometric data. The study concluded that sizes of existing tables and chairs still need improvement in all dimensions based on the students' anthropometric measurements.

2.2.2. Researches conducted within India

A Case study conducted by **Datar (2003)** was on "Work posture analysis and Musculo-skeletal problems experienced by the students of Architecture Profession". The main objective of investigation was to suggest modifications in furniture design and work posture of the

students on the basis of the anthropometric dimensions and study habits of the students of the Architecture profession from 1st, 2nd, 3rd and 4th year with short, medium and tall stature. 123 students from Department of Architecture, The Faculty of Technology, M.S. University, Baroda were considered as sample for measuring the pain experienced by students while working. Based on the results regarding pain experienced, 5 students (3 boys and 2 girls) from each year were selected for the case study. Majority of the respondents reported that the furniture was improper and complained of pain in several locomotive parts of the body.

A study conducted by **Qutubuddin et. al., (2012)** was on "Anthropometric Analysis of Classroom Furniture Used in Colleges" analysed the classroom furniture's of different colleges of Gulbarga on the basis of anthropometry of the students. A sample of 400 students (200 males & 200 females) ageing between 18 to 25 years were selected. It was found that the five different models of furniture used were made without any anthropometric considerations and were found to be incompatible with the user population. Some features like seat height, width etc were not as per the anthropometry of the students and also some of the benches used were without any backrest. The present study suggested that the design criteria should be selected based on the anthropometric dimensions of the students. The ill and improper design of desks may create many problems for the students such as fatigue, muscular stress, and discomfort/pain in different body parts. While making school furniture the anthropometric dimension of the user population should be used. The furniture should be designed to suit majority of the user population therefore it should be concentrated between 5th percentile female to 95th percentile male which covers majority of the user population.

Meghna (2013) conducted research on "Classroom furniture dimensions and anthropometric measurements of children in public schools". The main aim of study was to analyse the problems faced by children while sitting on classroom furniture and to correlate the dimensions of

classroom furniture with the school children's body dimensions. For this purpose, five publics schools were selected in New Delhi. After identification of schools, the researcher visited schools under study and selected 450 school children from these schools for collection of data. The data was collected with help of two tools Questionnaire and Observation. An anthropometric measurement of each child was compared to the relative furniture measures in order to identify a match or mismatch between the specific child and the furniture he/she uses. The data in this study indicated a substantial degree of mismatch between the bodily dimensions of these sixth through eighth graders and the classroom furniture available to them. However, it was also concluded that health professionals working in schools should be aware that full accommodation of students' needs would require ergonomically redesigned classroom furniture.

Goilkar et.al., (2016) conducted research on "A Review of Design and Development of College Bench by Ergonomics & Anthropometry Concept". This was aimed to suit not only a range of postures but a range of users. Reliable anthropometric data for a target population were necessary when designing for that population otherwise the product may not be suitable for the user. The use of anthropometric data in the design of school desks and tables in almost all modern developed countries has been acknowledged. Benches are very important in school and colleges. So, this paper deals with extensive review of design concept according to Ergonomics & Anthropometry.

Descriptive research was conducted by **Desai and Taifa (2017)** on "Anthropometric measurements for ergonomic design of students' furniture in India". The major aim of the study was to collect anthropometric measurements from population group (engineering students) and establish standard selection criteria and dimensions which are essential for designing an adjustable chair and table at engineering colleges from Gujarat State in India. 478 Students (290 males and 188 females) from three engineering colleges aged (aged 17–37 years) participated in the study. The students helped in getting health survey

(ergonomics assessment) and anthropometric measurements. The data were measured with the help of various tools. After data collection and analysis, authors came up with exhaustive dimensions for designing adjustable classrooms furniture. Dimensions recommended include; bench surface height, bench depth and width, back rest width and height, backrest angle, desk height, desk depth, width and desk angle. Therefore, an implementation of these data will help to create comfortability, safety, well-being, suitability, reduce Musculoskeletal disorders and improve performance of students in terms of attentiveness.

Kalurkar and Salunke (2017) undertook a research on “Evaluation of classroom furniture from ergonomic design considerations”. The present study is aimed to evaluate the different dimensions of classroom furniture with respect to anthropometric measures of students. For this purpose, 982 students in the age group 10-16 years are selected from 3 different schools from Solapur city. Various anthropometric measurements of the students are taken. Similarly, Dimensions of the existing desks available in the respective classrooms were also measured. Statistical analysis of the anthropometric data collected was done and relevant statistical parameters are estimated using SPSS software. The existing classroom furniture dimensions were compared with these match criteria. The results from the present study show that there is substantial mismatch between the existing classroom furniture and the anthropometric measurements of the students.

Singh and chahal (2017) carried a study on “Evaluation of fitness between school furniture and student body size”. The aim of present study was to determine the level of mismatch between student’s size and the furniture that they use at college. A total of 30 students were investigated. The body size of each student was assessed using standard anthropometric measurement technique. The existing furniture dimensions were also measured including seat height, depth and slope; table/desk height, depth and slope. The comparison between body size and furniture dimension was done by using parcels et al. (1999) scale.

The result of the study showed that, height of seat and desk/ table was appropriate for the students but seat depth and leg clearance space were not appropriate with student dimensions. The overall ergonomic design score of furniture was 4.5 and it showed that the design was poor and not appropriate for the students

Banerji and Bhattacharya (2019) carried research on “Design of Adjustable Desks and Chairs for University Classrooms Suitable for Students of Jadavpur University, India”. This paper demonstrates how adjustability of classroom desks and chairs can help to accommodate students of different body sizes. The first part of the of research deals with REBA analysis, used for ergonomic evaluation where very high final scores in the range of 8-10 were obtained. This included 20 U.G. students of Production Engineering Department of Jadavpur University, consisting of 16 males and 4 females, was inspected for REBA analysis. The second part of the paper suggests a suitable design for the desks and chairs with appropriate dimensions taking into consideration the anthropometric measurements of 48 students (41 males and 7 females) of Production Engineering department of Jadavpur University, Kolkata.

A research study by **Ilangkumaran et. al., (2019)** was conducted on “Ergonomic Assessment of Classroom Furniture in K.S. Rangasamy college of Technology”. The purpose of study was to examine the anthropometric match of the classroom furniture with standard ones. The structural defect of the furniture like cracks, scratches and breaks were also taken into account. The study found out that Shoulder and back pain problems are common among the college students. Students experience such problem due to low quality design desk bench. Hence, it was necessary that the college furniture should fit the requirements of the students. Matching furniture to anthropometric measurements was an important factor that should be considered in college furniture design.

2.2.3. Researches Related to design and development

Lin and Kang (2012) conducted a study on “Ergonomic Design of Desk and Chair for Primary School Students in Taiwan”. The objective of this

study presents an ergonomic application of anthropometric database which was established by National Science Council and National Tsing Hua University in Taiwan for designing high school and primary school desks and chairs. Finally, bases on the anthropometric database, the anthropometric consideration of school furniture is suggested for designing primary school desks and chairs in Taiwan. The design approach proposed a series of desks and chairs adjustable in ergonomic issues. In design consideration, the production cost, ease of management and installation is important factors to undertake in this project. The structure of adjustable item has been applied for pattern. The evaluation stage is holding on next stage in order to exam the design achievement. This study can be reference of how to use anthropometric database and ergonomic in product design.

A study conducted on "Student Furniture Design as Behavioural and Local Business Resources" by **Wardono and Susanto (2012)** analyses how students live and work in relation to the need for room furniture and how small local furniture traders face problems in response to that need. Data was collected through questionnaire from 123 students and descriptive statistic and Chi-square test were used. It was found that male and female students prefer furniture that is affordable, simple, natural, multifunction and durable, besides light, practical and flexible. Also, a new model was proposed to solve the traders' business problem.

Maheshwar and Javalkar (2014) conducted a research on "Ergonomic based design and survey of Elementary School Furniture"**.** This paper presents the ergonomic aspects in designing and prototyping of desks cum chairs used in elementary schools. The procedures adopted for the assessment included- the study of existing school furniture, design analysis and development of prototypes. The design approach proposed a series of adjustable desks and chairs developed in terms of ergonomic concepts. In the development stage, the production cost, ease of management, installation and storage were the important factors undertaken. A questionnaire based subjective comfort evaluation survey was carried out on the developed prototypes and the results showed

good response and satisfaction levels upto an overall 94 %. The details on the ergonomically designed prototype, its development process and customer satisfaction survey have been elaborated in this paper.

Ansari et. al., (2017) carried out the research on “Design and Development of an Ergonomic Chair for Students in Educational Settings”. The aim of this study was to design and develop an ergonomic chair, based on anthropometric data of students in educational settings. Anthropometric parameters were obtained from a stratified-random sampling with sample size of 207 students. In this study, an ergonomic chair was designed based on anthropometric data from students. The seat height, depth, and width of the chair were determined as 44 cm, 42 cm, and 42.15 cm, respectively. The height of the desk was adjustable in 19 to 29 cm, and the depth and length of the desk were considered as 51 cm and 65 cm. The width and height of the backrest were also 54 cm and 44 cm, and the backrest angle was adjustable in 95° to 105°. The chair was planned in the CATIA software and developed by a three-dimensional print. An ergonomic chair with adjustable parts can reduce musculoskeletal disorders in students. Designer also provided some ergonomic characteristics to the chair which included adjustability of footrest, backrest, armrests, and desk. A chair with such characteristic can be used by many students with different body sizes.

Hinai (2018) conducted research on “An Ergonomic Student Chair Design and Engineering for Classroom Environment”. This research study is proposed an innovative ergonomic chair design and engineering with the objective to satisfy all the basic needs of the students in the classroom environment. In order to design and engineering this proposed chair, relevant data was collected from the prospective students through face-to- face interview, and both online and off-line questionnaires surveys. The proposed chair was tested and validated and fine-tuned based on the students’ feedback after using it exclusively. This research study is concluded with study limitations and future research directions.

Kumar et.al., (2018) conducted research on “Ergonomic Design of Table and Chair based on QFD and Anthropometric Measurement and improved Facility Layout”. This study analysed the probable mismatch between university table and chair dimensions and anthropometric characteristics of 200 Bangladeshi (Jessore University of science & technology) students and emphasize on student needs. Comfortable learning in a classroom depends on several concealed factors and appropriate university furniture like tables and chairs. A remarkable mismatch was identified between student’s body dimensions and the classroom furniture (namely chair and table) dimension. Table height of the classroom furniture was low for the students. Also, the seats were high for the students. These conditions may lead to pain and musculoskeletal disorders. This research proposed dimensions that satisfied the anthropometric measurement to reduce the problem. The findings of the study also clearly demonstrate that the design and allocation of classroom furniture for Bangladeshi university students should be made according to anthropometric judgment to avoid unnecessary problems.

Muley (2018) conducted a case study on “Furniture Design for Pre-Primary School Children”. The aim of this study is to the design classroom furniture for school children aged in between 2-7 years old that will help to the development in terms of child’s social, cognitive, physical and emotional development. Project involves furniture design considering three aspects as visually interesting, ergonomically comfortable and logically engaging. Furniture is able to help them to learn playful and fun way. As a result, it was found that Existing furniture is not made as per anthropometric measurement for pre-primary school children. Thus, every school must check the school furniture as standard anthropometric measurement which will lead for children a comfortable sitting and increase in concentration in the class. Anthropometric measurement data of each individual child should be compared to identify a match or mismatch between the students and the furniture.

Healthy sitting culture and ergonomic issues are vital for reducing problems of school children.

Research conducted by **Burak et. al., (2020)** was on “The optimal design of school desks depending on the height and weight of students”. The aim of this research was to determine the most favourable posture of students while sitting, considering the relevant ergonometric and biomechanical characteristics of the human body. For the proposed model of the school bench which allows adjusting the different slopes of its surface, the corresponding computer model of the student and the table was first created, and then biomechanical and RULA analysis was performed in order to determine the maximum load in the lumbar part. The proposed ergonomic design of the desk will result in students being adequately positioned during their activities at school with the minimal risk of permanent deviations and other health problems.

Esmaeel et.al., (2020) conducted research on “Design of Classroom Furniture for use at Tertiary Institutions”. The aim of the research is to use the concept of ergonomics to design classroom desktop-chair for students in Uasin-Gishu County. Anthropometric data was collected from a total of 382 students of both genders. The selected tertiary institutions for the survey were Moi University (MU), University of Eldoret (UoE), Rift Valley Technical Training Institute (RVTTI) and The Eldoret National Polytechnic (TENP). The analysed anthropometric data set was used to design, a suitable classroom desktop-chair. The results revealed that mismatch between the students' body dimensions and the classroom desktop-chairs dimensions that may have discomfort for students in the long run. From the present research, it is well expected that criteria determinant for an adjustable desktop-chair needs to be used whenever designers wish to have adjustable classroom furniture (which is ergonomic design desktop-chairs) in the four selected tertiary institutions, Uasin-Gishu County, Kenya.

2.3. Conclusion

From the review of existing literature on various topics namely Anthropometry and Musculoskeletal problems, it was seen that there is a major mismatched found between furniture dimensions and students' body dimensions. An overview of the research highlighted that most of the studies conducted in Abroad are on Design Parameters of Primary School Furniture, Ergonomic evaluation and College Bench Design. Opinion of students regarding existing furniture and Re-designing of Primary school Furniture were also explored by various researchers. The Researches conducted within India highlighted the mismatched found between students' anthropometric measurements and Existing furniture dimensions. Few researches have also focused on Work posture analysis and Musculoskeletal problems faced by students due to improper furniture.

From these various researches it was inferred that most of the researches were undertaken in schools and keeping in mind the school children. Also, all the researches are based on anthropometry of students and classroom furniture. Hardly any studies have focused on the problems faced by students while using the classroom furniture and designing a furniture which is comfortable for the students of the universities. This motivates the researcher to study the problems that are faced by the students while using existing classroom furniture and Design a Prototype of Chair and Adjustable Table.

METHODOLOGY

CHAPTER – III

METHODOLOGY

The present investigation was undertaken to gather information regarding problems faced by the students with existing furniture while working in practical classes and designing a prototype for the selected practical room. The research was designed after reviewing various research outside India and within India. It was seen that there were several design aspects considered to design a piece of furniture, but due to certain limitations, the researcher could use specific design aspects for designing the prototype.

In order to achieve the aims of the present study, a detailed plan of work and the sequential procedure were followed which is presented in this chapter under the sub-headings:

3.1 Research Design

3.2 Operational Definitions

3.3 Locale of the Study

3.4 Unit of Inquiry

3.5 Sample Size and Sampling Procedure

3.6 Selection, Development and Description of the Tools

3.7 Data Collection

3.8 Data Analysis

3.9 Phases of Product Development

3.1. Research Design

The research design for the present investigation was descriptive in nature. Descriptive design was thought to be the most appropriate method to carry out the present research because it aims to gather demographic details of the students and problems faced by the students while working on existing classroom furniture.

3.2. Operational Definitions

3.2.1. Classroom Furniture: For the present study, Classroom Furniture was operationally defined as furniture used by the students for their practical classes.

3.2.2. Student: For the present study, it was defined as those Bachelor's students who were studying in the second and third year of Interior Design and Hospitality Management, in Department of Family and Community Resource Management.

3.2.3. Prototype: It was operationally defined as the Design of a chair and adjustable table for the students of Department of Family and Community Resource Management.

3.3. Locale of the Study

The present study was conducted in The Department of Family and Community Resource Management, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, Fatehgunj, Vadodara.

3.4. Unit of Inquiry

For the present study, the unit of inquiry were the students of the second and third year whose practical classes were held in the selected practical room no. 205 of The Department of Family and Community Resource Management, Faculty of Family and Community Sciences.

3.5. Sample Size and Sampling procedure

For the present study, the Purposive sampling technique was used to select the respondents. 80 Students from Second and Third year were selected

whose practical classes were held in the selected practical room No. 205 of The Department of Family and Community Resource Management. Further, from 80 respondents, 17 students who were facing highest problems in existing furniture were selected for testing the prototype.

3.5.1. Sample Selection Criteria

3.5.1.1. Inclusion Criteria

- For the present study, the practical room was limited to room no. 205 of The Department of Family and Community Resource Management.
- The Study was limited to students of the second and third year who were willing to participate.
- The study was limited to designing aspects like Historical precedent, Principle of design, design process, the material of the furniture, and fabrication process of the furniture.

3.5.1.2. Exclusion Criteria

- The study did not focus on anthropometric data of respondents as the selected population group was circulatory and can change after a period of time.

3.6. Selection, Development and Description of the tools

The exhaustive review of literature helped the researcher to select and prepare the required tool to facilitate data collection for the present study.

3.6.1. Selection of tool

In light of the objectives framed for the present study, Questionnaire - one data-gathering tool, a Record Sheet for recording the Designing aspects of the existing furniture and a Feedback form was prepared for a new prototype developed.

3.6.2. Description of tool

1. Questionnaire

A structured questionnaire was constructed keeping in view the objectives of the study. It comprised of two sections.

Section I: Background information of respondents.

This section contained questions related to respondents' background information like name, age, gender, specialization, year of study, weight and height.

Section II: Questions related to problems faced by students while using the existing classroom furniture of the selected practical room.

This section contained questions related to problems faced by the respondents while using the existing furniture of the selected practical room during their practical. The section II was divided into two parts: Problems faced due to body posture and Problems faced due to furniture. The responses were taken in 2 - point scale "faced" and "not faced".

2. **Record Sheet**

This included recording the dimensions of existing furniture (Table and Stool) and other designing aspects such as materials, durability and finishes used.

The measurements considered for existing furniture were:

- **Table**: Total Height, Length of the Table Top and Width of the Table Top
- **Stool**: Total Height of Stool, Seat Diameter and number. of Legs
- **Footrest**: Height from floor, Length, Width, Shape and Angle of the footrest.

3. **Feedback Form**

This included questions related to the new prototype developed. It was divided into two parts: the first part included questions related to the adjustable table and the second part included questions related to the chair.

3.6.3. Development of the tool

Tools were developed based on the information collected through a review of related literature by the researcher. Due consideration was given to include all points that would elicit the information needed to attain the objectives of the study.

3.6.4. Establishment of content validity of the scales

Based on available existing literature, a tool regarding problems faced by the students was prepared and given to the panel of 11 judges comprising of teachers from the field of Interior Design and Faculty of Family and Community Sciences. They were requested to state whether each statement fell in a category under which it was listed and to check the clarity and relevance of the content for each scale. The suggestions of judges were taken into consideration for the inclusion of the statement in the final tool. Changes were made accordingly and the final tool was prepared.

3.7. Data Collection

The data was collected by the researcher herself. Consent from each student was taken. Thereafter, the data was collected on a convenient time and day. The Data was collected in two phases by the researcher. The first phase included collecting data through questionnaire regarding the problems faced in the existing classroom furniture. The questionnaire was given to the respondents and data was collected between December 2022 to January 2023. The second phase included collecting data through feedback form regarding the new prototype developed in month of February 2023 through interview schedule. The purpose of the research was explained and rapport was built to get the true responses.

3.8. Data Analysis

The data was analysed by calculating frequency and percentage through descriptive analysis.

3.8.1 Categorization of Data

The following categories were made to enable researcher to analyse the data.

Section I: Background Information of the respondents

i. Age of the respondents (in years):

- 18-20 years

- 21-23 years
- 24 years and above

ii. **Specialization:**

- Interior Design (ID)
- Hospitality Management (HM)

iii. **Bachelor's Programme:**

- B.F.C.Sc - II
- B.F.C.Sc - III

iv. **Gender:**

- Male
- Female

v. **Weight of Respondent (in kg):**

- 35-54
- 55-74
- 75-93

vi. **Height of Respondents (in cm):**

- 135-154
- 155-174
- 175-193

Section II: Problems faced by students while using the existing classroom furniture of the selected practical room.

To find out the problems faced by students with existing classroom furniture, a set of 29 statements was developed. The responses were taken in 2 - point scale "faced" and "not faced". Also, the existing furniture was observed by the researcher and various aspects were noted down in the Record Sheet. The obtained data was presented in frequency and percentage using Graphs and Tables.

Section III: Developing the Prototype of a Chair and Adjustable Table

After noting the issues raised by the respondents, the researcher set to work creating an adjustable table and chair. The researcher created 2D

and 3D designs using AutoCAD 2016 and SketchUp 2020, respectively. The plans were completed and then sent to the carpenter for final development.

Section IV: Testing of Prototype

After creating the prototype, the researcher tested it on respondents who had more than 70% of issues using the present furniture. They were made to sit on the prototype for an hour in a position that was comfortable for them. The respondents were also given a feedback form to complete evaluating a chair and adjustable table.

3.9. Phases of Product Development

The product development was carried out in three phases during the study:

Phase 1: The Designer found out the problems faced by students in existing furniture and prepare rough sketches of the model design.

Phase 2: The final 2-D and 3-D drawings were prepared with every detail required in the design by using two software: AutoCAD 2016 for 2-D drawings and sketch up 2020 for 3-D drawings.

Phase 3: The prepared drawings of the Chair and Adjustable Table were outsourced to the carpenter for the development of the final prototype.

FINDINGS AND DISCUSSIONS

CHAPTER - IV

FINDINGS AND DISCUSSIONS

An attempt was made to identify the Problems faced by the students in existing classroom furniture and designing a prototype of a Chair and Adjustable Table. This chapter deals with presenting, interpreting and discussing the findings obtained by the analysis of the data collected through Questionnaire. The results are presented in the following sub sections:

Section I: Demographic Information of the respondents

Section II: Problems faced while working on existing classroom Furniture

Section III: Designing and Development of a Chair and Adjustable Table

Section IV: Testing of Prototype developed

SECTION I

4.1 Background Information of the respondents

This section contained personal information regarding age (in years), gender, specialization, year of study, weight (in kg) and height (in cm) of the selected Students studying in Second and Third Year from Department of Family and Community Resource Management.

Table 7: Distribution of the respondents according to their Background information

Sr. No	Background information of respondents	Respondents (n=80)	
		f	%
1	**Age (In years)**		
	18-20 Years	54	**67.05**
	21-23 Years	24	30
	More than 24 Years	2	2.5
2	**Gender**		
	Male	11	13.75
	Female	69	**86.25**
3	**Specialization**		
	Interior Design (ID)	40	50
	Hospitality Management (HM)	40	50
4	**Bachelor's Programme**		
	B.F.C.Sc- II	39	48.75
	B.F.C.Sc- III	41	**51.25**
5	**Weight (in kg)**		
	35-54	40	**50**
	55-74	35	43.75
	75-93	5	6.25
6	**Height (in cm)**		
	135-154	21	26.25
	155-174	55	**68.75**
	175-193	4	5
7	**Duration of time the classroom is used per day (in hrs.)**		
	1-3	5	6.25
	4-6	55	**68.75**
	7-8	20	25

Age (In years): The data in table 6, revealed that more than two-third (67.05 per cent) of the respondents were in age group of 18 to 20 years. It was found that less than one-third (30 per cent) of the respondents were in the age group of 21 to 23 years and remaining less than one-tenth (2.5 per cent) of the respondents were in age group of more than 24 year (Table 7, Fig.1.)

Gender: The data from the Table 6 revealed that majority (85.25 per cent) of the respondents were females while remaining more than one-tenth (13.75 per cent) of the respondents were male (Table 7, Fig.1.)

Bachelor's Programme: The data regarding Bachelor's Programme of the respondents depicted that more than one-half (51.25 per cent) of the respondents were in B.F.C.Sc- III and less than one-half (48.75 per cent) of the respondents were in B.F.C.Sc- II (Table 7, Fig. 1).

Specialization: It was observed from the data that one-half (50 per cent) of the respondents were from Interior Design specialization and remaining one-half (50 per cent) of the respondents were from Hospitality Management specialization (Table 7, Fig. 1).

Weight (in kg): The Weight of the respondents ranged between 35-93kg. Among these more than one-half (50 per cent) of the respondents had weight ranged between 35-54 kg while less than one-half (42.75 per cent) of the respondents had weight ranged between 55-74 kg. It was also observed that very few (6.25 per cent) of the respondents had weight ranged between 75-93kg (Table 7, Fig. 1).

Height (in cm): The data in Table 6 depicted that height of the respondents were in range of 135-193cm. It was found that more than two-third (68.75 per cent) of the respondents had height ranged between 155-174 cm while more than one-fourth (26.25 per cent) of the respondents had height ranged between 135-154cm. It also showed that less than one-tenth (5 per cent) of respondents had height ranged between 175-193cm (Table 7, Fig. 1).

Duration of time the classroom is used per day (in Hrs.): From the data gathered it was found that more than two-third (68.75 per cent) of the respondents spent time in classroom for 4-6 hrs per day. It was observed that less than one-fourth (25 per cent) of the respondents spent time in classroom for 7-8 hrs per day and remaining less than one-tenth (6.25 per cent) of the respondents spent time in classroom for 1-3 hrs per day (Table 7, Fig. 1).

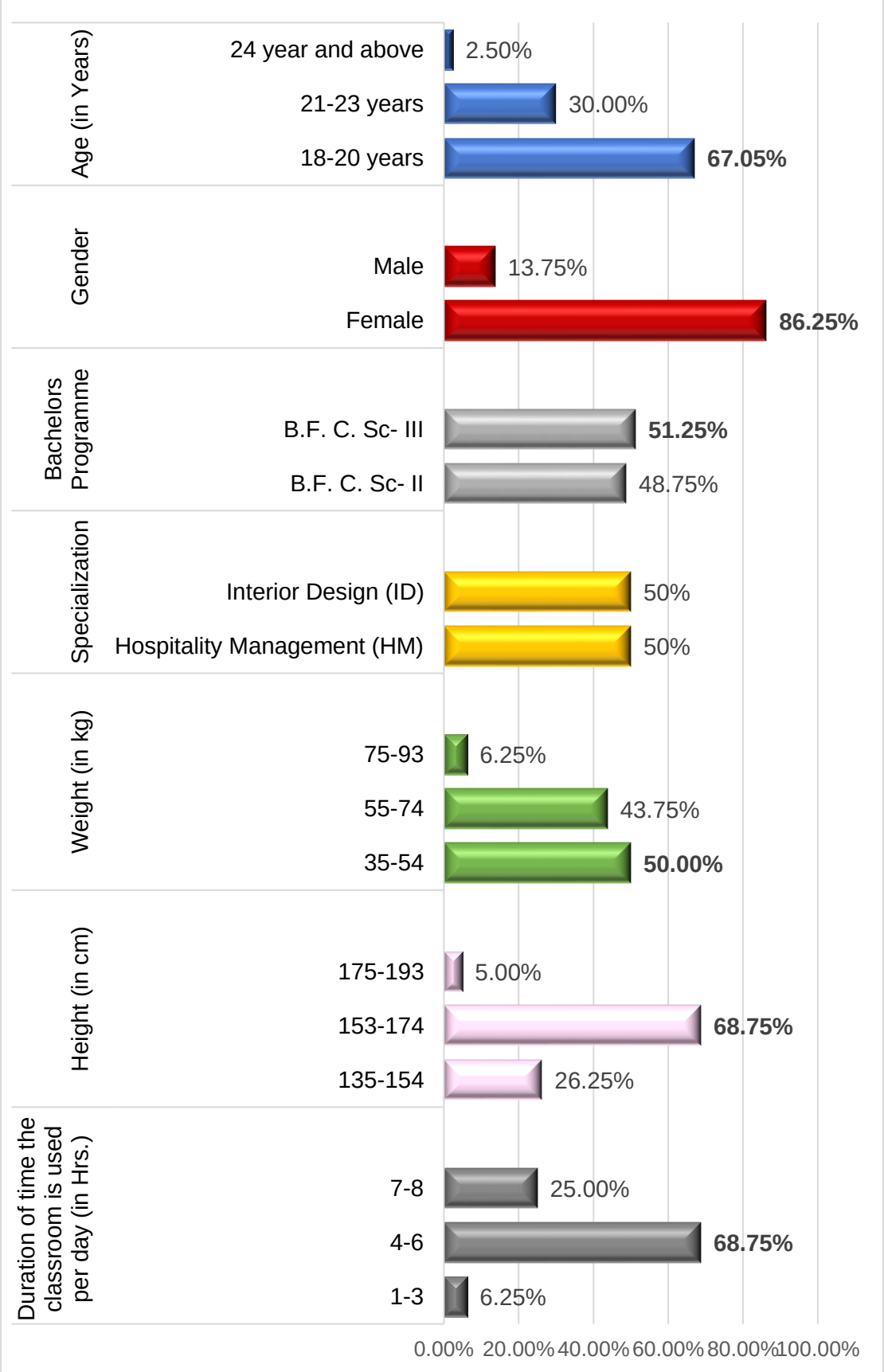


Figure 1: Percentage distribution of the respondents according to their Background Information

SECTION II

4.2. Problems faced while working on existing classroom furniture

This section deals with information regarding problems faced by the students while using existing Classroom Furniture. This section is divided into two parts: one is Problems faced due to body posture and second is Problems faced due to furniture.

4.2.1. Problems experienced due to body posture

This section contains statements regarding problem caused due to the body posture. The conclusion of data gathered is showcased in Table 8 and Fig.2.

Table 8: Distribution of the respondents according to problems experienced due to body posture

Sr. No	Problems experienced due to furniture	Respondents (n=80)			
		Experienced		Not experienced	
		f	%	f	%
1	Pain in Shoulder	63	**78.75**	17	21.25
2	Pain in middle back	58	**72.50**	22	27.50
3	Fatigues caused due to sitting posture	57	**71.25**	23	28.75
4	Pain in neck	54	**67.50**	26	32.50
5	Pain in upper back	53	**66.25**	27	33.75
6	Pain in lower back	52	**65**	28	35
7	Pain in arm muscles	45	**56.25**	35	43.75
8	Pain in hip muscles	44	**55**	36	45
9	Pain in thigh muscles	42	**52.50**	38	47.50
10	Pain in feet	39	48.75	41	**51.25**
11	Pain in hip joint	39	48.75	41	**51.25**
12	Pain in wrist	37	46.25	43	**53.75**
13	Pain in knee joint	35	43.75	45	**56.25**
14	Pain in upper arms	34	42.50	46	**57.50**
15	Pain in lower arms	34	42.50	46	**57.50**
16	Pain in elbow	32	40	48	**60**
17	Pain in ankle joint	20	25	60	**75**

The data gathered revealed that more than three-fourth (78.75 per cent) of the respondents experienced pain in their shoulder while working. Moreover, less than three-fourth (72.50 per cent) of the respondents experienced pain in middle back and more than two-third (71.21 per cent) of the respondents experienced fatigue due to their sitting posture. It was also observed from the data that less than one-fourth (25 per cent) of the respondents experienced pain in their ankle joint (Table 8, Fig 2).

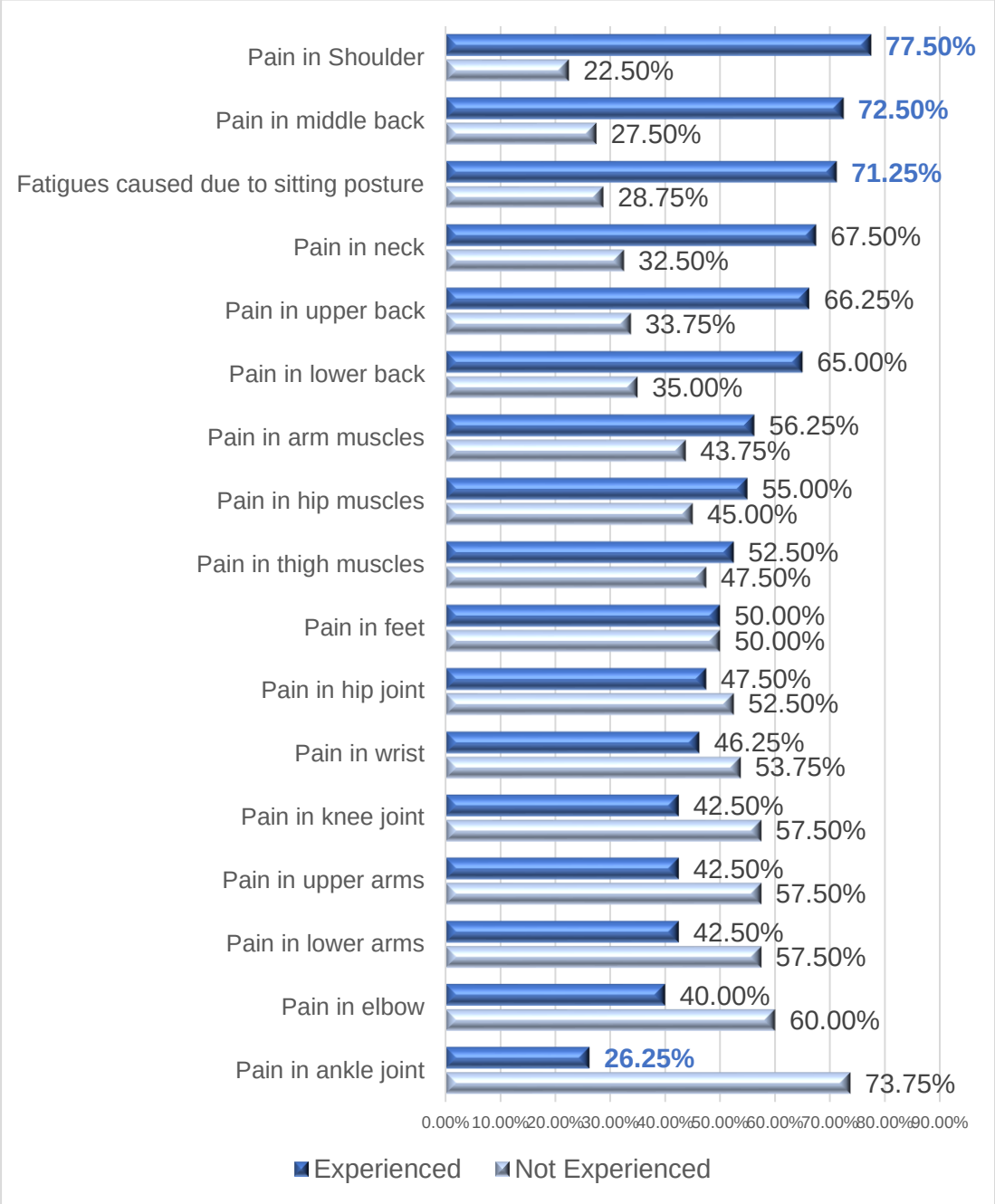


Figure 1: Percentage distribution of the respondents according to problem Experienced due to Body Posture

4.2.2. Problems Experienced due to furniture

This section contains statements regarding problem caused due to the furniture. The conclusion of data gathered is showcased in Table 8 and Fig.3.

Table 9: Distribution of the respondents according to problems experienced due to Furniture

Sr. No	Problems experienced due to furniture	Respondents (n=80)			
		Experienced		Not experienced	
		f	%	f	%
1	Insufficient Space for working	66	**82.50**	14	17.50
2	The furniture material is too hard for sitting	52	**65**	28	35
3	Furniture disturbs the sitting posture during class	49	**61.25**	31	38.75
4	Furniture disturbs the standing posture during class	45	**56.25**	35	43.75
5	Front edge of stool gives pressure on the underside of thighs	43	**53.75**	37	46.25
6	Injury caused while using existing furniture	41	**51.25**	39	**48.75**
7	Need to stretch the upper body too much because table height is too high	38	47.50	42	**52.50**
8	Pain below knees because footrest is too low	36	45	44	**55**
9	Pain in knees because stool Height is too low	36	45	44	**55**
10	Need to bend too much table height is too low	34	42.50	46	**57.50**
11	Pain in legs because stool height is too high	32	40	48	**60**
12	Pain below knees because table footrest is too high	32	40	48	**60**

The data on Table 9 and fig.3 revealed that more than three-fourth (82.50 per cent) of respondents found that the space was not sufficient for working. Furthermore, less than two-third (65 per cent) of respondents felt that the

seating material is very hard to sit on for too long. It was also observed that more than one-half (61.25 per cent) of respondents thought that the furniture disturbs their sitting posture during the class. It was also seen from the data that more than one-third (40 per cent) of the respondents experienced pain in their knees because the stool height was too low.

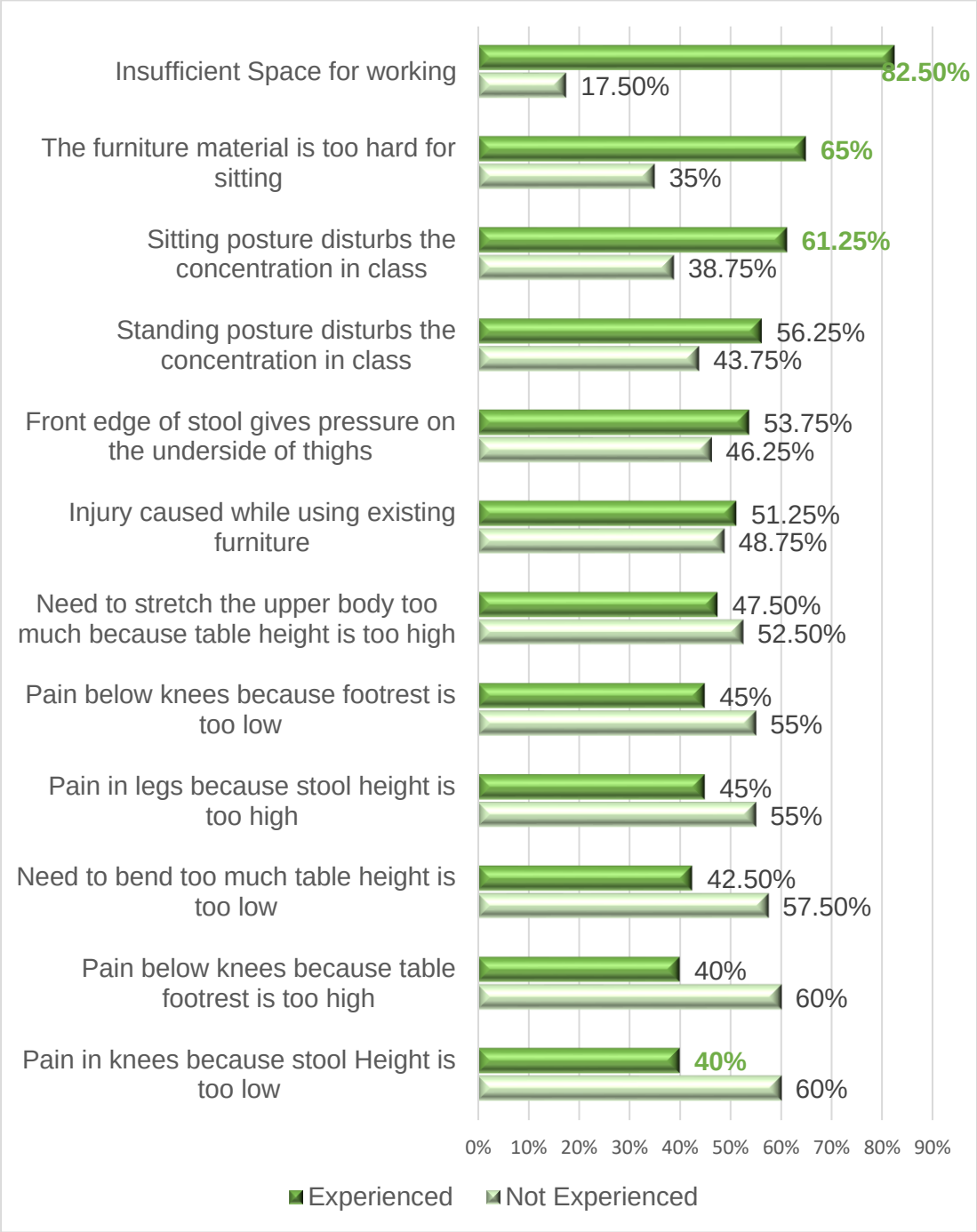


Figure 3: Percentage distribution of the respondents according to problem Experienced due to Furniture.

4.3. Record sheet for observing the Existing Classroom Furniture

This section deals with observations recorded regarding the design aspects of the existing classroom furniture. It includes observing the dimensions and other designing aspects of the material of the furniture. The data in Table 7 and Table 8 represented the designing aspects like Height, Length, Width, Thickness, Material used and durability regarding the existing classroom furniture. As the study was limited to room no. 205 of Department of Family and Community Resource Management, Furniture (Table and Chair) from this room was selected for observation. There were 2 types of tables and 5 types of stools in the room which were measured and observed by the researcher.

Table 10: Designing aspects of the existing Tables

Sr. No	Name of Furniture	Table Top				Footrest						Material			Photos of Existing Furniture
		Height	Length	Width	Thickness	Height from Ground	Length	Width	Angle	Shape	Thickness	Name of Material	Surface finish	Durability	
1	Table A	30”	48”	48”	3”	5”	1”	1”	180^{o}	Rectangular	1”	Plywood with laminate finish and metal frame for legs with brown powder coating	Smooth	25-30 Years	 **Plate 33: Existing Table A**
2	Table B	30”	96”	48”	3”	5”	1”	1”	180^{o}	Rectangular	1”	Plywood with laminate finish and metal frame for legs with brown powder coating	Smooth	25-30 Years	 **Plate 34: Existing Table B**

The Data in Table 10 revealed that there were two types of tables observed by the researcher. The height of the tables was fixed to 30” according to the standard dimensions. There was common Table provided to the students because of which the space for single student was 24” which was not sufficient for designing purpose. Therefore, according to the researcher’s observation the length of the single table was not sufficient. Moreover, the thickness of the table top is 3” which was sufficient and strong enough to work on. The data also revealed that the angle of footrest was 180^{o} which was not comfortable for keeping legs. It is recommended to be less than 30^{o}. The material of the table top was Wood with Laminate finish. It is smooth enough to work on. The researchers also observed that the table was made with combination of wood and metal which made it heavy enough to move.

Table 11: Designing aspects of the existing Stools

Sr. No	Name of Furniture	Stool					No. of Legs	Footrest					Material			Photos of Existing Furniture
		Height	Diameter	Length	Width	Thickness		Height from Ground	Length	Width	Shape	Thickness	Name of Material	Surface Finish	Durability	
1	Stool A	24”	14”	-	-	0.5”	4	6”	10”	1”	Rectangular	2”	Wood finished with Polish	Smooth but hard enough to sit for longer period	20-25 Years	 **Plate 35: Existing stool A**
2	Stool B	24”	14”	-	-	0.5”	4	5”	10”	1”	Rectangular	2”	Wood finished with Polish	Smooth but hard enough to sit for longer period	20-25 Years	 **Plate 36: Existing stool B**
3	Stool C	24”	13”	-	-	0.5”	4	6”	10”	1”	Rectangular	2”	Wood finished with Polish	Smooth but hard enough to sit for longer period	20-25 Years	 **Plate 37: Existing stool C**

Sr. No.	Name of Furniture	Stool					No. of Legs	Footrest					Material			Photos of Existing Furniture
		Height	Diameter	Length	Width	Thickness		Height from Ground	Length	Width	Shape	Thickness	Name of Material	Surface Finish	Durability	
4	Stool D	21”	14”	-	-	0.5”	4	0”	10”	1”	Rectangular	2”	Wood finished with Polish	Smooth but hard enough to sit for longer period	20-25 Years	 **Plate 38: Existing stool D**
5	Stool E	24”	-	14”	14”	0.5”	4	5”	10”	1”	Rectangular	2”	Wood finished with Polish	Smooth but hard enough to sit for longer period	20-25 Years	 **Plate 39: Existing stool E**

The Data in Table 11 revealed that there were five types of stools observed by the researcher. The standard height of stool was 18” from ground level but researcher measured the stools height and it varied from 21”-24”. Also, the footrest provided were at height range of 0”-6” from ground level. It was seen that there was no backrest and armrest in the stool which made it uncomfortable to sit on for long period of time. The researcher also observed that the stools edges were sharp enough which may create pain in the under thigh of the person sitting on it. The material of the stool was also wood finished with polish but the seat material was very hard which can hurt the person sitting on it.

SECTION III

4.4. Designing and Development of a Chair and Adjustable Table

This section describes the phases of designing and development of a Chair and Adjustable Table.

4.4.1. Phase I: Finding out the Problems faced by the students in Existing Classroom Furniture.

For the present study, a review was done, to find out the problems faced by students in the existing classroom furniture. A questionnaire was prepared regarding problems faced in existing classroom furniture and was given to the respondents to fill. After gathering the data, it was revealed that respondents had problems related to the furniture. The respondents experience pain in different body parts (Shoulder, Middle Back, Neck, Upper Back and Lower back) while working on existing furniture. They felt fatigued due to their sitting posture. The data also revealed that more than three-fourth (82.50 per cent) of respondents found that the space was not sufficient for working. Some of them felt the seat material was too hard to sit for longer period.

4.4.2. Phase II: Making of 2-D and 3-D drawings keeping in mind the details of the design.

The design of the chair and adjustable table was developed keeping in mind the problems experienced by the respondents while using the existing furniture as well as observations by the researcher. The researcher listed down all the problems and developed a design of Chair and Adjustable table. The designs were prepared using AutoCAD 2016 and Google SketchUp and then sent to a carpenter to build.

Table 12: Details of Chair and Adjustable Table Design Drawings

A	Adjustable Table	B	Chair
i	Table Top Detail	i	Legs Detail
ii	Leg Detail	ii	Seat Detail
iii	Height Adjustment Detail	iii	Armrest Detail
iv	Angle Adjustment Detail	iv	Backrest Detail
v	Handle Detail		

A. Adjustable Table

The Adjustable Table was designed with both a height adjustment mechanism and an angle adjustment mechanism keeping in mind the standard dimensions. The researcher noticed that respondents struggled to find enough space to work in the existing furniture. As a result, the table was made such that a single person could work comfortably at it.

i. Table Top Detail

The table top, as shown in Plate 40, is composed of three separate components, comprising a 12 mm plywood (2’-6” x 1’-9”) with a laminate finish and two sagwan hardwood box frames (2'-3" x 1'-9" x 2" each) finished with touchwood polish. 5mm Black acrylic (2'-6" x 4") with a 20mm depth is used to make a box for stationary goods. This box was attached to the plywood on the back end. The plywood's edges were shaped using a wooden half-round stick so that the edges turn out to be soft. Moreover, a half-round stick was positioned on the plywood on the user's side to prevent objects from falling when the table top is angled. Stainless steel screws, nut-bolts, and hinges are used to joint every component of the table top together.

ii. Table Legs Detail

The table's legs were made of sagwan wood and coated with touchwood polish, as seen in Plate 41. They are shaped like an X so that the design complements the mechanism and is aesthetically pleasant. Table leg height was specified as 2'-4". In order to prevent the joints from becoming loose over time, they were all screwed together. The distance between the legs was 2’-1”. There were two footrest (2’-1” x 2”) provided one in the front and other at back. The footrests are placed 4” above the ground at angle of 15^{o}.

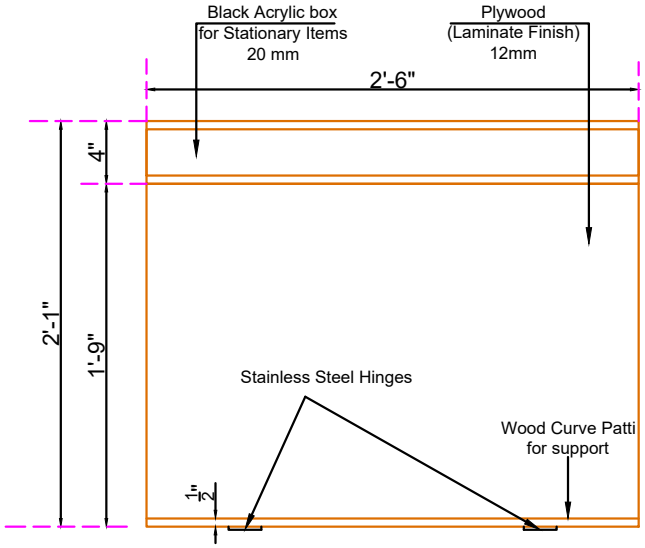


Table Top Detail
Top View

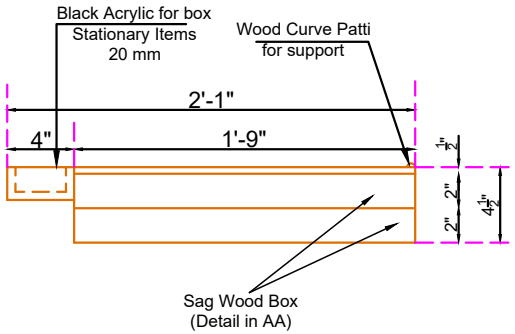


Table Top Detail
Side View

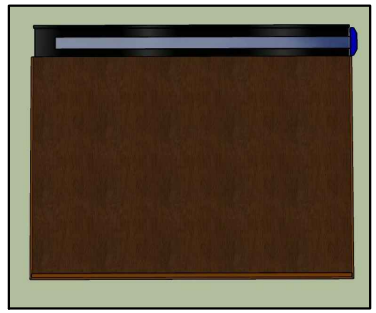
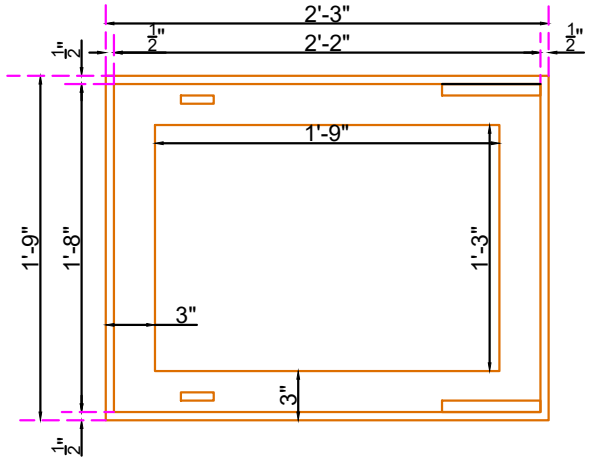


Table Top
Top View (3d)

Table Top
3d View



Detail AA
Sag Wood Box Frame
Internal Detail
Top View

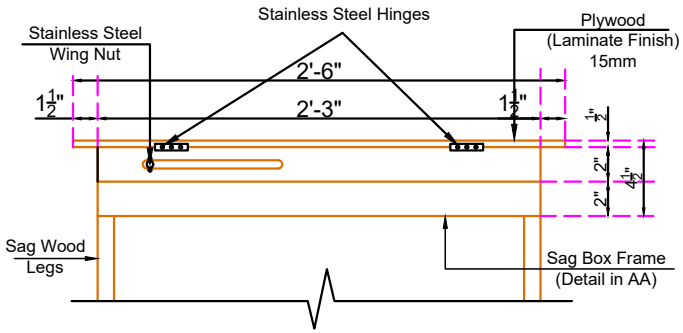


Table Top Detail
Front View

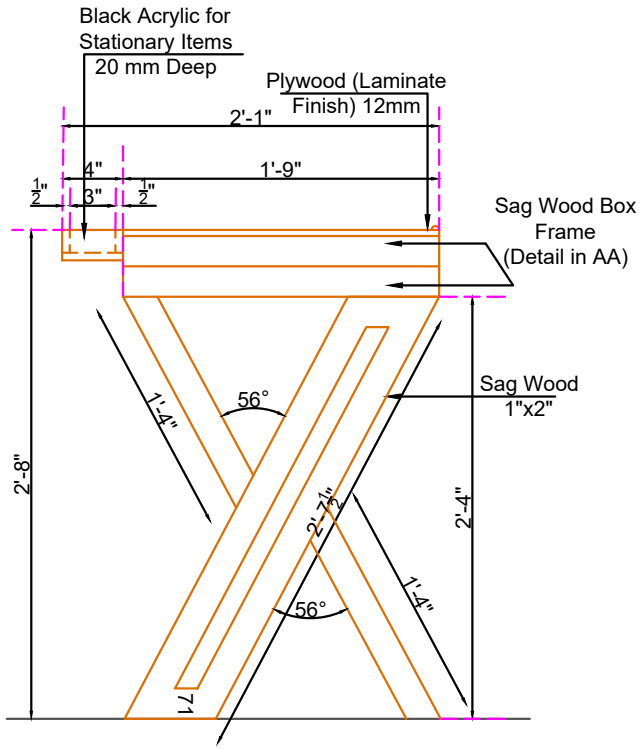
Title	Table Top Detail
Material	There are three different materials used in the Table Top. The Box Frame is made of Sag Hardwood finished in Touchwood Polish. The Main Table Top is Made up of 12mm Plywood with Laminate finish. The Box provided for stationary items is made up of 5mm thick Black Acrylic sheet
Dimension	Main Table Top- 2'-6" x 2'-1" Box Frame - 2'-3" x 1'-9" x 2" Acrylic Box - 2'-6" x 4" x 1.5"

Material Detail

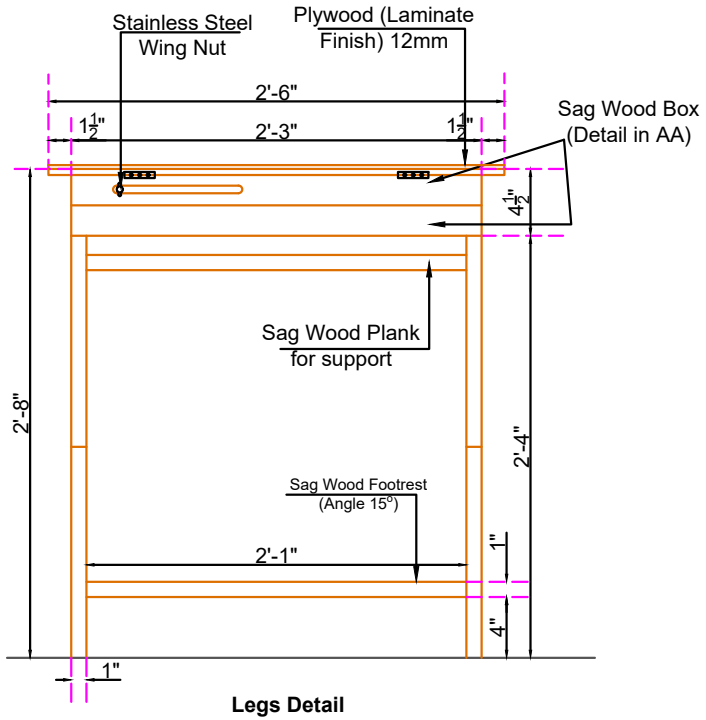
Sag Hardwood | Laminate | Acrylic 5mm

* All Dimensions specified are in Feet and Inches.

Plate 40: Table Top Detail



Legs Detail
Side View



Legs Detail
Front View

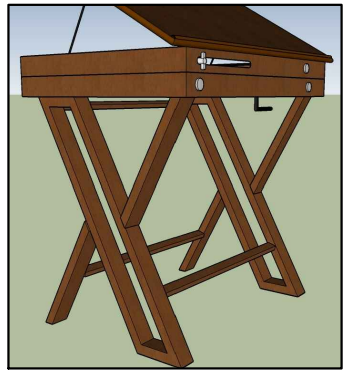


Table Legs Detail
3d View

Table Legs Detail
Front View (3D)

Title	Table Leg Detail
Dimension	Total Leg Height - 2'-4" Footrest Height from Floor - 4"
Material Detail	Sag Hardwood

* All Dimensions specified are in Feet and Inches.

Plate 41: Table Legs Detail

iii. Height Adjusting Mechanism

Two Sagwan box frames measuring 2'-3" x 1'-9" x 2" each, four Sagwan wood sticks each measuring 1'-7" in height and 1" thick, a 10mm stainless steel rod 24" long, a metal handle, and stainless-steel nut bolts make up the Height Adjusting Mechanism. The mechanism was built such that it would automatically get hidden inside the box frame when not in use (Plate 42).

The stainless-steel rod has a handle connected to it, and the rod is fastened to two hardwood sticks on either side using screws and nut bolts. These sticks are connected to the box frame's edges in an X pattern. The table rises when the handle is turned in a clockwise direction, and drop away when it is turned in an anticlockwise direction. Two nuts on either side of the table need to be tightened after the height has been set to a comfortable level so that the table is stable throughout the use.

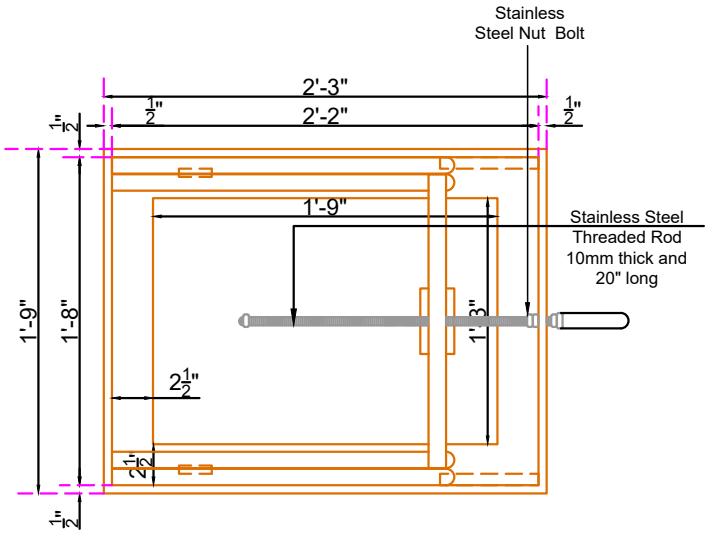
iv. Angle Adjusting Mechanism

For the angle adjusting mechanism a rectangular metal rod was attached to the backside of plywood with hinges so that the metal rod moves easily. On the upper sagwan wood box frame there were 12mm deep grooves done on an interval of 2**”.**

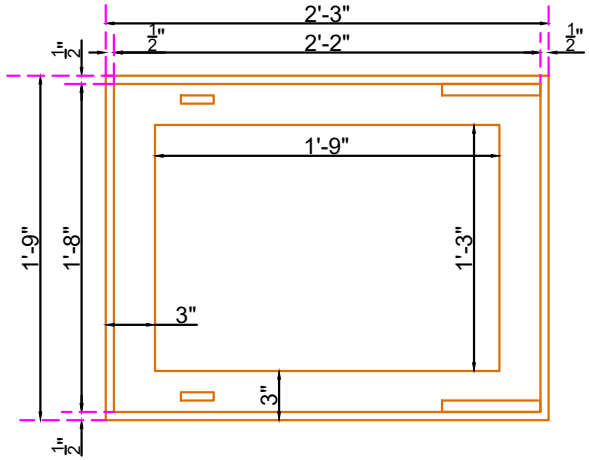
when there is need of angle, the user must pick up the upper most top that is plywood and fix the metal rod inside the groove. It will get stable and user can use the table (Plate 43).

v. Handle Detail

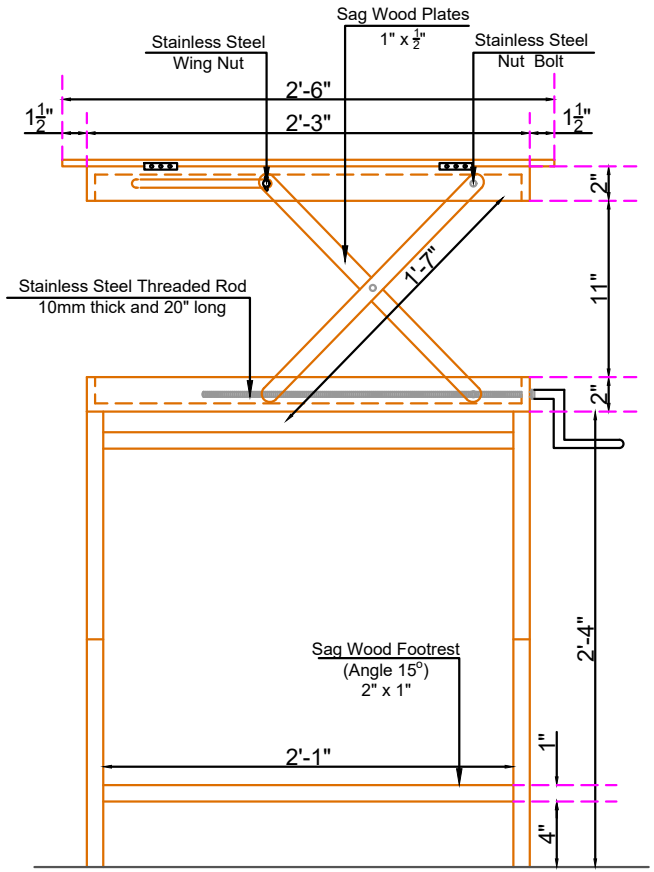
A handle was included to make it simple to operate the height-adjusting mechanism since the Adjustable table was meant to be manually controlled. A simple metal rod with black paint on it served as the handle. For ease of use, the stainless-steel rod and metal handle were joined together by welding. The handle was 2" outside the plywood so that it would not contact the plywood's lower surface. In order to protect the user while operating, the handle has been provided with a rubber grip (Plate 44).



Height Adjustment Mechanism
Internal Detail
Top View



Detail AA
Sag Box Frame
Internal Detail
Top View



Height Adjustment Mechanism Detail
Front View

Height Adjustment Mechanism Detail
3d View

Height Adjustment Mechanism Detail
Front View (3d)

Title	Table Height Adjusting Mechanism Detail
Operation	The Handle when rotated clockwise the Table rises up and when the handle is rotated anti-clockwise the table drops down. The mechanism includes a locking system. when you come to the desired height the person needs to lock the wing nuts provided on two side so that table is stable and does not move.
Dimension	Stainless Steel Rod - 24" long and 10mm Thick Adjustable Height Range- 2'-8" to 3'-8"

Material Detail

Sag Hardwood

Wing Nut

Stainless Steel
Threaded Rod

* All Dimensions specified are in Feet and Inches.

Plate 42: Height Adjusting Mechanism Detail

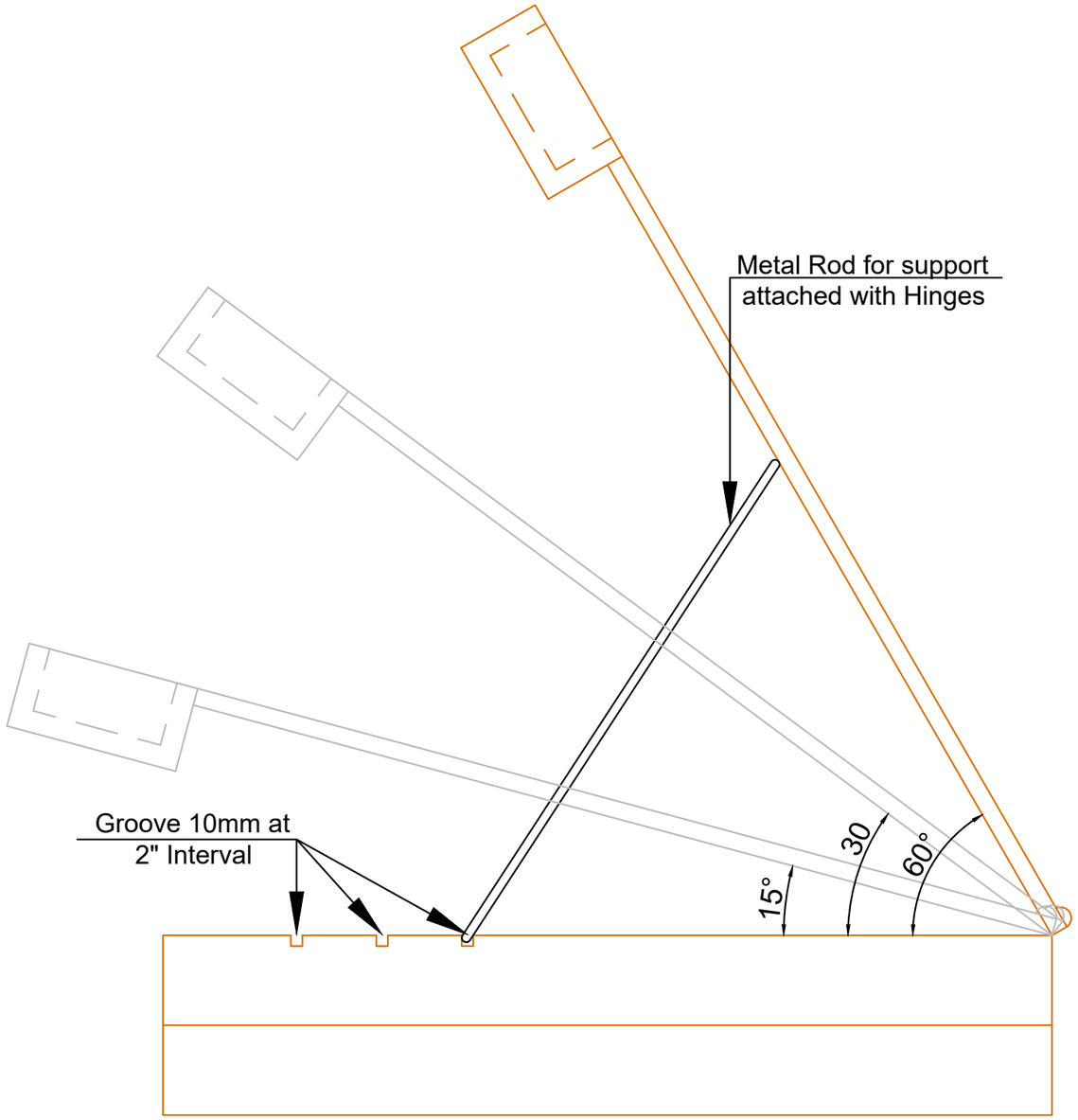


Table Angle Changing Mechanism

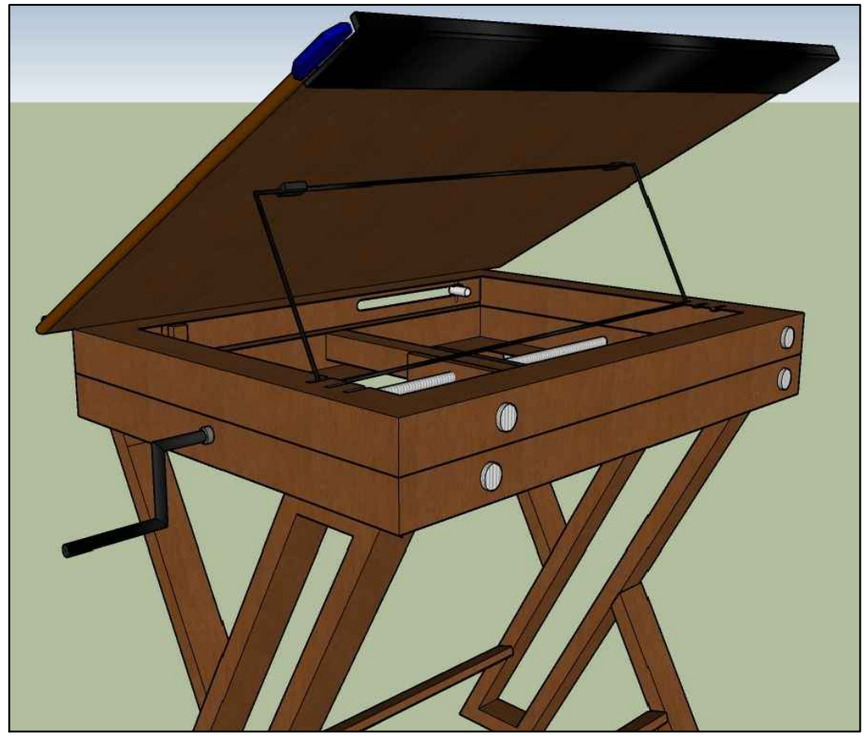
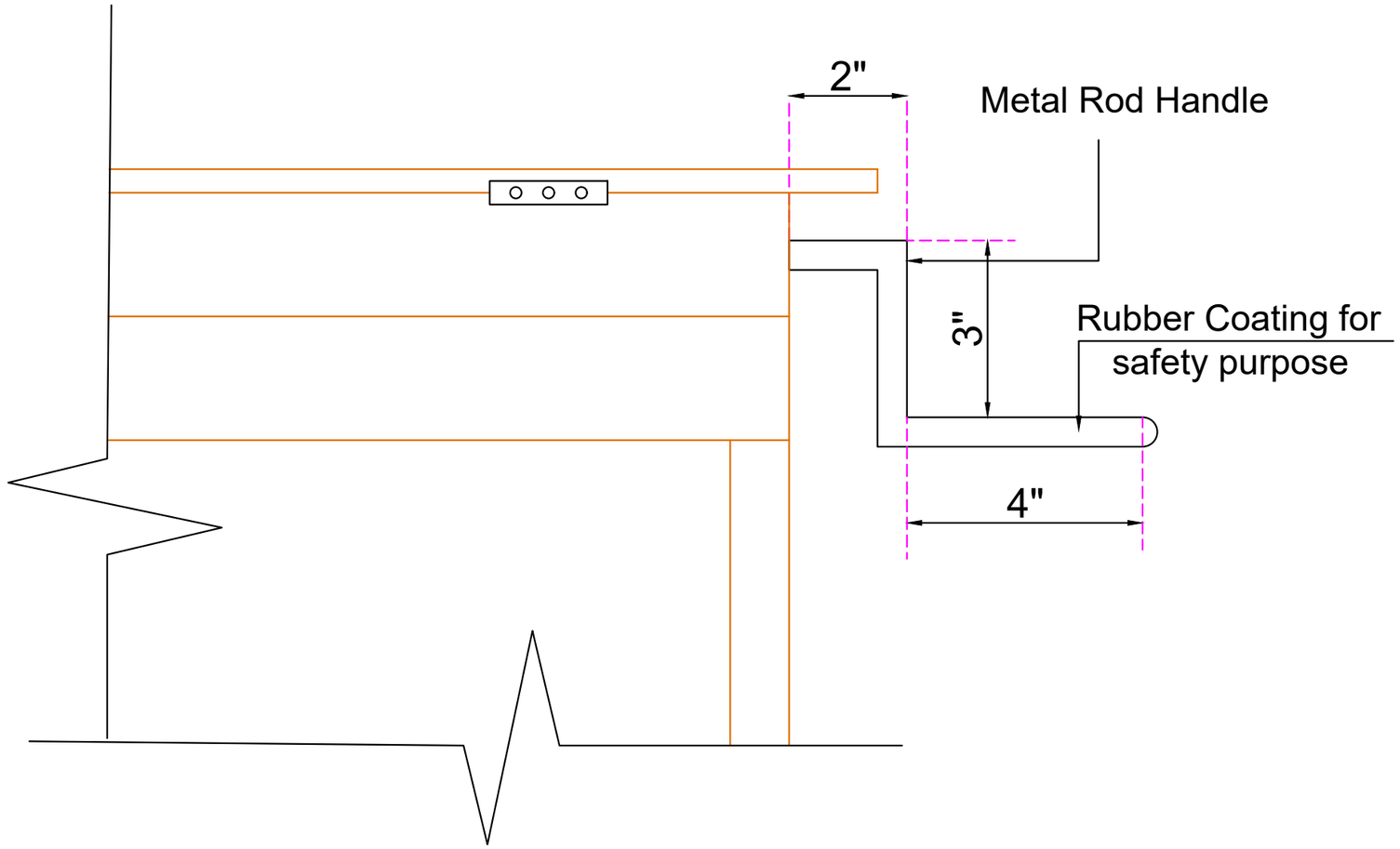


Table Angle Changing Mechanism
3d View

Title	Table Height Adjusting Mechanism Detail
Operation	Rise the main Table top and place the metal rod inside the groove suitable for use so that it gets fix inside the groove and is table while using.
Dimension	Metal Channel - 1'-9" x 9" Grooves - 3 grooves 5mm deep at interval of 2"
Material	Metal finished with Black spray paint

* All Dimensions specified are in Feet and Inches.

Plate 43: Table Angle Changing Mechanism Detail



Handle Detail
Front View

Handle Detail
3d View

* All Dimensions specified are in Feet and Inches.

Plate 44: Handle Detail

B. Chair

The researcher saw that pupils were given stools from the existing classroom equipment, which were not suitable for prolonged use. There were certain elements missing from the current stools. There was no backrest or armrest, and the seat material was hard enough. The stools were at the wrong height in relation to the tables. Researchers created a chair with all of these considerations in mind, making it pleasant to sit in and work for extended periods of time.

i. Chair Legs Detail

To Create a combination with Table, the legs of chair were designed giving an angle of 77^{o}. The legs were made of sagwan wood. The wooden block taken for legs is of 2” by 1”. The height of front legs was 2’-2” and back legs was of 2’-6” (Plate 45).

ii. Chair Seat Detail

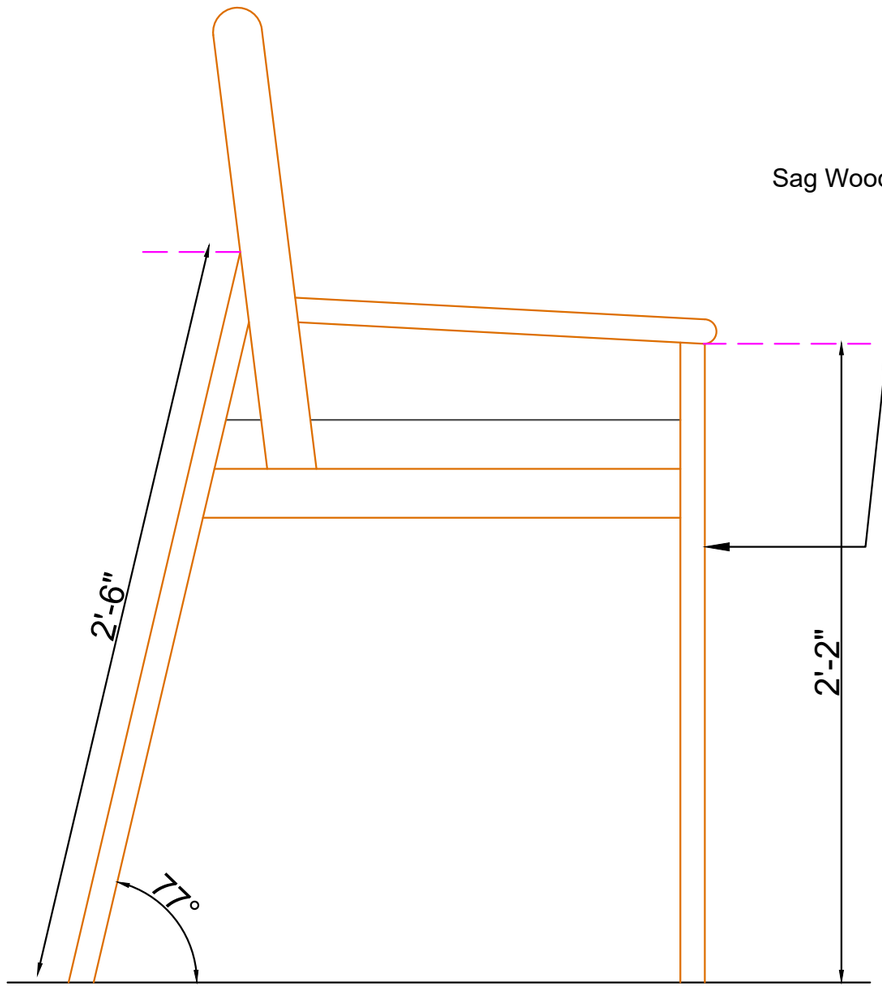
The Chair seat measuring 1’-6” x 1’-10” was made up of sagwan wood frame with 12mm plywood placed above the frame. This plywood was fixed to the frame with metal clamps from inner side so that they were not visible. 2” foam sheet covered with rexine was placed on the plywood to make the seat surface soft. The seat height was 1’-6” from the ground level (Plate 46).

iii. Chair Backrest Detail

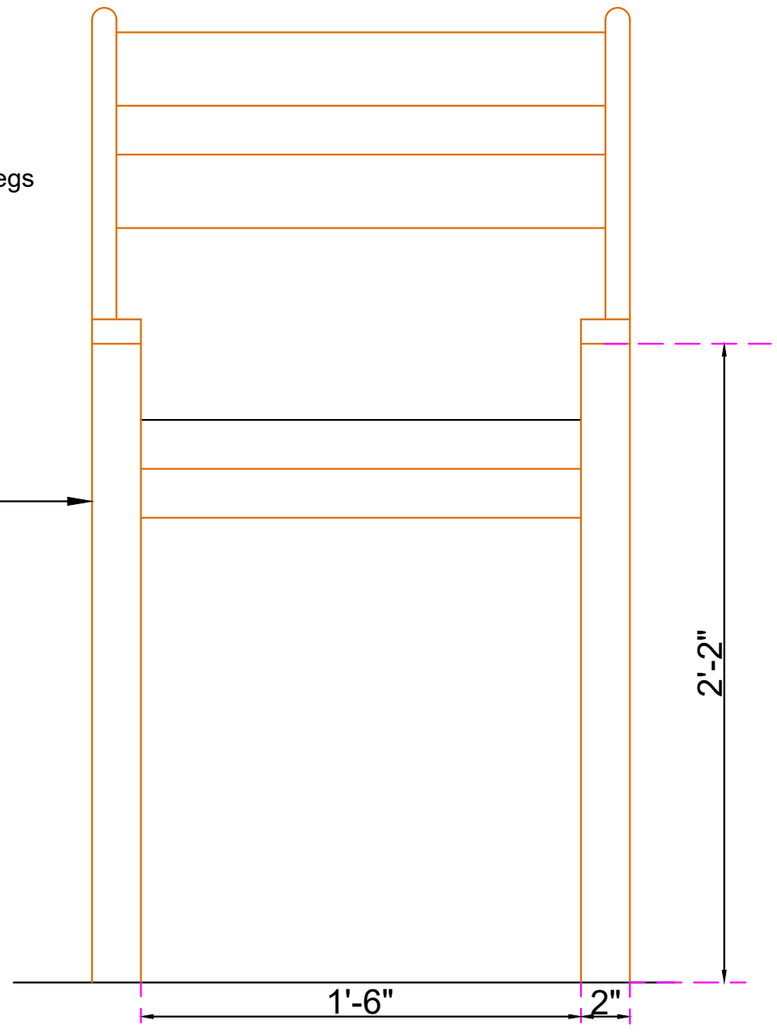
The Backrest of chair was made up of sagwan wood. It is inclined at an angle of 97^{o} from the seat. The backrest consists of two wooden planks of 3” in height and 1’-8” width placed at interval of 2” (Plate 47).

iv. Chair Armrest Detail

The armrest of chair was made with a tilted style. In front the height of armrest was 6” from the seat and at the back it was 7”. The armrest is also made up of sagwan wooden block of 2” width and 1” thickness (Plate 48).

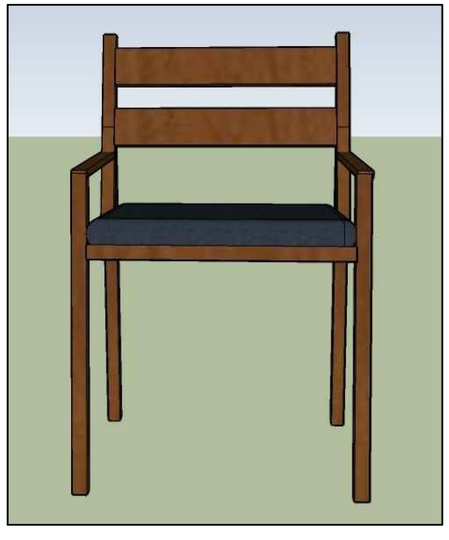


Chair Legs Detail
Side View



Chair Legs Detail
Front View

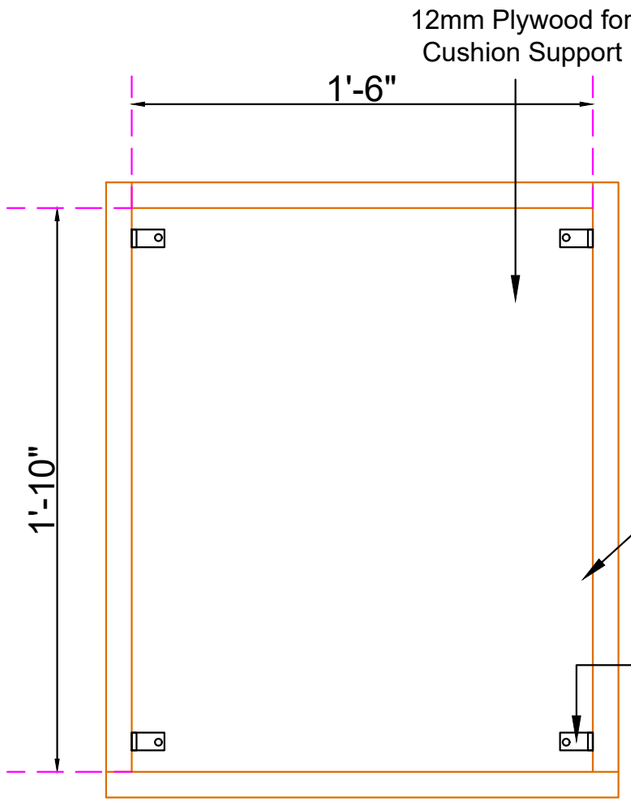
Chair Legs
3d View



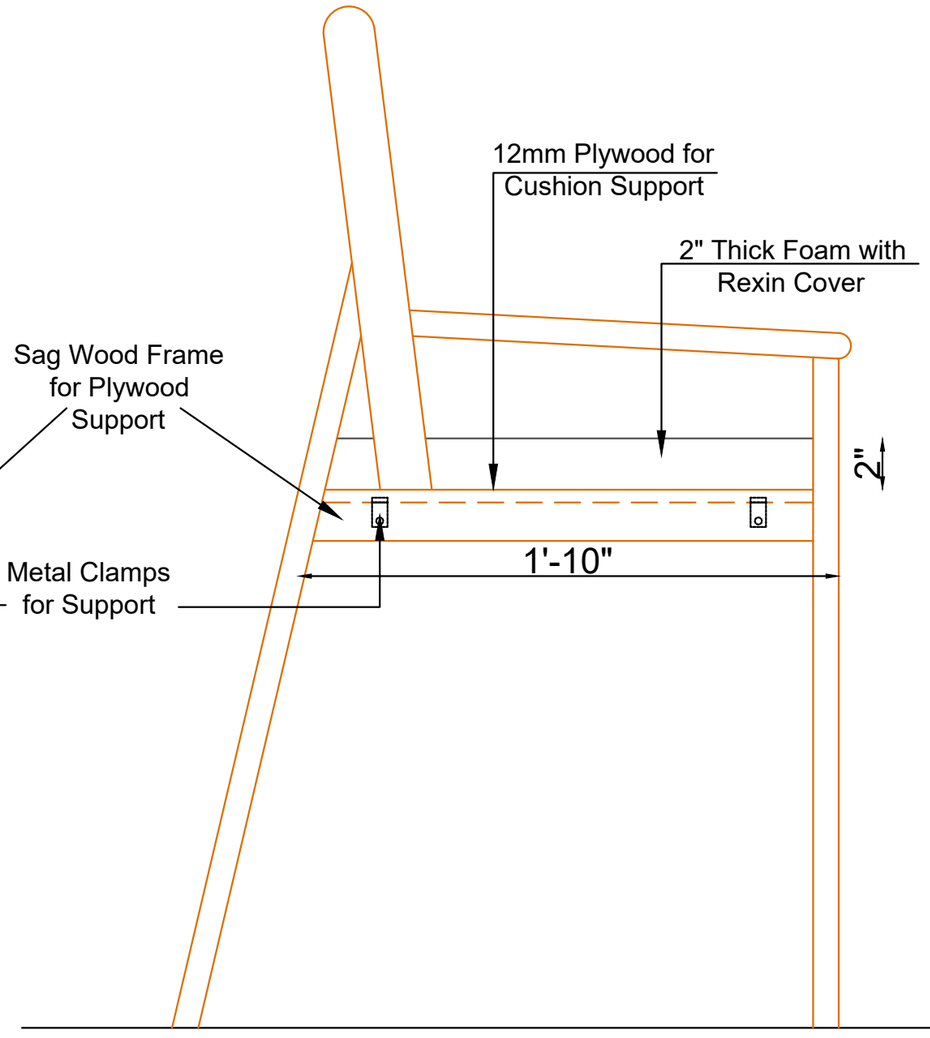
Chair Legs
Front View (3d)

* All Dimensions specified are in Feet and Inches.

Plate 45: Chair Legs Detail

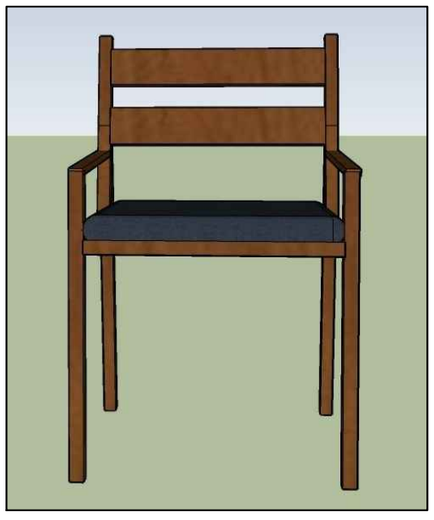


Seat Detail
Bottom View



Seat Detail
Side View

Chair Seat
3d View



Chair Legs
Front View (3d)

* All Dimensions specified are in Feet and Inches.

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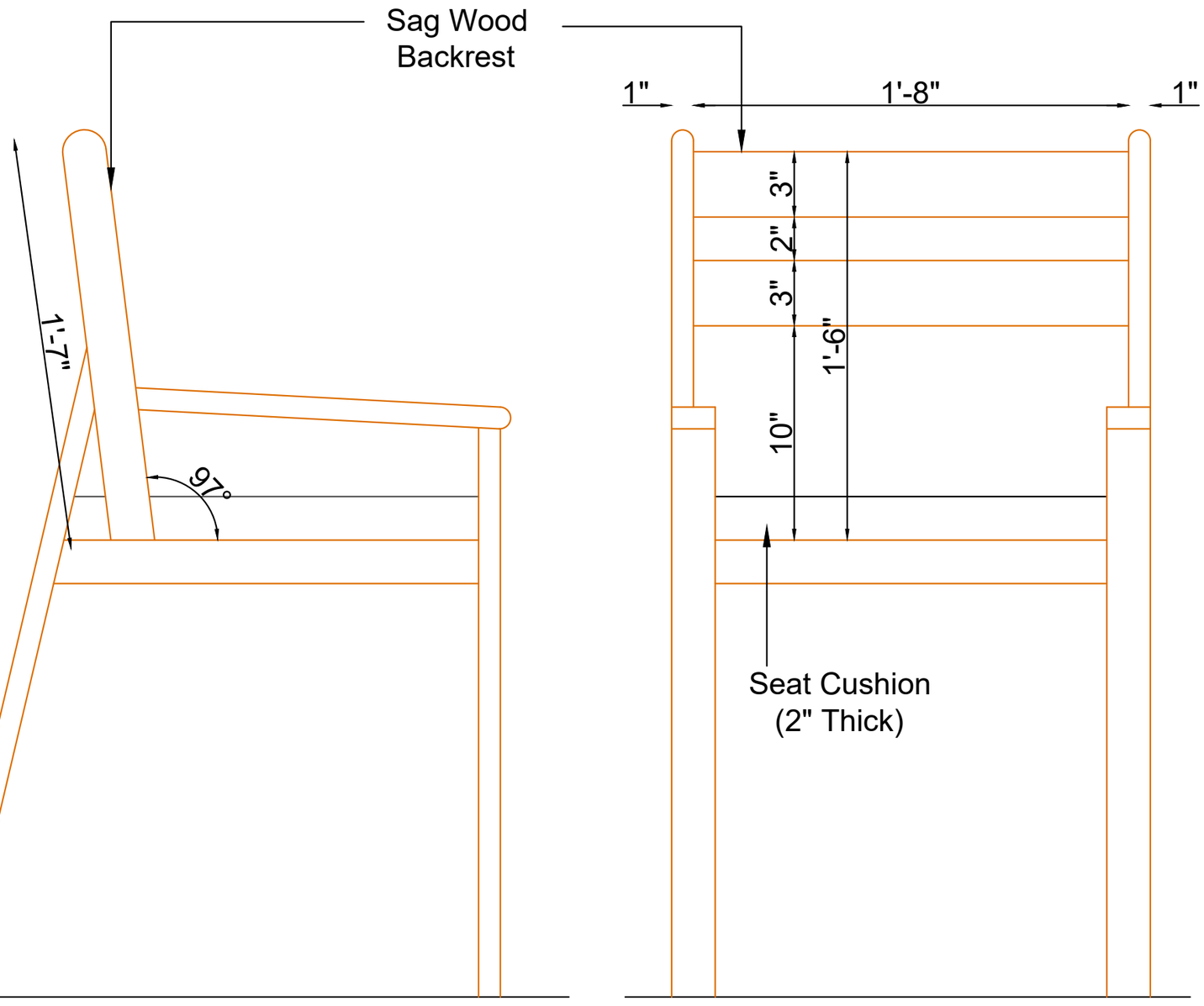
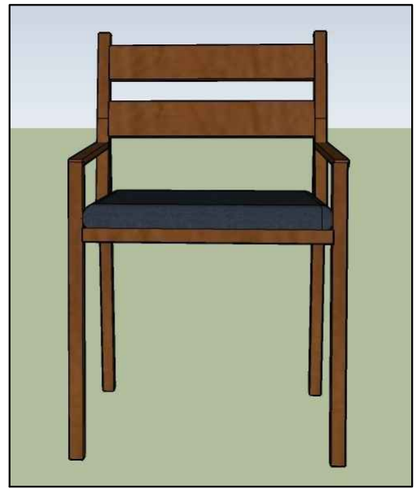
Plate 46: Chair Seat Detail



Backrest Detail
Side View

Backrest Detail
Front View

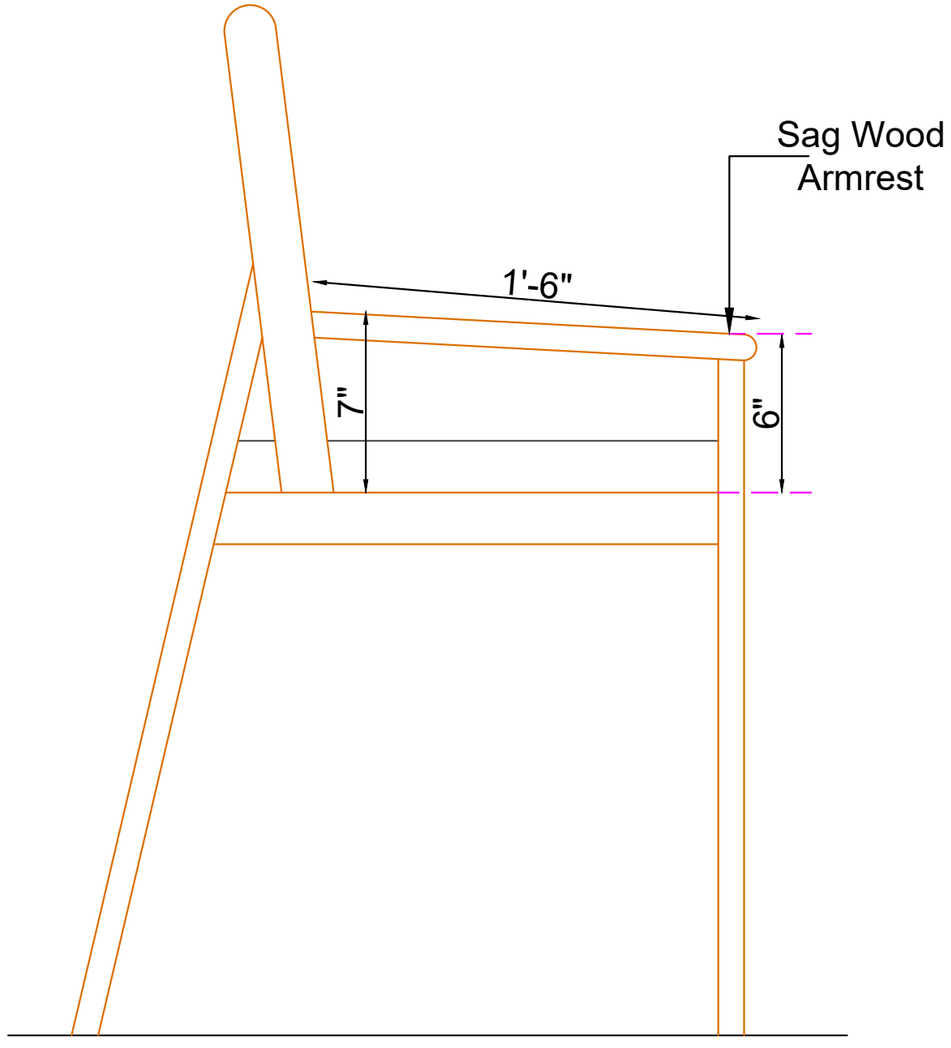
Chair Backrest
3d View



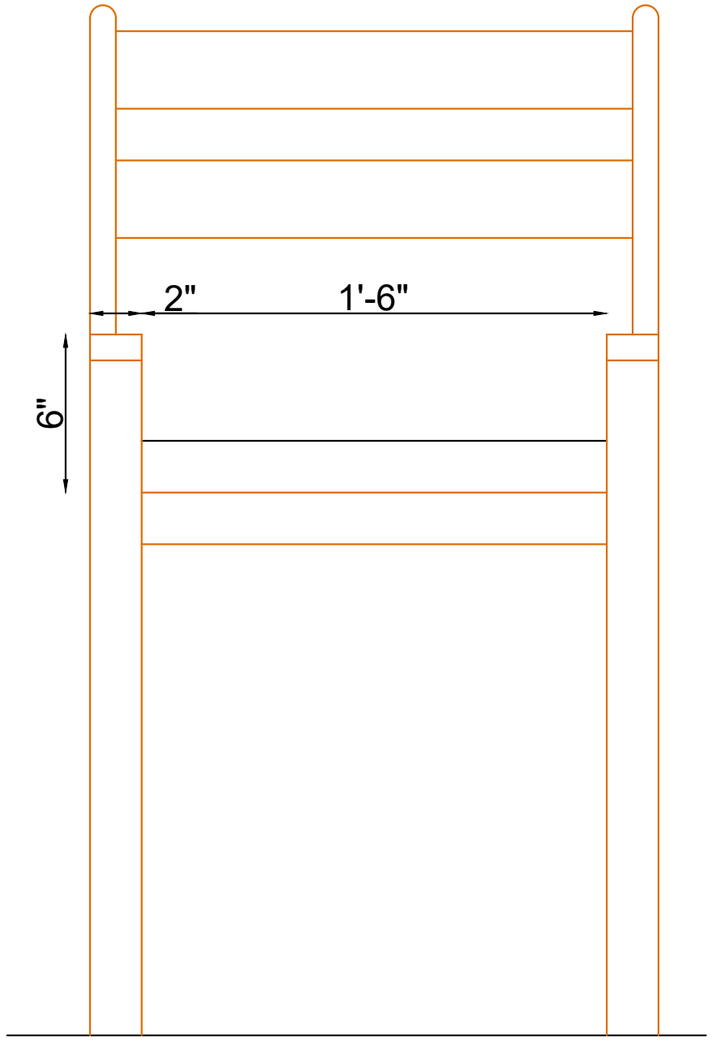
Chair Legs
Front View (3d)

* All Dimensions specified are in Feet and Inches.

Plate 47: Chair Backrest Detail

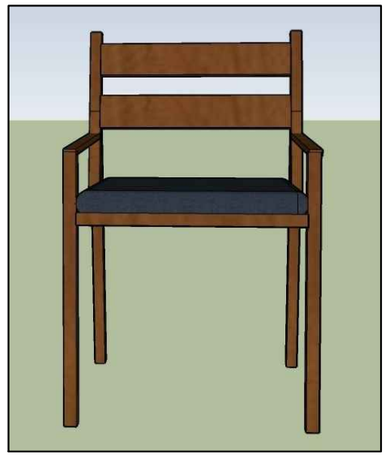


Armrest Detail
Side View



Armrest Detail
Front View

Chair Armrest
3d View



Chair Legs
Front View (3d)

* All Dimensions specified are in Feet and Inches.

Plate 48: Chair Armrest Detail

C. Layout of Classroom 205

After taking note of the issues the students had with the current furniture, the researcher provided a design of Prototype of the chair and adjustable table. For the present study, the practical room was limited to room no. 205 of The Department of Family and Community Resource Management. Therefore, the researcher proposed a layout for room no. 205 with the proposed chair and adjustable table as shown in plate 49. As the furniture was developed for practical classes the layout accommodated 20 students at a time.

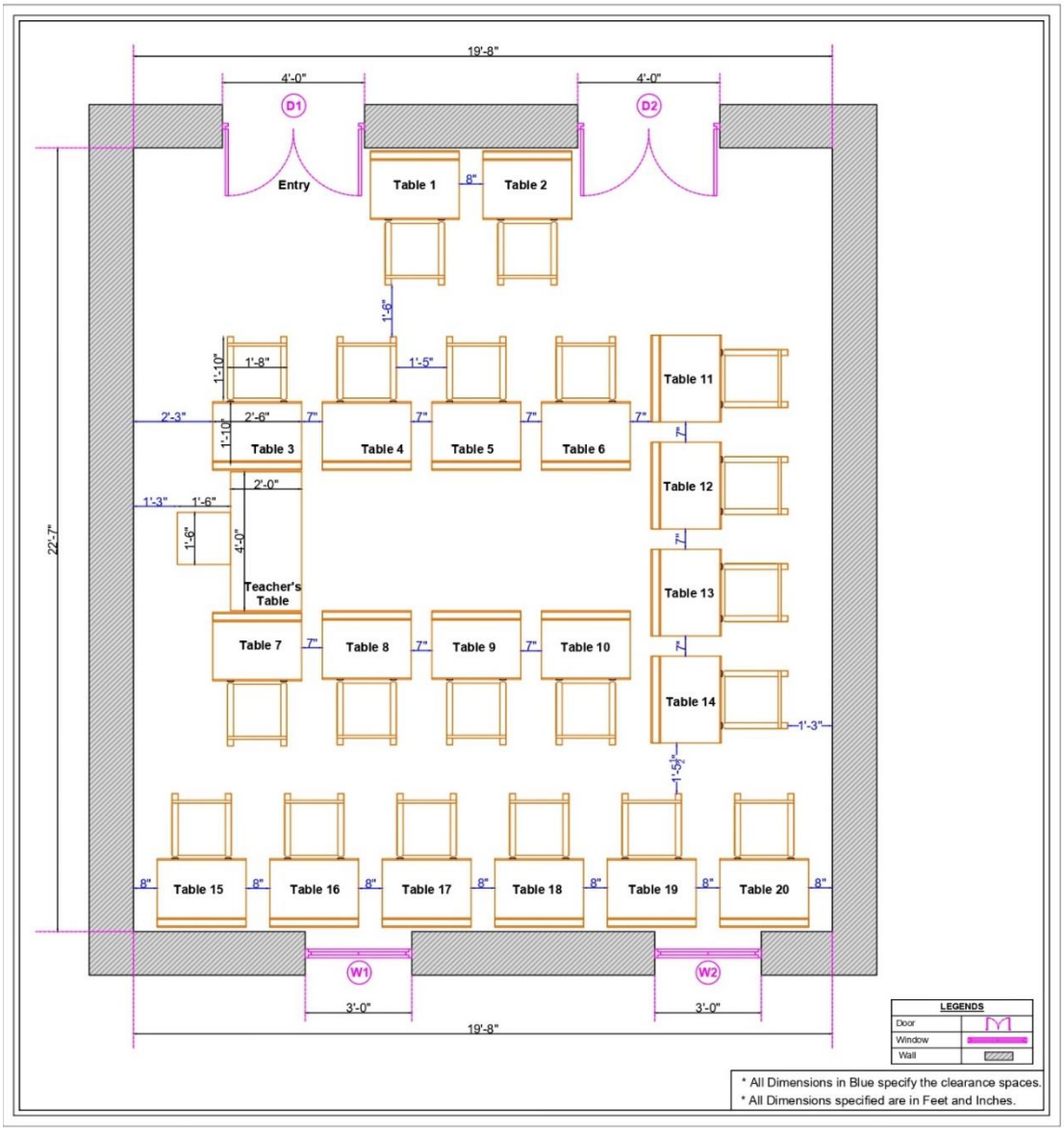


Plate 49: Proposed Layout of Room no. 205

4.4.3. Phase III: Out sourcing the design to the carpenter for the development of the final prototype.

First the Carpenter was made thorough with design and details in designs. The prepared drawings of the Chair and Adjustable Table were out sourced to the carpenter for development of final prototype. The process making the Chair and Adjustable Table is presented below:

i. Process of Making the Adjustable Table

Plate 50: Making of Table Top

Plate 51: Making of Table Legs

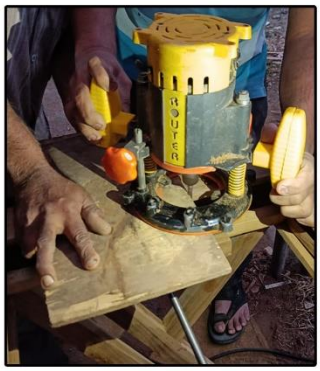


Plate 52: Grooving for Angle Mechanism

Plate 53: Fixing Table Legs

Plate 54: Fixing Table Top

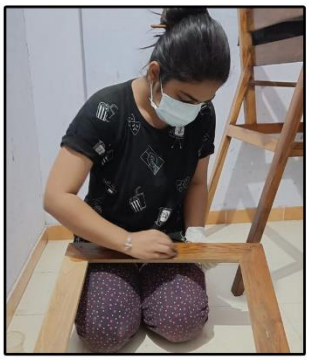


Plate 55: Final Polishing with Woodtouch Polish

Plate 56: Final Adjustable Table

ii. Process of Making the Chair

Plate 57: Making of Chair Legs

Plate 58: Making of Chair Back Angle

Plate 59: Making of Chair Backrest and Armrest

Plate 60: Polishing with Woodtouch Polish

Plate 61: Adding Seat to the Seat Frame

Plate 62: Final Chair

SECTION IV

4.5. Testing of Prototype developed

The major goal of this study was to identify issues with the existing furniture that students were using and create a prototype of chair and adjustable table. Also, the prototype was tested on students who had the highest percentage of issues. This section describes the process of testing the prototype. Those responders who reported difficulties exceeding 70% were chosen to test the prototype. The data gathered before designing and developing the prototype was assessed by the researcher and it was found that there were 17 respondents who experienced maximum problems.

Plate 64: Testing of Prototype

These 17 respondents were made to sit on the developed prototype after which they were given a feedback form to fill. The testing was carried out in the Seminar Room of Department of Family and Community Resource Management. The selected respondents were asked to work on the table in their comfortable posture for time period of 1 hour as shown in Plate 58. The feedback of respondents regarding the prototype was showcased below in two sections. The first sections showed the assessment of

respondents regarding the Adjustable Table and the second section presented feedback of respondents regarding the chair.

Table 13: Distribution of the respondents according to the assessment of the Adjustable Table

Sr. No	Assessment regarding the Adjustable Table	Respondents (n=17)			
		Agree		Disagree	
		f	%	f	%
1	The width of the table top provides enough space for working.	17	**100**	0	0
2	The adjustments of the Table are easy to modify.	17	**100**	0	0
3	The Table light in weight and movable.	16	**94.12**	1	5.88
4	The Table is stable in all reasonable postures.	16	**94.12**	1	5.88
5	The height of footrest provided on table is comfortable for keeping legs properly.	15	**88.24**	2	11.76
6	The height of table is comfortable to work on.	15	**88.24**	2	11.76
7	The length of the table top provides enough space for working.	15	**88.24**	2	11.76
8	The design of Table is aesthetically pleasing to eyes.	15	**88.24**	2	11.76
9	The angle provided to the Table top is correct for working.	14	**82.35**	3	17.65
10	There is enough leg space provided under table.	14	**82.35**	3	17.65
11	The Table allows comfortable Hand and Body motions.	14	**82.35**	3	17.65
12	The hands and arms are free from pressure of sharp edges of the table.	9	**52.94**	8	47.06
13	The material used in Table is noisy while using.	8	**47.06**	9	52.94

The data in table 13 revealed that all (100 per cent) respondents agreed that the width of the table top provided enough space for working and the adjustments in the table were easy to modify. Furthermore majority (94.12 per

cent) of the respondents agreed that the table was light in weight and movable and stable in all the reasonable postures. It also concluded that majority (88.24 per cent) of the respondents agreed that the footrest was provided at proper height, the height of table provided was comfortable for working, the length of the table provided was enough for working and the design of the Table was aesthetically pleasing to eyes.

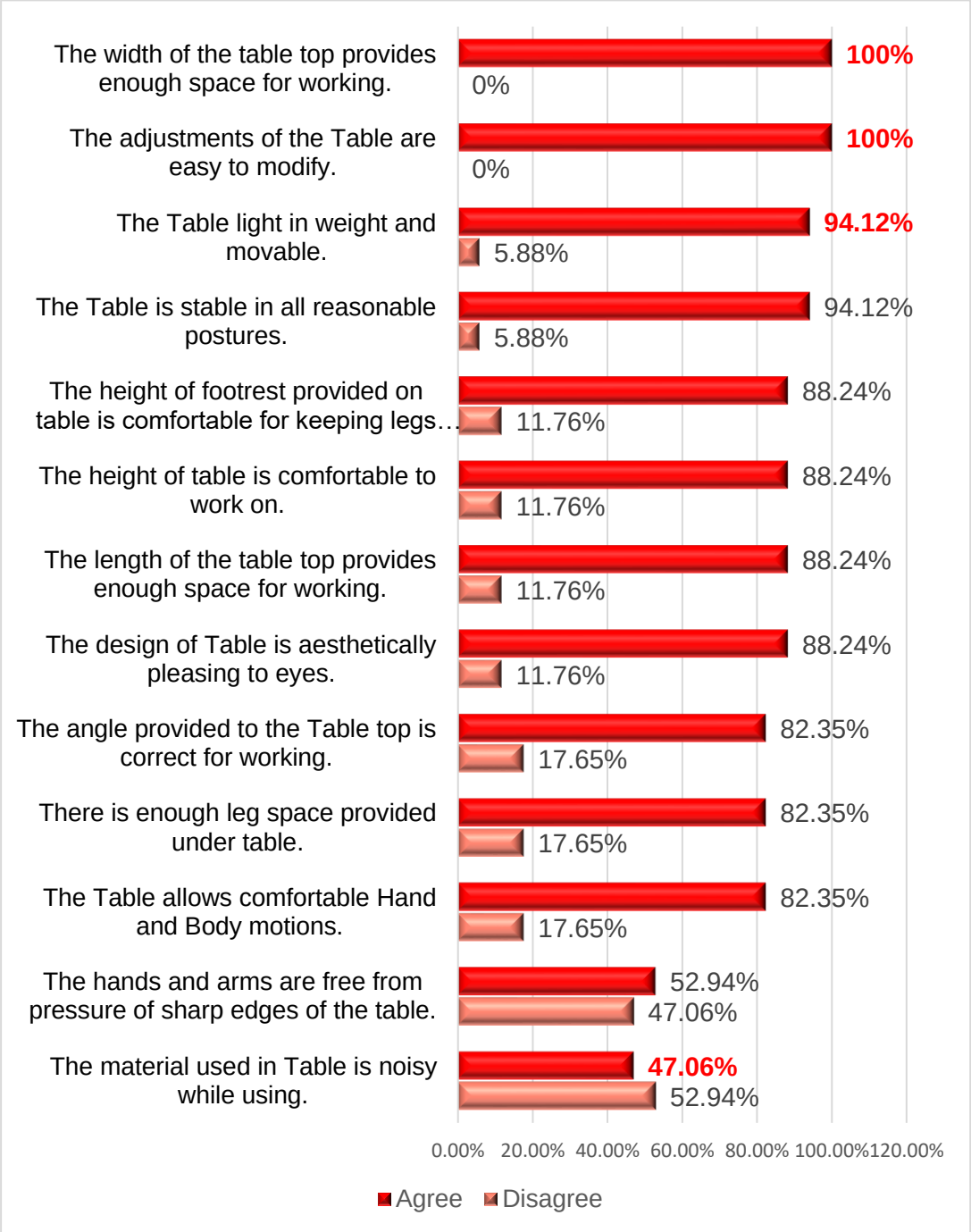


Figure 4: Percentage Distribution of respondents according to the assessment regarding the Adjustable Table

Table 14: Distribution of the respondents according to the assessment of the Chair

Sr. No	Assessment regarding the Chair	Respondents (n=17)			
		Agree		Disagree	
		f	%	f	%
1	The width of seat provided is enough for sitting.	17	**100**	0	0
2	The Chair light in weight and movable.	16	**94.12**	1	5.88
3	The angle of backrest of chair supports the back properly.	15	**88.24**	2	11.76
4	The design of Chair is aesthetically pleasing to eyes.	15	**88.24**	2	11.76
5	The length of seat provided is enough for sitting.	15	**88.24**	2	11.76
6	The material used in Chair seat is comfortable to sit for a longer period.	14	**82.35**	3	17.65
7	The Front edge of chair seat gives pressure on the underside of thighs.	14	**82.35**	3	17.65
8	The Chair allows comfortable Hand and Body motions.	14	**82.35**	3	17.65
9	The Chair is stable in all reasonable postures.	13	**76.47**	4	24
10	While sitting on chair, the feet rests flat on floor.	12	**70.59**	5	29.41

The data in Table 14 and fig.5 revealed that all (100 percent) respondents agreed that the width of the seat provided was enough for sitting. Moreover, majority (94.12 per cent) of respondents agreed that the chair was light in weight and easily movable. Furthermore majority (88.24 percent) of respondents agreed that the angle of back provided supported the back properly, the design of chair was aesthetically good and the length of the seat provided was comfortable for sitting. Besides it was also concluded that less than three- fourth (70.59 per cent) of respondents agreed that the feet rested flat on floor while sitting.

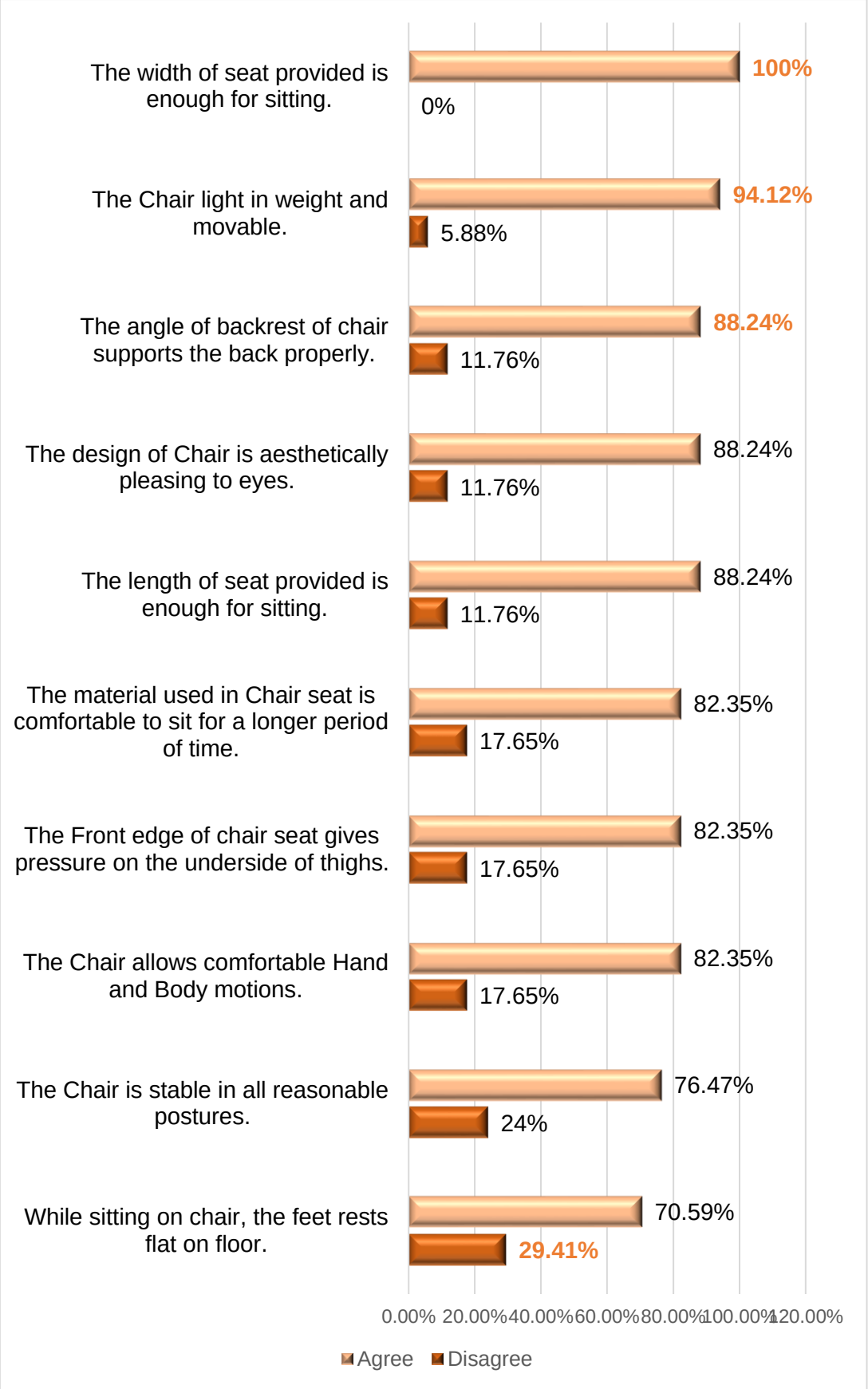


Figure 5: Percentage distribution of respondents according to the assessment regarding the Chair

SUMMARY, CONCLUSION AND RECOMMENDATIONS

CHAPTER - V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Education is a way to build and shape the perfect future of the students. When one thinks about maximizing progress in the classroom, furniture isn't the first thing that comes to mind. But that should be our first thought. Numerous studies have shown that inadequate classroom furniture can afflict children and cause chronic pain. It negatively impacts their general education and academic success. It's not just about child development, but the scope of classroom furniture goes far beyond that developmental strategy.

Classroom furnishings should be reviewed regularly to ensure proper focus, engagement and collaboration among students. However, it has been found that different people have different physical needs and in most cases of classroom furniture this has been overlooked. The type of students that need to learn and the type of instruction that takes place in the classroom will determine the type of furniture chosen. An educational institution is a place far from home where children are educated and socialized to meet the needs of the world. To achieve these objectives, they must stay in the laboratory for long periods of time (average 4-6 hours per day). Sitting for long periods of time causes pain in different parts of the body. One may also feel fatigue due to improper posture while working. All of these can lead to musculoskeletal disorders, which can develop into serious chronic diseases. Student education should be a top priority in any classroom, but that doesn't mean that investing in proper seating is overlooked. When choosing the right furniture, attention should be paid to every detail, as it can facilitate the learning process of students.

Thinking about school furniture and investing in customized solutions can transform the learning environment. Because of the different personalities, ages, learning abilities, and challenges students face with existing furniture, it's important to consider a variety of classroom furniture. Hence, the present study was undertaken to find out the problems faced in existing classroom furniture while working. These were assessed through set of questions. From the data gathered, a prototype of Chair and Adjustable Table was developed which was then tested whether it solved the problems faced in existing classroom furniture

or not. From the review of existing literature on various topics highlighted that most of the studies conducted were on Design Parameters of Primary School Furniture, Ergonomic evaluation, Work posture analysis, Musculoskeletal problems and College Bench Design. Opinion of students regarding existing furniture and Re-designing of Primary school Furniture were also explored by various researchers.

Courses such as “Furniture Design” and “Ergonomics in Interiors” are among trust areas of the field of Family and Community Resource Management. Hence, the information gathered through the present research would widen the database and will help in strengthening the curriculum by making suitable modifications. Moreover, it will be helpful for Architects, Furniture Designers and students of Interior Design to gain insight into the Adjustable Furniture Design. The study will beneficial about popularizing the concept of Adjustable furniture for Classroom in various Institutes. Also, it will facilitate Architects, Interior Designers and Furniture Designers to adopt concept of Adjustable Furniture in their design projects.

Statement of problem

The present study aims to analyse the problems faced by students in existing furniture of selected practical room and to design a Prototype of the Chair and Adjustable Table.

Objectives of the study

1. To find out the problems faced by the students in existing furniture of the selected practical room of Department of Family and Community Resource Management.
2. To collect the measurements of existing furniture of table and chair.
3. To design a prototype of the chair and adjustable table for the selected practical room of Department of Family and Community Resource Management.
4. To prepare a testing tool for testing the prototype designed to solve the problems faced by the students while working existing furniture of

selected practical room of Department of Family and Community Resource Management.

Delimitations of the study

1. The practical room will be delimited to Room no. 205 of the Department of Family and Community Resource Management.
2. The Design is delimited to designing of Chair and Adjustable Table only.
3. The Study will be delimited to second- and third-year students of the Department of Family and Community Resource Management.
4. The Study will be delimited to 80 students for data collection and 17 students for Prototype testing.

Methodology

The research design for the present research was descriptive in nature. Purposive sampling technique was used to select the respondents. 80 Students from second and Third year were selected whose practical classes were held in selected practical room of The Department of Family and Community Resource Management, The Maharaja Sayajirao University of Baroda. Further, from 80 respondents, 17 students were purposively selected for testing the protype designed.

For the present study Questionnaire, a Record Sheet for recording the Designing aspects of the existing furniture and a Feedback form for new prototype developed to solve the problems in the existing classroom furniture was prepared. A structured questionnaire was constructed keeping in view the objectives of the study. It comprised of two sections: Section I included questions related to background information of respondents like name, age, gender, specialization, Bachelors Programme, weight and height. Section II included questions related to problems faced by the respondents while using the existing furniture of selected practical room during their practical. The section II was divided into two parts: Problems faced due to body posture and Problems faced due to furniture. The responses were taken in 2 - point scale “faced” and “not faced”. The Record sheet included recording the dimensions of existing furniture (Table and Stool) and other designing aspects such as Materials, Durability and Finishes used. The last tool was Feedback Form which

included questions related to the new prototype developed to solve the problems in existing classroom furniture.

Major Findings

The major findings of the study were presented here.

Section I

Background Information: This section included questions related to their background Information. It was revealed that the age of respondents ranged between 18-30 years amongst which more than two-third (67.07 per cent) of the respondents were in age group of 18 to 20 years. It was found that majority (85.37 per cent) of the respondents were females while remaining more than one-tenth (14.6 per cent) of the respondents were male. The data regarding Bachelors Programme of the respondents depicted that more than one-half (51.22 per cent) of the respondents were in third year and less than one-half (47.56 per cent) of the respondents were in second year. It was observed from the data that one-half (50 per cent) of the respondents were from Interior Design specialization and remaining one-half (50 per cent) of the respondents were from Hospitality Management specialization. In the catogary of the Weight of the respondents, more than one-half (51.22 per cent) of the respondents had weight ranged between 35-54 kg. It was found that more than two-third (68.29 per cent) of the respondents had height ranged between 155-174 cm. From the data gathered it was observed that more than two-third (68.29 per cent) of the respondents spent time in classroom for 4-6 hrs per day.

Section II

Problems faced while working on existing classroom furniture: This section deals with information regarding problems faced by the students while using existing Classroom Furniture. This section was divided into two parts: one was Problems faced due to body posture and second was Problems faced due to furniture. The data gathered revealed that more than three-fourth (76.83 per cent) of the respondents experienced pain in their shoulder while working. It also revealed that majority (82.93 per cent) of respondents found that the space was not sufficient for working.

Record sheet for observing the Existing Classroom Furniture:

This section deals with observations recorded regarding the designing aspects of the existing classroom furniture. It includes observing the dimensions and

other designing aspects to the material of the furniture. The data related to table revealed that the height of the tables was fixed to 30” according to the standard dimensions. Moreover, the thickness of the table top is 3” which was sufficient and strong enough to work on. it was also observed that material of the table top was Wood with Laminate finish. It is smooth enough to work on. The data related to Stools revealed that the stools height varied from 21”-24”. It was seen that there was no backrest and armrest in the stool which made it uncomfortable to sit on for long period of time. The material of the stool was also wood finished with polish but the seat material was very hard which can hurt the person sitting on it.

Section III

Design and Development of a Chair and Adjustable Table

The stages of planning and developing a Chair and Adjustable Table are described in this section. Phase I of the process involved gathering information from the respondents and discussing the issues with current furniture. The data indicated that respondents had issues with the furnishings. While working on pre-existing furniture, the respondents experien pain in their shoulders, middle back, neck, upper back, and lower back. Phase II involved compiling a list of every issue and constructing the chair and adjustable table while taking the respondents' issues into consideration. AutoCAD 2016 and Google SketchUp were used to create the designs. For the final construction of the plans, phase III involved outsourcing them to a carpenter.

Section IV

Testing of Prototype

For testing the prototype, those responders were selected who reported difficulties exceeding 70per cent were chosen to test the prototype. The data gathered before designing and developing the prototype was assessed by the researcher and it was found that there were 17 respondents who experienced maximum problems. These 17 respondents were made to sit on the developed prototype for 1 hour and were given a feedback form to fill. The data gathered regarding the Adjustable Table revealed that all (100 per cent) respondents agreed that the width of the table top provided enough space for working and the adjustments in the table were easy to modify. The data gathered regarding

the Chair revealed that all (100 percent) respondents agreed that the width of the seat provided was enough for sitting.

Conclusion

The present research was undertaken with objective to identify the problems faced by the students with existing classroom furniture and designing a prototype of chair and adjustable table for selected practical room of Department of Family and Community Resource Management. These were assessed through set of questions and observations made by the researcher. From the data gathered, a prototype of Chair and Adjustable Table was developed which was then tested on those students who faced maximum number of problems in existing furniture.

The data collected showed that the respondents' ages varied from 18 to 30 years, within which more than two-thirds (67.07 per cent) of them were falling into the 18 to 20-year age category. It was seen that the majority (85.37 per cent) of respondents were female. According to the data obtained on the respondents' bachelor's programs, more than half (51.22 per cent) of the respondents were in their third year. Based on the data, it was also determined that 50per cent of respondents had a specialization in interior design. Related to the respondents' weight, more than half (51.22 per cent) of the respondents had a weight between 35 to 54 kg. The respondents' height ranged from 135 to 193 cm. More than two third (68.29 per cent) of the respondents had height between 155 to 174 cm. Also, more than two-third (68.29 per cent) of the respondents spent 4-6 hours every day in a classroom.

The data related to problems faced in existing furniture was divided into two sections. The data related to first section revealed that more than three-fourth (76.83 per cent) of the respondents experienced pain in their shoulder while working. The data related to second section revealed that majority (82.93 per cent) of respondents found that the space was not sufficient for working. While observing the existing furniture it was seen that the table height was improper with respect to stools provided. It was also concluded that the stools were not comfortable because they had no backrests and the seat was pure of hardwood which made it difficult to sit for a longer period of time.

Keeping in mind all these details gathered through questionnaire and observations, the researcher designed and developed a Chair and Adjustable Table which was then tested on those students who had a maximum number of problems.

The data gathered through feedback form regarding the Adjustable Table revealed that all (100 per cent) respondents agreed that the width of the table top provided enough space for working and the adjustments in the table were easy to modify. The data gathered regarding the Chair revealed that all (100 percent) respondents agreed that the width of the seat provided was enough for sitting. As a result, it was seen that the table and chair developed were more comfortable to use while working on the existing furniture.

Implications of the study

The finding of the present study had the following implications:

For the field of Family and Community Resource Management

The field of Family and Community Resource Management is concerned with the management of resources such as Space, Furniture and Ergonomics. “Ergonomics in Interior” and “Furniture Design” are subjects taught at each level. The findings of the study will be helpful for the students of Interior Design specialization for considering the importance of Adjustable Furniture Design and incorporating the knowledge gained in their interior projects in the future.

For Architects, Interior Designers and Furniture Designers

The findings of the present study would act as feedback to the Architects, Interior Designers and Furniture Designers to design furniture keeping in mind the population characteristics who are going to use that furniture. The designers can recommend and incorporate such mechanisms of Adjustable furniture design in their interior projects.

For Government

The government should make efforts in formulating strategies and policies which mandates and Commercial space developers to design Adjustable Furniture at public and commercial spaces which can increase urge for buying such furniture for Classroom.

For Students

The findings of the present study will be helpful to the students they will get to know which part of body they experience major pain due to long use of existing furniture. The findings will also be beneficial to the students as they can work on comfortable furniture throughout the day without any problem.

For The Department of Family and Community Resource Management

The findings of the present study will be beneficial to the department as the design of prototype can be used to develop furniture for students in future.

Recommendations for Future Studies

1. A similar study can be conducted focusing on designing other types of furniture.
2. Researcher can undertake similar type of study in other institutes in Gujarat or different states in India.
3. A Similar study can be done on larger sample size.
4. Further research can be done on other groups of respondents like professionals working in different fields.

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APPENDICES

APPENDIX I

Institutional Ethics
Committee for Human
Research
(IECHR)

FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

Ethical Compliance Certificate 2022-2023

This is to certify that **Ms. Shruti Chaudhari's** study titled, **Problems faced by students in existing furniture and designing a prototype of Chair and Adjustable Table for selected practical room of Department of Family and Community Resource Management** has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number **IECHR/FCSc/M.Sc./2022/09.**

Prof Shagufa Kapadia
Chairperson
IECHR

Prof Mini Sheth
Member Secretary
IECHR

APPENDIX II

Estd. 1949
NAAC Accredited 'A' Grade

DEPARTMENT OF FAMILY & COMMUNITY RESOURCE MANAGEMENT
FACULTY OF FAMILY & COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA, VADODARA

INFORMED CONSENT FORM

The Department of Family and Community Resource Management, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, Vadodara, supports the practice of protection of human participants in research. The following will provide you with information about the Research that will help you decide whether or not you wish to participate. If you agree to participate, please be aware that you are free to withdraw at any point throughout the duration of the research without any penalty. In this study, you will be asked about your background information (Name, Age, Gender, etc.) and problems faced while using the existing classroom furniture. All information you provide will remain confidential and will not be associated with your name. Your participation in this study will require approximately 15-20 minutes. Please do not leave any response blank. If you have any further questions concerning this research, please feel free to contact us by Phone or email. (Ms. Shruti Chaudhari, +91 7383500779, c09shruti@gmail.com).

Please indicate with your signature in the space below that you understand what participation in the study involves and agree to give consent to participate. Your Participation is strictly voluntary. All information will be kept confidential and your name will not be associated with any research findings.

I ~~Mr.~~/Ms. Aastha. Bhatt agree to Participate in the study titled - Problems faced by students in existing furniture and designing a prototype of Chair and Adjustable Table for selected practical room of The Department of Family and Community Resource Management.

Name & Signature of Respondent
Date:

Ms. Shruti Chaudhari
M.Sc. (F.C.Sc.)
Department of FCRM,
FFCSc, MSU

Ms. Rutu Modi &
Ms. Rakhi Dasgupta
Research Guide &
Assistant Professor
Department of FCRM,
FFCSc, MSU

APPENDIX III

DATA COLLECTION TOOL

(Questionnaire)

SECTION I

BACKGROUND INFORMATION

1. Name:
2. Age :
3. Specialization :

   ☐ Interior Design (ID) ☐ Hospitality Management (HM)
4. Bacherlors Programme :

   ☐ B.F.C.Sc. -II ☐ B.F.C.Sc. -III
5. Gender :

   ☐ Male ☐ Female ☐ Others
6. Weight :
7. Height :
8. Mobile No.:
9. Duration of Time the classroom is used per day (in Hrs):

SECTION II

Problems faced while working on existing classroom furniture

Sr. No	Problems	Faced	Not faced
Problems faced due to body posture			
1	Fatigues caused due to sitting posture		
2	Pain in thigh muscles		
3	Pain in arm muscles		
4	Pain in hip muscles		
5	Pain in upper back		
6	Pain in middle back		
7	Pain in lower back		
8	Pain in elbow		
9	Pain in wrist		
10	Pain in knee joint		

11	Pain in upper arms		
12	Pain in lower arms		
13	Pain in ankle joint		
14	Pain in hip joint		
15	Pain in feet		
16	Pain in neck		
17	Shoulder tension		
Problems faced due to furniture			
1	Insufficient Space for working		
2	Injury caused while using existing furniture		
3	Need to stretch the upper body too much because table height is too high		
4	Need to bend too much table height is too low		
5	Pain in legs because stool height is too high		
6	Pain in knees because stool Height is too low		
7	The furniture material is too hard for sitting		
8	Furniture disturbs the sitting posture during the class		
9	Furniture disturbs the standing posture during the class		
10	Front edge of stool gives pressure on the underside of thighs		
11	Pain below knees because table footrest is too high		
12	Pain below knees because footrest is too low		

APPENDIX IV

OBSERVATION TOOL

(RECORD SHEET)

Record Sheet for Designing Aspects of Existing Tables

Sr. No	Name of the Furniture	Table Top				Footrest								Photos of Existing Furniture
		Height	Length	Width	Thickness	Height from the Ground	Length	Width	Shape	Thickness	Name of the Material	Surface Finish	Durability	

Record Sheet for Designing Aspects of Existing Stools

Sr. No	Name of the Furniture	Stool					No. of Leg	Footrest					Material Details			Photos of Existing Furniture
		Height	Diameter	Length	Width	Thickness		Height from Ground	Length	Width	Shape	Thickness	Material	Surface Finish	Durability	

APPENDIX V

FEEDBACK FORM

(Interview Schedule)

1. Name:
2. Specialization:
   ☐ Interior Design (ID) ☐ Hospitality Management (HM)
3. Bacherlors Programme:
   ☐ B.F.C.Sc. -II ☐ B.F.C.Sc. -III
4. Gender:
   ☐ Male ☐ Female ☐ Others
5. Mobile No.:

Please (✓) mark against those applicable for you about the Proposed Classroom Furniture (Chair and Adjustable Table) :

SR. NO	Statement	YES	NO
ADUJSTABLE TABLE			
1	Does the width of Table top provide enough space for working?		
2	Does the length of Table top provide enough space for working?		
3	Is the height of table comfortable to work on?		
4	Is the height of footrest provided on table comfortable for keeping legs properly?		
5	Is there enough leg space under table?		
6	Is the angle of Table top correct for working?		
7	Are the adjustments of the Table easy to modify?		
8	Is the Table light in weight and movable?		

9	Are the hands and arms free from pressure of sharp edges of the table.		
10	Is the design of Table aesthetically pleasing to eyes?		
11	Is the material used in Table noisy while using?		
12	Does the Table allow comfortable Hand and Body motions?		
13	Is the Table stable in all reasonable postures?		
CHAIR			
14	Does the width of seat provide enough space for sitting?		
15	Does the length of seat provide enough space for sitting?		
16	While sitting on chair, does the feet rest flat on floor?		
17	Is the Chair light in weight and movable?		
18	Does the angle of backrest of chair supports back properly?		
19	Is the material finish of Chair comfortable to sit for a longer period of time?		
20	Does Front edge of chair seat gives pressure on the underside of thighs?		
21	Does the Chair allow comfortable Hand and Body motions?		
22	Is the Chair Stable in all reasonable postures?		
23	Is the design of Chair aesthetically pleasing to eyes?		

ABSTRACT

ABSTRACT

The physical comfort of a student in the classroom is a topic that is often neglected and needs to be spoken about. Every day, children can spend up to 6 hours at their workstations and nearly 83% of them sit in chairs and desks that are too high for their bodies. As a result, classroom ergonomics is crucial to the learning environment. A good posture should be supported by the classroom furniture, especially as children's bodies change quickly. Students should ideally be seated with their backs against their seats and their feet firmly planted on the floor. Poorly designed furniture can hamper the goals and ideals for tomorrow’s learning environments. Therefore, it is important to look for a solution that solves the problems regarding the existing classroom furniture. Hence, the present study was undertaken to find out the problems faced with existing classroom furniture and design a prototype of a Chair and Adjustable Table which can solve the problems in existing furniture.

The descriptive research design was adopted for the present research. The questionnaire was prepared to assess the problems faced by the students with existing classroom furniture. Purposive sampling technique was used to select the respondents. 80 respondents from the second and Third year were selected whose practical classes were held in the selected practical room of The Department of Family and Community Resource Management, The Maharaja Sayajirao University of Baroda. Further, from 80 respondents, 17 respondents were purposively selected for testing the prototype designed. The data was analysed and presented by applying descriptive statistics.

The findings showed that the age of respondents ranged between 18-30 years amongst which more than two-third (67.07 per cent) of the respondents were in age group of 18 to 20 years. It was found that majority (85.37 per cent) of the respondents were females. The data regarding Bachelors Programme of the respondents depicted that more than one-half (51.22 per cent) of the respondents were in B.F.C.Sc. -III. Further, it was observed from the data that one-half (50 per cent) of the respondents were from Interior Design specialization. The Weight of the respondents ranged between 35-93kg. Among these more than one-half (51.22 per cent) of the respondents had weight ranged between 35-54 kg. The height of the respondents was in the

range of 135-193cm. It was seen that more than two-third (68.29 per cent) of the respondents had height ranged between 155-174 cm. From the data gathered it was also observed that more than two-third (68.29 per cent) of the respondents spent time in the classroom for 4-6 hrs per day.

The data gathered regarding the problems faced with existing furniture revealed that more than three-fourth (76.83 per cent) of the respondents experienced pain in their shoulder while working. It also revealed that the majority (82.93 per cent) of respondents found that the space was not sufficient for working. For testing of Prototype, only those respondents who indicated problems of greater than 70% were chosen to test the prototype. The data gathered regarding the Adjustable Table revealed that all (100 per cent) respondents agreed that the width of the tabletop provided enough space for working and the adjustments in the table were easy to modify. The data gathered regarding the Chair revealed that all (100 percent) respondents agreed that the width of the seat provided was enough for sitting. Overall, it was seen that both table and chair were comfortable than the existing furniture. Through the findings, it can be concluded that most students experience issues with the existing furniture in the classroom since it is not designed for their body type. Due to the constantly changing student body composition, no college or university can maintain furniture that is tailored to individual student's body proportions. But, similar solutions, such as adjustable tables, can be offered which can help students in working comfortably without any problem.