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The Impact of Collocation on the Effectiveness of Agile is Development Teams

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Abstract

This article looks at the impact of collocation on the effectiveness of information system development teams. The research objective was to investigate which features of the collocation environment have the greatest influence on team effectiveness and how these can assist in a better design for a collocation working environment. The empirical foundation for this research was a number of agile software development teams. The two key factors which were found to impact team effectiveness were the impact of noise and interruptions, the use of war room layouts and the need for break-away areas.

Keywords: Collocation, War Rooms, Team Effectiveness, System Development, Agile Software Development.

Introduction

Throughout the history of software development the structure and layout of the working environment, as well as the way in which employees have been situated within the working environment, has gone through a number of changes. These range from the individualistic, hierarchical approach, to the team approach commonly adopted in organisations today. These changes aimed at leveraging time, cost, quality, productivity and success of development projects (Avison and Fitzgerald, 2003). A team approach was often found to improve productivity, flexibility and performance (Katzenbach and Smith, 1993; Olson, Covi, Rocco, Miller, and Allie, 1998). In an effort to further improve the time, cost and quality of software development projects, an approach known as 'radical collocation' has also been devised whereby the members are located in the same room for the duration of the project (Olson *et al*, 1998).

Collocation is a less drastic approach than radical collocation, which involves collocating a number of teams in the same open area. A radical collocation approach has been advocated by agile methodologies, as it largely supports the values on which these methodologies are based (Cockburn, 2002; Cockburn and Highsmith, 2001). The collocation of software development teams undertakes to increase the ease, frequency and interaction of communication within the team, reduce the time taken to complete a project, and improve the productivity and performance of the team

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The objective of this research is to identify the aspects of collocation that influence effectiveness of agile teams. This will provide organisations with guidance on how to design the optimal collocated setting to leverage the agile software development team effectiveness. This research is relevant as collocation is a widely adopted approach to agile software development, and the impact of collocation on teams as well as the optimal design of team rooms is of increasing interest to many organisations.

First some background information on collocation and team room design is presented. This is followed by an overview of the research methodology which we adopted. The findings are then discussed in more detail and the paper concludes by evaluating whether the findings and implications have satisfied the research objectives.

Definitions and Prior Research

What are teams?
A team is defined here as "a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable" (Katzenbach and Smith, 1993, p.45).

Teams are effective as the productivity of a team is greater than the sum of the productivity of the individual team members (Smith, Harris, Myersclough, and Wood, 2000), especially when a project or task requires a range of knowledge and skills. In addition, team members work towards a common goal, have the same objectives and are thus more adaptable to change (Katzenbach and Smith, 1993). Team members also develop trust relationships which contributes to the successful accomplishment of the team objectives (Katzenbach and Smith, 1993).

The agile approach
Software development is now considered as a "team sport" (Booch and Brown, 2002) as the tasks involved are often large and complex (Smith *et al*, 2000) and hence require a team effort. In particular, agile software development is structured around teams. The concept of agile methodologies came into being in order to provide a means to overcome some of the limitations of the traditional methodologies (Nerur, Mahapatra and Mangalaraj, 2005).

In 2001, the Agile Software Development Manifesto was created which detailed the four core values and the supporting principles that agile methodologies are based on (Lindstrom & Jeffries, 2004); Individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan (Cockburn, 2002). These values were created in an effort to introduce an approach to software development that was more focused on people and communication in order to achieve project success, and less on technology and structured processes (Lindstrom and Jeffries, 2004).

According to Cockburn and Highsmith (2001, p.132] "people working together with good communication and interaction can operate at a noticeably higher level than when they use their individual talents". Thus, as opposed to others, agile teams are self-organised, extremely focused on both the people within the team and collaboration, aim to increase user involvement, and tend to locate team members physically closer.

The collocation of teams
Collocation is defined as "the physical proximity of the various individuals, teams, functional areas, and organisational subunits involved in the development of a particular product or process" (Rafii, 1995), p.78). In order to further improve productivity and collaboration, agile teams are known to collocate their team members in a single room known as a 'team room'. Radical collocation is a strategy that involves "putting an entire project team in one room for the

duration of the project" (Teasley, Covi, Krishnan and Olson, 2000, p.339).
This strategy was developed in response to communication difficulties, such as the time wasted on communication in distributed environments and the regular communication breakdowns that occur on projects (Teasley *et al*, 2000).

The concept of war room came into existence in World War II during which major leaders had *"special rooms outfitted with key maps and other information as well as the key figures 'at hand'"* wherein they would meet and discuss their strategies (Teasley *et al*, 2000, p. 671).

Figure 1 represents two typical war room layouts that have a capacity for 8-10 people. The walls have floor- to- ceiling whiteboards which allow for visual representations and artefacts to be displayed to all of the workers within the room. Workstations are situated away from the collaboration area at the conference desk, which aims to provide workers with some privacy when other team members are designing and collaborating at the conference table. From this point onwards, the 'war room' will be referred to as the 'team room'.

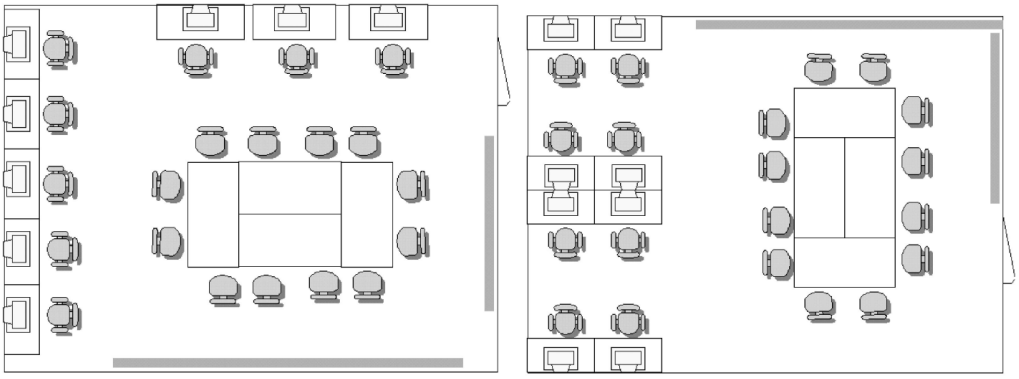

Fig 1: Examples of Radically Collocated Environments [11]

A number of advantages can be drawn by incorporating the team room into software development.
Firstly, as communication is continuous, easy and interactive, team members are able to gain knowledge by overhearing discussions held by their team members (Hinds and Kiesler, 2002). By being in a team room, team members are also able to create relationships with each other and gain an understanding of how they work and what their moods may be at a particular time, thus reducing the number of unwanted interruptions (Hinds and Kiesler, 2002). Learning and motivation are also improved within the team (Olson *et al*, 1998), and the satisfaction levels of both the customer and the team members are high (Teasley *et al*, 2000). All of the team members present in a team room have a common goal; regardless of whether they are working on individual tasks which remains visible at all times. Most importantly, by collocating team members in a team room, the productivity of the team and thus the timeliness of a project can be improved (Teasley *et al*, 2000).

Collocation in a team room can also have certain disadvantages. For instance, there is a lack of privacy in the team room and the frequency of interruptions or distractions is high (Hinds and Kiesler, 2002). Team members also reported that they are often distracted by the communications going on around them while working on tasks requiring concentration. A further concern identified is that team members are worried that their superiors will not be able to identify or differentiate their individual

performance and contributions (Teasley *et al*, 2000).

However, despite these disadvantages, people still find that the value derived from working in a collocated environment outweighs the negatives. Team members involved in collocated teams have acknowledged they initially feared that working so closely with the rest of the team would cause too many interruptions, but agreed that they were soon able to adapt to the environment, and began realising the value that the collocation provided (Olson and Olson, 2000).

It is clear that different aspects of collocation have been reported in literature but little is known on the impact of these collocation aspects on the effectiveness of agile teams. This study addresses this gap and thus provides an insight on the way in which organisations should design their collocated environments in order to achieve optimal team performance results.

Research Methodology

The research was exploratory and interpretive in nature and both quantitative and qualitative approaches were employed to fulfil the research objectives. Data was collected from two Cape Town based software development companies, which employed the SCRUM agile software development practices in a collocated setting. These companies will be referred to as Company I and Company II.

Data was collected through online questionnaires, semi-structured interviews and observations. The online questionnaire consisted of statements to which respondents indicated their (dis)agreement using a 5-point Likert scale. This questionnaire was distributed to all members of the collocated teams.

95 respondents attempted to complete the online questionnaire, of which 68 were fully completed. Because most of these (54) were completed by respondents currently working in South Africa, the non-South Africans were excluded to ensure representativeness and cohesion. 5 questionnaires were removed from the sample as they failed the validity check (i.e. their responses to the negatively phrased questions did not tally). Therefore, the final sample size was 49.

After initial analysis of the questionnaires, face-to-face interviews were conducted with five teams from each of the two sample companies. A third company also completed the questionnaires but failed to attend the interview sessions. However, their quantitative responses were also included in the sample. For reference purposes, Teams A to E were in Company I and teams F to J in Company II.

The interview questions were compiled after analysis of the quantitative data. Each team was questioned according to their questionnaire results. The interviews were informal and open-ended, and were conducted in order to gather rich feedback on the aspects of collocation and the team effectiveness factors. The average team size consisted of seven team members. The interviews in company I were recorded using a video camera but for Company II only voice recordings were made. All of the interviews were later transcribed.

Upon completion of the interviews at Company I, the collocated work setting of the agile software development teams was observed with minimal disturbance to team members. The layout of the environment as well as the use of shared artefacts, such as whiteboards and flipcharts, was noted. For privacy reasons, Company II did not allow any observations.

Findings

In order to further identify aspects of collocation that impact team effectiveness and fulfil the secondary objective of the research, questions were asked in both the questionnaire and the interviews regarding factors that relate to the design of the collocated working environment.

The following aspects were identified and discussed as key factors that could have an impact on the effectiveness of a team working in a collocated environment:

- Noise and Interruptions
- Break-away Areas
- The Physical Working Environment

Each of these factors was individually analysed by taking into account the relevant questionnaires and interview data.

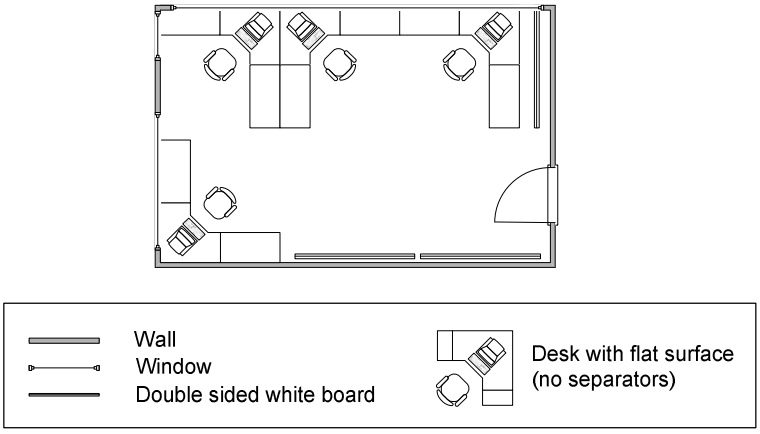

Fig 2: The Radically Collocated Team Room

Figure 2 represents a radically collocated team room at Company I. Team E occupied this room, and consisted of 4 team members. The floor area was approximately 25m^2. Figure 3 provides a basic representation of the open plan environment of Company I, and accommodated many collocated teams. These teams operated in areas of approximately 35m^2 and generally consisted of 6 team members. The collocated team areas were separated from each other and from the other business functions within the collocated environment by double sided white boards, filing cabinets and separator panels

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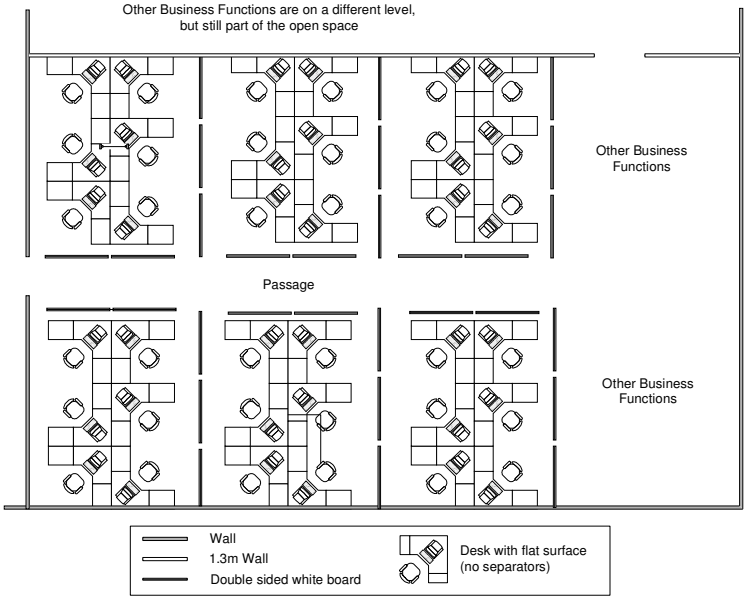

Fig 3: The Open plan Collocated Working Environment

Noise and Interruptions

Due to the many activities happening simultaneously within the collocated environment, noise and interruptions are inevitable. 69% of the respondents agreed with the statement that collocated environment is noisier than other types of environments, while only 29% agreed that the noise level decreased productivity. The mean for the first question is the higher of the two at 3.73 whereas the latter is only 2.82, the lowest of all questions in the questionnaire. In terms of consensus, there was only a small difference between the standard deviations of the two questions at 0.88 and 0.95 respectively, which indicates that there is very little consensus within the sample with regards to noise in a collocated environment.

Table 1: Impact of collocation on noise and interruptions

Statement	Agree	Dis-agree	Mean (3 = neutral)	Standard Deviation
Collocation is noiser	69%	12%	3.73	0.88
Collocation decreases productivity	29%	45%	2.82	0.95
Collocation increases interruptions	59%	20%	3.49	1.10
Quality would increase with fewer interruptions	57%	24%	3.57	1.08

The interruptions construct consisted of two questions, the results of which had the highest level of disagreement in the sample. The overall mean for this factor is 3.53. 59% of the sample was in agreement that individuals are more often interrupted when working within the collocated environment. 57% agreed that the quality of work produced by individual team members would increase with fewer interruptions, whereas 24% disagreed with this statement. The standard deviations for these two questions are 1.10 and 1.08 respectively.

Responses from the interviews suggest that teams from Company I acknowledged that noise are a problem within this environment. For instance, noise is seen by managers as disruptive and invasive on the work progress. The team member view, however, differed. For instance, one team member commented that *"it might be an issue when you start, but after a while you just get so used to it. You just learn to filter it out"* (F2). Another member within this team said that team members use earphones if they do not want to be disturbed.

However, one team member mentioned that *"[noise] is definitely sometimes distracting"* (H6). Although this appears to be a minority view, it does show that some individuals are negatively influenced by noise.

Interruptions by fellow team members were rarely seen as problematic. The majority of interruptions were from fellow collocated teams. The collocated teams within the open plan environment often worked on components that were interdependent, thus requiring clarification from other teams. It was mentioned by team member C4 that "by being interrupted 30% more, 20% of this will increase your productivity and 10% might be useless". This team felt strongly that the interruptions were important to their work.

Teams from Company I had previously worked at this company in a distributed environment where managers were located on a different floor than the rest of the

development teams. Interviewed teams felt strongly that, when previously operating in the distributed environment, walking between offices wasted a lot of time. It was found that the close proximity of team members in the collocated environment, and the ease with which members could get information from each other through interruptions led to this environment being much more efficient. According to Team D, interruptions would also trigger sessions where the team members were able to identify if there was a need to get the team as a whole together to discuss a certain issue. The ease with which this could be done was deemed to be invaluable.

From the results of the questionnaires and interviews it is evident that there are mixed feelings within the sample about the impact of noise and interruptions on the effectiveness of collocated teams. The literature suggested that noise and interruptions would be an inhibitor to team effectiveness. This was supported by the finding from the questionnaire data. However, the majority of team members commented that they were able to quickly get use to, and effectively cut out noise. In conjunction with this, interruptions were identified by the literature as a disadvantage of the collocated environment, yet the opposite was found during the interviews. This is due to the fact that the work of the different teams is often dependent on each other and as a result, team members find the interruptions to be useful in clarifying issues and ambiguity. Overall, the interruptions contribute towards team effectiveness within the collocated environment.

Break-away areas

Break-away areas, also known as a "hotelling space" (Covi *et al*., 2002) are private areas in which individuals can work alone for a period of time, separating themselves temporarily from the collocated environment (Covi *et al*., 2002). Its use stems from the need of team members to work in isolation when work requires in-depth focus.

Although questions relating to the use of break-away areas were omitted from the questionnaire, it was discussed in interviews after having provided a brief explanation of this concept to the team members.

The teams interviewed had different responses with regards to the use of break-away areas. Company I had previously made use of break-away rooms. However, due to a lack of space, these rooms had to be later used to accommodate some other business functions. Team C commented that break-away rooms are available for team members at their home office, but that these rooms are too small and people rarely make use of them. It was added that team members only make use of the break-away areas when tasks and work items are difficult and require more concentration and focus.

Other teams within Company I, who have not made use of break-away areas before, were asked if they would find these areas useful and would utilise them if they had the option at their offices. The majority of team members said that they would not. Team members felt strongly that their own collocated environment was adequate. Another aspect mentioned was that team members constantly needed each other for information and support during software development and so working alone in a separated room would bring unnecessary complexity to this process.

Team members from Company II had very similar responses to Company I. Company II did not have break-away areas, but team members strongly believed that this concept would not increase their productivity. Team member G2 commented that *"[one gets] comfortable with [one's] own desk".* The teams from Company II showed a fair amount of resistance to the idea of break-away areas, saying that these would prove to be inconvenient for team members. Team members from Teams G and H expressed concerns about how they would be able to use their fixed desktop computers in a room like this. This concern was due to the fact

that team members at Company II were not issued with laptops, and so could not easily take their work into another area.

Despite these negative feelings towards the break-away room, a minority of team members did comment that they would make use of this type of area should they be given the option. Member J4 mentioned that: "*I think that would be a good idea because every now and then you just need an hour with no interruptions. So I think that would work, people would use it".* Team member I5 also supported this statement: *"I do it sometimes, I go and find a meeting room and I work there for a few hours. If there was a break-away room then I would use that. But I don't know that it would be necessary because a normal meeting room serves that function".*

A suggestion was made by Team G to have a form of break-away room where team members could have meetings or take phone calls. This may reduce the amount of noise within the collocated environment and thus potentially increase team effectiveness.

Relatively little literature was found to support the use of break-away areas, but it was suggested that rooms be provided in collocated environments in which team members are able to work separately and in private. The results from the interviews suggested that the companies did not currently make use of break-away rooms. Consensus was reached amongst the majority of team members that, if break-away areas were available, they would rarely be used. It was also suggested that the rooms could potentially negatively impact a team's effectiveness, as the concept would contradict the purpose of the collocated environment.

Physical Design of the Collocated Environment

The questionnaire included two questions with regards to the physical design of the collocated environment. 29 out of 49 respondents agreed that the layout of the collocated team room is important for team success, and 19 were satisfied with the current design of the team rooms. The means for these two questions are 3.73 and 3.16 respectively. 18 respondents answered neutral to both questions, suggesting that team members were either unsure about their feelings or had little opinion with regards to the design of their collocated environment. The standard deviations for the questions are a relatively high 0.81 and 0.90 respectively, indicating that a lack of consensus between the respondents.

Table 2: Impact of team room layout.

Statement	Agree	Dis-agree	Mean (3 = neutral)	Standard Deviation
Team room layout is important for team success	59%	4%	3.73	0.81
Our team room design is satisfactory	39%	24%	3.16	0.90

A strong form of collocation called 'radical collocation' was discussed in the literature. This form of collocation was being adopted by only two of the ten interviewed teams, both from Company I. Team D was collocated together with a research and design team in a single room, and for purposes of this study was considered as being radically collocated. Team members from Team D had been operating in the radically collocated environment for two months, and were generally satisfied with the working environment. This team commented that they did not mind sharing

the room with another team, and added that they preferred the radically collocated environment to the open plan working area. The layout of the room was deemed to be adequate and the only dissatisfactory feature identified was that the air conditioning was too cold.

Team E was the only interviewed team that was radically collocated as per definition. This team consisted of three team members and a SCRUM Master. An interesting observation was that the members of Team E were generally unsatisfied about being radically collocated. The main concern of the team members was that they felt disconnected from the other collocated teams working in the open plan area. These team members also complained about the air conditioning unit being too cold.

Although factors such as the air conditioning unit are relatively unrelated to the effectiveness of teams in the collocated environment, it was identified as an issue that negatively influenced the team members' perceptions of the radically collocated room environment.

During the interview with Team C it was noted that they were temporarily located in single room for two days, and that these team members did not enjoy the radically collocated working environment. The team members commented that they did not feel part of the "vibe and the buzz" (C4) during that time. An interesting observation made by the team was that the working environment should also not be too quiet. This team established that it is necessary to interact with the other teams within the company, and found that when they were radically collocated it was difficult to communicate with these teams due to the physical distance between the teams.

Company II had many collocated teams within one open plan area, but none of the teams were radically collocated. There was consensus amongst the teams of Company II that a radically collocated team would not necessarily be more productive. Team member H6 commented: *"I'm not sure if I would prefer it. It would be like cutting me off from the rest of the business, from the rest of the people"*. Member H4 said: *"I would feel claustrophobic I think, boxed in with these eight people. Having that sense of openness helps; it's like your energy is not just bouncing off a wall, it's going into the open space".*

The collocated teams within Company II were highly dependent on the other teams for completing the daily work, as a lot of the systems are tightly integrated with each other. Team member J1 remarked: *"I personally like working closely with the other teams because we work on similar things, and what we do affects each other. So in a way our team is collocating with their team"*. In support of the open plan area consisting of many collocated teams, H6 said that *"sometimes you pick up on conversations from other teams and you can help them or you can trigger something about what you need to go and look at"*. The flow of information within the environment was seen as invaluable and definitely contributed to the team members' daily execution of work.

Team I had mixed opinions about the concept of being radically collocated. One team member said that it might be beneficial at certain times whilst team member I2 commented: *"I would say that it would be best if we were together in our room. I think we distract other teams".* This team acknowledged that they were one of the noisier teams within the open plan environment. Team I was also situated in the centre of the open plan environment and as a result often disturbed other teams. Space seemed to be an issue for the team and team member I5 made a suggestion for an improved collocated team working environment for their team in particular: *"Not a closed-off, private room maybe, but I think it would be better if we were more to the side. So it's not perfect as it is. When we do our stand-up meetings, they're in the passage. So we could do with an improvement. Maybe not in a closed-off, private room, but with a bit more of a sense of own space."*

The literature suggested that a radically collocated team would be the preferred choice for teams using agile methodologies such as SCRUM. The results from the interviews were however very different. Only one of the two teams enjoyed the radically collocated environment, and the other collocated teams would not want to move to a single, dedicated team room, had they the option to do so. Team members were not keen to be disconnected from the rest of the collocated teams, and so the increase in the distance between teams which would come with the radically collocated environment would be considered to negatively impact team effectiveness.

Conclusion

The main purpose of this research was to explore various aspects relating to the collocated environment in order to provide insights into the optimal design of a collocated working environment. This research was conducted using a sample of collocated agile software development teams that were all adopting the SCRUM approach to software development. From the analysis and findings of the questionnaire and interview data that was gathered, the following conclusions can be drawn:

The SCRUM software development teams that are working in the collocated environment are generally satisfied with the designs of their collocated environment. Working in an open plan area and being collocated with other software development teams is beneficial as it leads to increased knowledge and information sharing, and promotes the feeling of involvement and inclusion of each team. As a result, teams do not see the need to be radically collocated in separate team rooms as this might not necessarily improve team effectiveness any more. Additionally, noise and interruptions do not have a significant influence on the effectiveness of teams. Interruptions can sometimes even positively contribute to team effectiveness due to the information transfer between team members by these interruptions. Finally, break-away areas are not common within the agile software development collocated environment, and for the most part will not be regarded as valuable by the development teams.

A key recommendation arising from the findings is that managers should not only consider collocating team members with each other, but investigate the possibility of collocation with other teams in an open plan environment, as this contributes to the feeling of connectivity and involvement that is shared within the environment.

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