



Designing Active Learning Spaces: what to consider?

A literature review





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Executive summary

This review was commissioned by the Centre for Academic Teaching and Learning (CAT) at Utrecht University, exploring the design and layout of active learning spaces in higher education. This review study aimed at finding more information about the design and layout of active learning spaces in higher education. The review emphasizes the need to optimize the design of learning spaces to facilitate interactive and engaging learning activities, aiming to improve students' learning experiences at Utrecht University.

A literature search was conducted primarily focusing on peer-reviewed journals in English, utilizing the systematic review by Talbert and Mor-Avi (2019) as a primary source and structuring the findings according to their theoretical framework, supplemented with articles offering insights into specific aspects of designing active learning spaces in higher education and more recent publications.

The results outline three key aspects of connectedness in active learning spaces: visibility, mobility, and learning tools. Within these key aspects, the results discuss how seating positions and table shapes impact student behavior and engagement, emphasizes the importance of mobility and flexible furniture arrangements in promoting collaboration and interaction, and explores the integration of analogue (e.g., whiteboards) and digital (e.g., projectors) learning tools to enhance student engagement and facilitate effective communication in the classroom.

The discussion highlights limitations in the reviewed literature on active learning spaces, including a lack of research from Europe and a need for more comprehensive studies. Recommendations are provided to improve learning environments, emphasizing the importance of a polycentric layout, teacher-student proximity, movable furniture, flexible seating arrangements, consideration of different learning activities, and integration of both analogue and digital tools. Additionally, the recommendations stress the need to accommodate students' individual needs and facilitate communication and cooperation among students and teachers.

1. Introduction

This is a practice-oriented review commissioned by the Centre for Academic Teaching and Learning (CAT) as part of the 'Future Learning Spaces' project at Utrecht University. It is an addition to the earlier evaluation study by Dolfig & Dijstelbloem (2022), which focused on gaining insights and experience on how to optimise the design and use of current and future 'Active Learning Spaces (ALS)' of Utrecht University. This review study aimed at finding more information about the design and layout of active learning spaces in higher education. The focus was not exclusively of finding hard evidence, but to gather inspiration and ideas to learn more about creating engaging and effective learning environments. This information could contribute optimizing the design of current active learning spaces and inform the design of new active learning spaces at the University of Utrecht (UU).

To start, let us take a brief look at the history and the changes of learning spaces. From ancient Greece to the present day, the utilization of learning spaces has experienced remarkable transformations (see Figure 1 (Park and Choi, 2014)). In ancient Greece, there was no formal university system, and teaching revolved around rhetorical styles where students gathered around their teacher for classroom dialogues. During the Middle Ages, universities introduced a more structured teaching environment, with desks arranged in two vertical rows facing each other. Eventually, teachers began standing at the front centre of the room behind a lectern, reading from a book while students sat in linear rows of desks. With the advent of the industrial age, classrooms expanded to accommodate the shift in education from elitism to massification. Universities were constructed on a larger scale, and classrooms were expected to be more efficient. This traditional layout remains prevalent in many university classrooms today. However, the future aims to promote skills that have a positive impact on the learning process, such as communication, creativity, collaboration, and critical thinking (so-called '21st century skills', see Talbert and Mor-Avi (2019)).

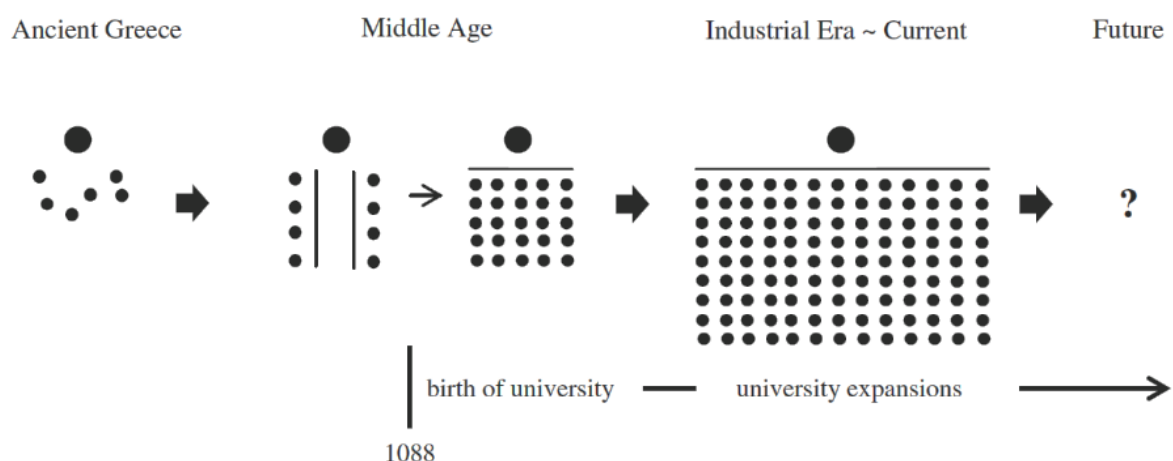


Figure 1 Historical changes in classroom design (Park and Choi, 2014)

Active learning spaces play an important role here. They are thought to promote improvements in communication and collaboration between students and teachers. Unfortunately, there is no clear terminology within the field to discuss this teaching approach (see Talbert and Mor-

Avi (2019)). We use the term 'Active Learning Spaces' in this review and choose this to emphasise that these spaces are intentionally designed to promote *active* learning. Similar terminology, such as 'Active Learning Classrooms', can also be found in other literature, but the term 'classroom' is limiting and evokes associations with old-fashioned educational settings. We use the term 'space' to refer to a concept beyond the classroom, and to stay in line with the project 'Future Learning Spaces' at Utrecht University.

In literature, various types of active learning spaces are referenced. One example is the 'studio classroom spaces,' which are characterized by Taylor (2009) as "a combination of movable furniture, tables that group students into learning teams, a centrally located or movable teacher's station that does not create a "front" of the room, wireless laptops and computer projection, and wall spaces for writing or posting ideas". In a broader context, this signifies that within an active learning space,' teachers position themselves not in front of the class but within the class or amidst a group. Moreover, active learning spaces foster collaborative group activities, the fluid transition between different modes of work, an engaged teaching approach, active involvement from participants, and a substantial level of interaction among students. Consequently, several studies suggest that in active learning spaces, there is a higher level of communication, more group activity and more interactivity and collaboration compared to traditional classroom spaces (see, for instance, Connolly and Lampe 2016, Rands and Gansemer-Topf 2017, Cotner et al. 2013, Byers and Imms 2016).

1.1. UU Active Learning Spaces

Utrecht University also has active learning spaces at its disposal: e.g. the Hybrid Active Learning Classroom (HALC), the Teaching & Learning Lab (TLL) and the Learning Plaza (LP).

The Hybrid Active Learning Classroom (see Figure 2) is characterized by: a room without a front or attention wall, a central teaching position for the teacher, a central teacher desk on wheels, eight group tables for six students each, electric sit-to-stand tables on wheels, two screens and a whiteboard for each table, 48 chairs on wheels and a few stools.



Figure 2 Hybrid Active Learning Classroom at Utrecht University

In the two educational spaces of the Teaching & Learning Lab (see Figure 3), the arrangement of the space is adaptable to the teaching methods intended by the instructor. Using tables and chairs in any setting, adjusting table heights, or removing all furniture—everything is possible in these experimental educational spaces. In addition to the flexible use of furniture, modern equipment is available that can be utilized during teaching



Figure 3 Teaching and Learning Lab at Utrecht University

moments, such as movable smartboards and whiteboard walls for collaborative and active learning and observation cameras for subject-specific research.

The Learning Plaza is characterized by a diverse and shared use of space (see Figure 4). It accommodates a mix of functions for formal and informal learning for both students and staff: instruction, discussion, group work, meetings, lunch, self-study, and relaxation. These activities take place in different zones. The idea is that the space is available as a study workplace when it is not,



Figure 4 Learning Plaza at Utrecht University

or only limitedly, booked for formal education. The Learning Plaza, with a capacity of 150 persons, is a space in development; this former restaurant has been furnished for group work with furniture already present at Utrecht University. Since September 2022, learning activities are organized here, and the space is and will be further developed and arranged in co-creation with teachers, students, and staff.

1.2. Prior reviews and evaluation(s)

The HALC and TLL were evaluated by Dolfing and Dijstelbloem (2022). In this evaluation carried out in collaboration with educational experts, teachers, students, and support staff, Dolfing and Dijstelbloem gained valuable insights by collaboratively designing, implementing, and evaluating lesson plans in these active learning spaces. This evaluation provided more insights into how the design of learning spaces could be optimized to facilitate interactive and activating learning activities that fits in with the Utrecht Educational Model. In line with several studies suggesting that active learning spaces could facilitate and even stimulate high level of communication, group activity,

interactivity and collaboration (see, for instance, Connolly and Lampe 2016, Rands and Gansemer-Topf 2017, Cotner et al. 2013, Byers and Imms 2016), Dolfig & Dijstelbloem (2022) observed that when teachers from Utrecht University are adopting activating teaching methods, conventional classroom designs could hinder the implementation of such teaching practices. More information, however, is needed to facilitate the transition from traditional learning spaces to active learning spaces.

The outcomes of their evaluation study comprise three key components: (1) a guidance program aimed at assisting teachers in effectively designing and implementing interactive learning activities within the current and future active learning spaces, (2) a comprehensive checklist intended to optimize the setup and arrangement of these active learning spaces, and (3) well-founded recommendations for shaping interactive learning activities within such spaces. In addition, Dolfig and Dijstelbloem's study emphasized the noteworthy interplay between lesson plan design and learning space setup. They discovered that the teaching design assumes a leading role and can be effectively complemented by the design of the learning space.

The results found by Dolfig and Dijstelbloem (2022) were supported by the systematic review study of Talbert and Mor-Avi (2019). This review involved 37 peer-reviewed research studies focused on active learning classrooms primarily in higher education. Based on their review of the literature, Talbert and Mor-Avi emphasise the importance of "connectedness" as a design concept that leads to positive outcomes in active learning spaces. They found that elements promoting connectedness, such as architectural design, furniture, or tools, result in the most significant benefits for active student learning. This brings them to three key aspects to consider when designing active learning spaces: visibility, mobility and learning tools.

For example, regarding visibility and mobility, they observed during groupwork sessions that the positioning of teachers within the room significantly impacted students' engagement. Students tended to be more active and participative when the teacher was nearby. This observation is reflected in the checklist of Dolfig and Dijstelbloem (2022), which emphasises the importance of the ability to move around the groups to monitor group work and provide support, underscoring the significance of the distance between tables. Regarding learning tools, Dolfig and Dijstelbloem (2022) observed the importance of enabling students to collectively view whiteboards and screens, fostering inclusivity in visual engagement. Thus, for effective collaboration, the distinction between analogue and digital learning tools becomes less crucial; it appears to be much more important that all learners can observe and actively participate.

The review of Talbert and Mor-Avi (2019) suggests that there is more (recent) information available that could inspire the design of active learning spaces. Therefore, this review study was conducted additionally to find more recent information that could be used when designing active learning spaces at the UU. The information involves inspiration, ideas, designs and layouts of active learning spaces in higher education. This information could contribute in optimizing active learning spaces, and as such students' learning experiences at the UU.

2. **Methodology**

To gain a comprehensive understanding of the literature regarding active learning spaces, a literature search was carried out to identify publications that provided relevant information. The search primarily focused on peer-reviewed journals written in English, as this ensured a minimum level of quality and credibility regarding the research findings.

The systematic review conducted by Talbert and Mor-Avi (2019) was taken as a primary source. The theoretical framework they describe was used to structure the findings in this review report as well. Articles were selected from their list of references that provide information useful in the context of design active learning spaces in the context of the UU.

In addition, the literature search was elaborated by including articles that provide more information about specific aspects of designing active learning spaces (e.g. the effect of table shape or seat position on student learning), the context of higher education, and more recently published articles.

3. Results

In this section, the findings from the literature review are described, focusing on three key aspects. First aspect is the importance of connectedness through visibility (section 3.1). Second aspect is the significance of connectedness through mobility (section 3.2). The meaning of connectedness through learning tools is discussed (see 3.3). Each section is followed by several essential conclusions that highlight the key insights and implications derived from the research.

3.1. Connectedness through Visibility

Numerous studies emphasise the significance of connectedness through visibility by comparing traditional classrooms to active learning spaces and its different types. Two aspects were highlighted in the research: the design of educational spaces, with a special emphasis on seating positions, and the significance of table shape in designing learning environments. Let us start with a brief overview of the research before delving into specific studies that address one crucial aspect each in sections 3.1.1 and 3.1.2.

According to Park and Choi (2014), learning spaces convey an image of the pedagogical philosophy of teaching and learning. This means that students' seating position can influence their behaviour, engagement, and communication in class. For instance, seating in rows directs attention to the front, promoting listening (see Figure 5), while seating in a polycentric layout encourages active communication among students (see figure 6). Other studies have demonstrated that a well-designed learning space can effectively engage students in class and have noteworthy impacts on their learning (see Salter et al., 2013). Such spaces can lead to enhanced interaction among students and teachers, promote active, collaborative, and cooperative learning among students, and encourage social engagement among students. Rezaei (2020) also emphasized that the arrangement and utilization of space play a vital role in students' learning outcomes. In 3.1.1, we will present the study by Park and Choi (2014), which is relevant not only for

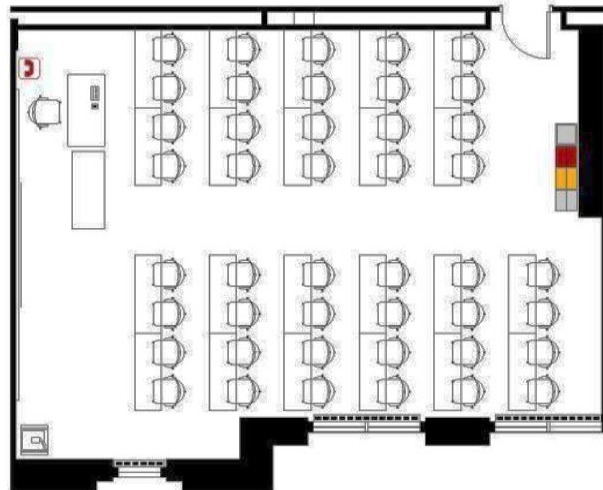


Figure 5 A Schematic Diagram of the Traditional Classroom (Brooks 2012)

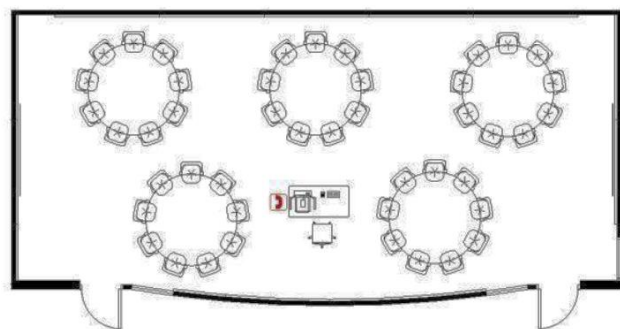


Figure 6 A Schematic Diagram of a Polycentric Layout (Brooks 2012)

traditional classrooms but also for learning spaces with a polycentric layout, and indeed, for all types of learning spaces.

The second aspect we will discuss is the choice of furniture in a learning environment. Researchers have examined how furniture, such as tables, can impact students' behaviour and level of engagement. Several studies highlight the advantages of grouping or clustering students instead of having them seated in rows. For instance, one approach is to let students sit at round tables, as suggested by Lomas and Oblinger (2006), as it fosters collaboration and communication among students. Additionally, the literature posits that different table shapes can influence student behaviour. Studies by Colbert (1997) and Brooks (2019) suggest that the shape of the table can impact how students interact and engage during activities. Furthermore, the composition of student groups, whether in dyads (groups of two) or triads (groups of three), is also considered significant. Research by Shanks et al. (2013), Goodnough et al. (2009), and Pijeira-Diaz et al. (2019) explores the differences in student interactions, productivity, and learning outcomes when working in these various group sizes. Taken together, these findings underscore the importance of thoughtful seating arrangements and group dynamics in creating conducive learning environments that foster collaboration, engagement, and active learning. In section 3.1.2, we will focus on the study by Vujovic et al. (2021) about the influence of table shapes and group sizes on collaboration in a learning environment.

3.1.1. Seating positions: 'Golden zone' and 'shadow zone'

Seating positions in class seems to have an impact of student performance (Perkins and Wieman, 2005). Teachers assume that most engaged students tend to sit at the front of the class and the weakest students tend to sit at the back. It is usually assumed that the level of student performance, interest and engagement determines the preference for seat location. Perkins and Wieman (2005) describe the opposite of cause and effect. They suggest, based on their findings, that the seat location contributes to the level of performance. In accordance, Park and Choi (2014) discovered that certain locations within the classroom are more preferred than others (see Figure 7), which is essential to consider when designing learning spaces.

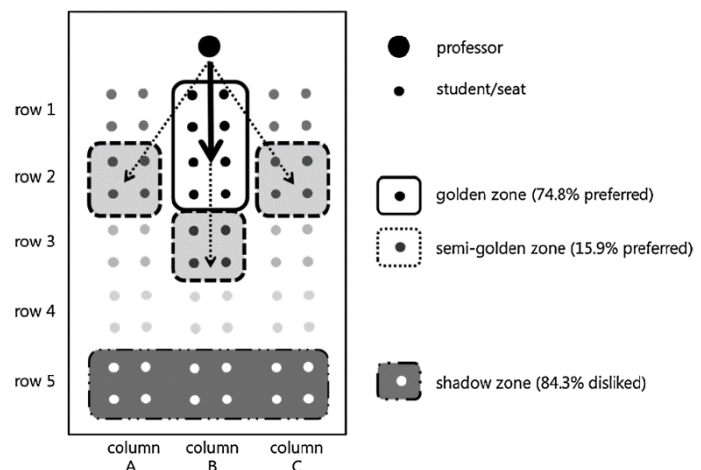


Figure 7 Golden zone and shadow zone in classroom (Park and Choi, 2014)

The most desirable seating positions are called the 'golden zone' and characterised by three aspects. First, they offer an excellent opportunity for good eye-contact and interaction with the teacher. Second, they provide an optimal environment for maintaining concentration and motivation for longer periods. Third, they offer the best view of the screen and whiteboard without being distracted by other students.

On the other hand, the least preferred seating positions are called the 'shadow zone' due to four reasons. First, students in this area are far from the whiteboard and the teacher, which can hinder understanding. Second, there is a lack of eye-contact with the teacher, leading to reduced concentration and motivation. Third, the view is obstructed by students in front-seats. Fourth, the 'shadow zone' naturally leads to distractions, such as chatting with nearby students, using smartphones, or even falling asleep.

The seating positions in the classroom can indeed impact the learning conditions, with front-seated students experiencing more positive effects on their learning experiences compared to those seated in other areas of the classroom. Students who sit in the front generally experience a stronger sense of belonging, which means they have a significantly higher ability to communicate and interact with the teacher. They also exhibit more interest in class, better understanding of the course content, increased active participation, improved concentration for longer durations, higher motivation, and a greater willingness to ask questions and engage in discussions. Additionally, these students are less likely to be bothered by distractions from others.

In the design of active learning spaces, the idea of the 'golden zone' can be recognized, namely in their polycentric layout, which involves creating multiple focal points instead of a single one at the front of the room. The aim is to direct students' attention not just towards the teacher but also towards each other, promoting group cohesion, supporting collaborative and active learning, and avoiding differences in learning outcomes as described here above. As in the introduction already mentioned, Taylor (2009), for example, proposes a studio classroom space with a central or movable teacher's station to support this approach. Research conducted by Terry Byers, Wesley Imms, and their collaborators (see references in Talbert and Mor-Avi, 2019) on active learning spaces with polycentric layouts reveals notably higher ratings on measures of student engagement and learning outcomes.

In the current active learning spaces at the UU, the teacher is closer to all students compared to conventional teaching rooms. Teachers can approach students and student groups more easily and interact with them to support their learning process. This assumes that these active learning spaces have a large golden zone, and the shadow zone(s) are limited. In addition, from the perspective of inclusive education, it is important to consciously think about how to design active learning spaces in the future in a way that there are no shadow zones. This avoids situations in which students are not or less involved in the learning activities due to the design of the classroom.

3.1.2. Shape of tables: round and rectangular

The recent study by Vujovic et al. (2021) explored the influence of table shapes (round and rectangular) and group sizes (dyads and triads) on collaboration in a learning environment. They made differentiated observations (see Figure 8).

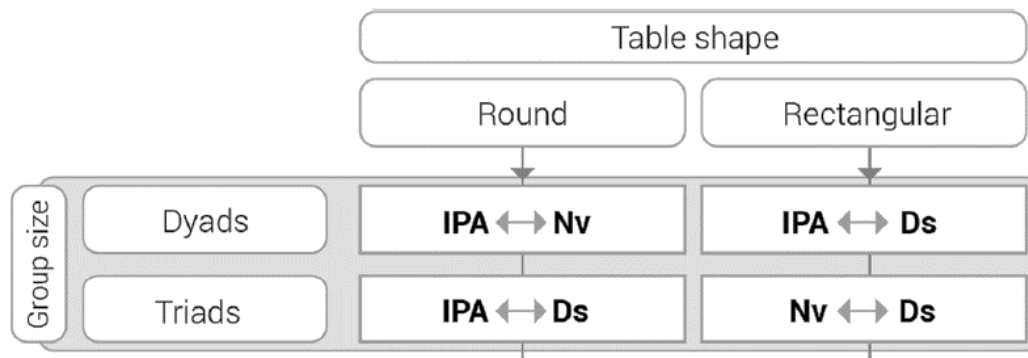


Figure 8 Table shapes (round and rectangular) and group sizes (dyads and triads) on collaboration in a learning environment (edited version from Vujovic et al. 2021)

For dyads (groups of two), the researchers found that students using round tables tended to combine physical artefacts (IPA) such as a laptop or cards, and engage in non-verbal interaction (Nv) more frequently. In contrast, students working at rectangular tables were more involved in explanations and discussions (Ds) while interacting with physical artefacts. Moreover, when using round tables, students communicated less with each other when they were engrossed in working with artefacts, compared to those using rectangular tables. Rectangular tables in dyads stimulated more interpersonal verbal communication, such as discussions and explanations (Ds), while students were engaged with artefacts (IPA).

On the other hand, for triads (groups of three), round tables fostered more alternations between discussion (Ds) and the use of physical artefacts (IPA), while rectangular tables induced more co-occurrences of discussion and non-verbal interaction (Nv). It was observed that when triads used rectangular tables, students tended to engage in alternating between the action of non-verbal interaction and discussion (Ds) more frequently than any other actions.

Although the active learning spaces at the UU facilitate larger student groups (6-8 students), the study of Vujovic et al. (2021) demonstrates the significance of considering both group size and table shape when designing learning environments to optimize collaboration among students. The study highlighted that dyads and triads behave and interact differently when using the same table shape. There seems no one-size-fits-all solution regarding table shapes and seating arrangements, so whatever setting and furniture was chosen, its use needs to be evaluated considering the purpose of the education it needs to facilitate. The effectiveness of each configuration depends on its purpose, intended use, and specific learning tasks. Therefore, it would be useful to investigate how larger student groups interact at different table shapes and how this effects their learning processes.

3.1.3. Conclusion

Based on the literature about the design of learning spaces, several important conclusions can be drawn:

- The design of learning spaces implies certain behaviour of both teachers and students and thus also the learning process.
- Seating positions can create a hierarchy, in the form of golden and shadow zones, among students which can lead to advantages or disadvantages in learning experiences. To create equal

learning opportunities and an inclusive learning environment, it is important to reduce hierarchy as much as possible, for example by keeping equal distances between teacher and students.

- Seating position plays a crucial role in shaping students' sense of belonging. It can either facilitate or complicate interactions between teachers and students.
- The shape of the table influences students' behavior during collaborative activities, indicating that different table shapes can impact how students interact and engage with each other and with the learning materials.
- Considering both group size and table shape is essential when designing learning environments to optimize collaboration and promote positive learning outcomes among students.

3.2. Connectedness through Mobility

Creating connectedness through mobility entails addressing two essential aspects highlighted in literature: the freedom of movement through chairs, and the flexibility in transforming learning spaces. Let us provide a framework for these aspects before delving into specific studies in sections 3.2.1 and 3.2.2.

The first aspect we will discuss is the freedom of movement for students and thus the consideration of their individual needs. Recognizing that every student is unique, with varying physical requirements and preferences, designing learning spaces that consider individual needs, such as size, weight, or other special requirements, ensures a more inclusive and comfortable environment for everyone. Providing adjustable furniture and adaptable layouts can enhance accessibility and support a diverse range of learners. As emphasised by Harvey and Kenyon (2013): "Although seating may be only one element among a multitude of design considerations, it is one of the most easily changeable variables in classroom learning environments, and one that may be more important than people think." Section 3.2.1 will further elaborate on this aspect.

The fixed arrangement of tables in rows and immobile chairs in traditional classrooms (see Figure 3) can limit student interactions and hinder collaborative activities. There are lots of different ways how this can be overcome, for example by introducing movable furniture and flexible seating arrangements. This allows teachers to create dynamic spaces that promote communication, group work and student engagement. Overcoming the traditional limitations of the classroom enables flexibility in the design of learning spaces. The study by Rands and Gansemer-Topf (2017), for instance, found that teachers who move around are more likely to have discussions with students than in a traditional space. In section 3.2.2, the study of Henshaw et al. (2011) will be presented, where they conducted an experiment transforming a traditional classroom into an active learning classroom using swivel tablet desks and aisles to promote interaction and highlight the key effects.

3.2.1. Freedom of movement through chairs

Chairs play a multifaceted and crucial role in the classroom, significantly impacting the learning environment in various dimensions (see the literature review in Harvey and Kenyon 2013).

First, chairs contribute to students' comfort, safety, and health. As the present student population changes in terms of body shapes and sizes, the importance of ergonomic correctness in seating becomes evident. Poor posture, back pain, and neck pain can result in missed school and

work. Breithecker (2006), for instance, highlights that brain activity is reduced when the body remains inactive, such as in traditional classrooms. To address this, it is recommended adopting active-dynamic sitting, which involves using chairs with swivel features and flexible designs. This encourages postural changes, improves blood circulation, stimulates muscles, and allows pelvic and spinal shifting, promoting effective and continual movement.

Secondly, chairs have a psychological appeal in the classroom. Comfortable and supportive seating contributes to a positive learning atmosphere, enhancing students' emotional well-being and engagement. Connolly and Lampe (2016), on the other hand, suggest that chairs that are not too comfortable can encourage people to move more often.

Moreover, chairs play a significant role in fostering social interaction and collaboration among students. They facilitate teamwork and group work, enabling students to easily transition from lecture mode to group mode during a session. The flexibility and mobility of seating styles are crucial in supporting the goals of active learning and teaching methods. 21st-century students highly value the movability and manoeuvrability of seating, as it enables them to work in groups or teams, which is increasingly common in modern classrooms.

Based on these insights, Harvey and Kenyon (2013) conducted a study to identify important design characteristics of classroom seating styles according to students and faculty. They focused on dimensions like Comfort and Space, Learning Engagement, and Interactivity. In their study, students expressed the highest satisfaction with the modern mobile chair (1a) and the trapezoid tables with chairs on casters (5a) (see Figure 9). On the other hand, traditional tablet armchairs and fixed tiered seating with tablet arms



Figure 1a.



Figure 2a.



Figure 3a.



Figure 4a.



Figure 5a.

Figure 9 Five total seating styles: modern mobile chairs (1a), tablet arm chairs (2a), fixed tiered seating with tablet arms (3a), rectangle tables with standard chairs (4a), and trapezoid tables with chairs on casters (5a) (Harvey and Kenyon 2013)

received the lowest scores. The results indicate that the furniture that allowed for the most mobility received the highest ratings in key aspects of the student experience in the classroom.

The two chosen chairs share two important features. First, mobility: these chairs enable quick and easy transitions between different teaching modes, (seated) learning activities, and tasks, which enhances flexibility within the classroom space. The ability to rotate easily also ensures an open line of sight between students and teachers, as well as with visual focal points like whiteboards or screen projections, promoting interactivity. The mobility of these chairs likely encourages postural changes and physical movement, supporting active sitting, which is beneficial for health, comfort, concentration, focus, and effective learning. Secondly, comfort and space: these chairs offer easy and unrestricted access in and out of the seat, accommodating students of various shapes, sizes, and abilities, including both left- and right-handed students.

In summary, the students' preference for the mobile and versatile chairs emphasizes the importance of mobility, comfort, and space in classroom furniture. These features enhance the student experience, promote active engagement, and support effective learning. The question, however, is when and what these chairs will be used for. Another interesting question to investigate would be whether furniture could be tailored to individual needs and preferences, and if this would benefit student learning. For example, the research by Henshaw et al. (2011), which will be presented in the next section, shows that rotatable chairs can indeed increase interaction. But they can also have negative effects, as teachers noted. They observed that the increased interactions between students were not limited to the topic, as students "frequently swung around to chatter".

3.2.2. Flexibility in transforming learning spaces

Since there are different types of chairs and tables, there are also numerous possibilities of how a learning space can be arranged. To promote active learning behaviour, it is desirable to ensure sufficient variety in the forms of learning and thus also easy switching between different set-ups. For example, when teachers move through the room more freely and students connect with their peers all around them, it greatly improves group activity and collaboration with both peers and the teacher. It is helpful if a big effect can be achieved with a small movement or change. This is also reflected in the following study by Henshaw et al. (2011).

Henshaw et al. (2011) conducted an experiment where they transformed a traditional classroom into an Active Learning Classroom using 'swivel tablet desks' (seats which can swivel 360 degrees and are fixed to the floor, see Figure 10) and aisles to promote interaction (see Figure 11). The changes resulted in three key effects.

First, it facilitates Face-to-Face Interaction; the design encourages students to have face-to-face interactions. Rotatable chairs and movable furniture allow students to easily face each other, promoting eye contact and making class interactions feel more natural. This setup enhances participation and creates a more interactive learning environment.



Figure 10 The swivel tablet desks in the experiment by Henshaw et al. (2011)

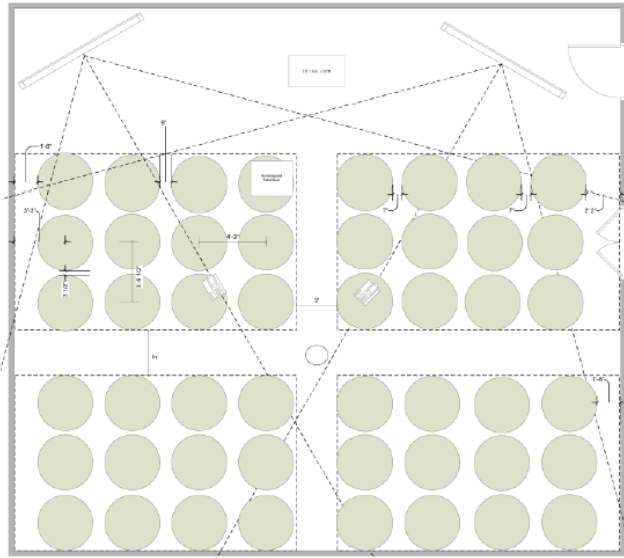


Figure 11 Experimental classroom layout (Henshaw et al. 2011)

instruction within the same space. Teachers can easily switch between lecture, class discussions, and small group activities within a single class period. This reduces instructional and room reconfiguration time, making transitions between instructional modes quicker and more efficient.

3.2.3. Conclusion

Based on the research literature about the mobility in learning spaces, several important conclusions can be drawn:

- Chairs and flexible seating arrangements are crucial for creating modern and effective learning environments, promoting collaboration and active learning experiences.
- Movable and rotatable furniture can facilitate quick transitions between instructional modes and learning activities, enhancing engagement and creating dynamic learning environments.
- Flexible and inclusive learning spaces foster connectedness among students, encouraging active participation and collaboration.
- Rotatable chairs have a positive impact on student engagement and interaction as they enable eye contact and thus informal conversations and peer-to-peer interaction.
- Rotatable chairs may also have negative effects, potentially leading to distractions and reduced focus in the classroom.
- Flexible furniture allows teachers to move freely around the classroom while teaching. This immediacy positively affects student learning outcomes, motivation, and participation. It removes perceived barriers between the teacher and students and reduces the distinction between the front and back of the room. Students find it easier to pay attention and feel encouraged to ask questions and participate in class discussions.

3.3. Connectedness through Learning tools

Active learning spaces, and the various types of them, are characterised by several key elements (see, for instance, Taylor 2009). These include a centrally located or movable teacher's station that avoids creating a fixed "front" of the room (as discussed in section 3.1), movable



Figure 12 Teaching and Learning Lab at Utrecht University

furniture facilitating the formation of learning teams (as explored in section 3.2), and, as we will discuss in this final section, the integration of both analogue (section 3.3.1) and digital learning tools (section 3.3.2), such as wall spaces for writing or posting ideas, wireless laptops, and computer projection. Utrecht University uses a combination of analogue and digital tools in the active learning spaces (see Figure 12).

3.3.1. Analogue tools: 'Thinking Spaces'

In traditional classrooms, there is often only a single blackboard placed at the front of the room, primarily accessible to the teacher, leaving students outside the central area facing challenges in seeing the board clearly. In contrast, active learning spaces are designed differently incorporating a range of analogue tools to enhance the learning experience. Analogue learning tools include different types of whiteboards, but also glass-marker boards, and writable glass tabletops. Collaboration on, for instance, a whiteboard can, as Dolfing and Dijstelbloem (2022) also found in their evaluation study, foster creativity, and group cohesion.

These learning tools can be strategically distributed around the classroom, cover multiple walls and ideally be easily accessible to both teacher and students (see Figure 13). In such spaces, students are actively encouraged to engage with the learning material by utilising these analogue tools during class activities.



Figure 13 Active Learning Classroom with different Learning Tools (Connolly and Lampe 2016)

In Beichner et al. (2007) description of an active learning space, whiteboards are referred to as a 'public thinking space' where students actively engage in sharing knowledge and ideas. According to the authors, students particularly enjoy the collaborative process of working on a problem as a group and then sharing their findings with the entire class. This sharing is facilitated by whiteboards that surround the room, allowing students to present their work and insights to their

peers. Additionally, handheld whiteboards are shared within each group, providing a more intimate and interactive platform for group presentations.

According to Pashak and Hagan's (2014) research conducted in a LearnLab environment, "huddle boards" (a type of whiteboards) emerged as a noteworthy tool for communication, capturing special attention from students. In this LearnLab setting, the room was equipped with (technologically advanced) teaching tools, including smart boards, huddle boards, and copy cams. The study's findings revealed that the use of huddle boards was associated with increased student attention. Compared to other teaching tools, huddle boards had the highest positive impact on student attention levels. Smart boards also showed a statistically significant relationship with higher attention levels. On the other hand, PowerPoint slides scored lower in retaining student attention. This discrepancy can be attributed, according to Pashak and Hagan, to the interactive nature of huddle boards, which focus on facilitating group work, documentation, and synthesis of ideas, rather than solely presenting new concepts.

According to Connolly and Lampe (2016), writable glass tabletops are another valuable means of communication in an active learning space. These surfaces can support brainstorming and encourage creative expression among students. Additionally, the ability to write on the tables facilitates group decision-making processes.

By engaging in collaborative idea-sharing and writing down their thoughts together, students are encouraged to discuss and exchange ideas within the group. This collaborative activity has been shown to improve communication in both small and large group settings, as evidenced by student feedback and enhanced learning outcomes. The use of writable glass tabletops fosters a more interactive and participatory learning environment, promoting active engagement and effective communication among students.

3.3.2. Digital tools: 'Shared Spaces'

Several studies emphasise the importance of readily available digital tools, such as digital projectors, computers, laptops and smart boards. The presence of these tools in active learning spaces is regarded as essential for enhancing student learning and fostering increased interaction within the learning space.

Byers and Imms (2016) conducted a study on the interaction between learning spaces and digital technology, and its impact on teaching and learning. Their findings showed that in an active learning classroom, the use of digital technology is perceived as more beneficial for learning compared to the same technology used similarly in a traditional classroom environment. While this was observed in primary schools, it is also seen in the evaluation study by Dolfing and Dijkstra (2022) and thus provides inspiration for the design of learning spaces in higher education. It suggests that combining digital technology with the design and features of an active learning space can improve students' learning experiences and perceptions of the learning environment.

Connolly and Lampe (2016) highlight the significance of digital projectors in enabling a polycentric layout within a classroom in higher education. By incorporating digital displays, students' visual attention can be directed to multiple points in the room, allowing for greater flexibility in seating arrangements. As a result, the focus shifts to students and student-centred learning.

The use of digital content projected on screens empowers students to engage with learning materials and visual stimuli from various angles and locations within the classroom. This dynamic approach makes the polycentric layout a practical and effective design choice, promoting a more interactive and engaging learning environment. The integration of digital projectors facilitates active participation and collaborative learning, fostering a student-centred approach to education.

3.3.3. Conclusion

Based on the research literature about analogue and digital learning tools, several important conclusions can be drawn:

- Analogue tools such as whiteboards enhance student engagement, promote collaboration, facilitate effective communication among students, and support creative expression and brainstorming activities in the classroom.
- Digital tools such as projectors and computers allow for simultaneous presentation of multiple groups' ideas, facilitating effective (class) discussions and comparisons of different concepts.

4. Discussion

In this review paper, the literature was examined regarding active learning spaces aiming to identify best practices and formulating practical recommendations for designing effective classrooms and learning environments in higher education. Certain limitations, however, have emerged in our efforts, which we will briefly outline.

The first limitation pertains to cultural context. The studies reviewed primarily focus on experiences, outcomes, and observations derived from research conducted in the United States and Asia. Unfortunately, no results were found of research conducted in (West) Europe. Valuable dos and don'ts, however, for designing active learning spaces could still be extracted that may be applicable to higher education in the context of Utrecht University.

The second limitation relates to the scope of the studies reviewed. Valuable insights have been gained into specific aspects of the design of active learning spaces, showing how small differences can significantly influence the behaviour of both learners and teachers. This is evident, for example, in the context of table shapes. While the studies we looked at may not perfectly match the group sizes usually organized in the active learning spaces at Utrecht University, they provide enough inspiration to further investigate small aspects and details within a learning environment and their impact on both students and teachers' behaviour and as such on-student learning processes.

The third limitation concerns the lack of research in this domain of study. Despite the lack of sufficient review studies, a better understanding was developed regarding the reasoning behind and effects of learning space design. Key concepts and detailed aspects were identified that could make a big difference. In a follow-up study, these concepts and aspects could be translated to the context of Utrecht University.

Finally, and in anticipation of the following recommendations, it would be important to consider that didactics and the design of the learning space cannot be separated. The successful implementation of teaching in active learning spaces depends, as Dolfing and Dijkstra (2022) also stressed, on how well the design of the lessons, the design of the classrooms and the professionalisation of the teachers are aligned. This review did not elaborate on this, but repeatedly highlighted both the advantages and disadvantages of this aspect.

5. Recommendations

The following key points offer valuable insights that can help create effective learning environments. The recommendations are mainly aimed at improving communication and cooperation among students and between students and teachers.

- Create a polycentric layout to create eye-contact and to encourage active communication and engagement among students. This may require more freedom of movement and is probably not the most space-efficient design for a classroom, but it can improve the sense of belonging and as a result active participation and collaboration.
- Be aware of the importance of teacher-student proximity. Ensure the same distance between the teacher and different groups or students to create an inclusive learning environment, which means keeping everyone involved and providing equal opportunities (remember the 'golden zone'). Strive for a setup that allows close interaction between teachers and students to positively influence learning behaviour and outcomes, for instance by providing enough space between (groups of) students so teachers can walk towards students (remember the 'shadow zone').
- Use chairs and tables that are easily movable so that the seating arrangement can be quickly and efficiently adapted to the lesson plan and learning activity.
- Some chairs can lead to people swung around more often to chatter. So, pay attention to when chatting is (not) desired.
- Recognize that different learning activities may require different seating arrangements, and tailor the design accordingly.
- Use flexible seating arrangements. Create adaptable seating options that promote collaboration, group work, and easy transitions between different learning activities. Make use of different types of chairs to accommodate diversity. Make use of chairs which facilitate movement and an active-dynamic sitting.
- Consider table shapes and group sizes. Explore the benefits of round, rectangular and other differently shaped tables and consider the impact of group size on collaboration and interactions during activities.
- Focus on students' individual needs. Design learning spaces that consider students' physical requirements and preferences, ensuring inclusivity and comfort for all learners.
- Integrate a mix of analogue tools (like whiteboards) as well as digital tools (such as screens or interactive boards) to enhance student engagement and sense-making activities.
- Make sure students can easily share their physical artefacts and screens can be shared so everyone can watch, for instance by designing multiple focal points.

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