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A qualitative exploration of cardboard architecture in post-pandemic schools

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A B S T R A C T

Governments have responded to the COVID-19 pandemic with social distancing measures, school closures and society lockdowns. The disruption in the functioning of schools have evoked a myriad of emotions among students including the pervasive fear of others and anxiety about a virus that cannot be controlled. As schools reopen, one immediate focus is to ensure proper sanitary measures in classrooms. While important, it is also equally critical that schools effectively support students’ transition back to the classroom environment. This paper considers how cardboard architecture may support transitions between remote home learning and formal school-based education. We use a case study of the Unboxy project, a kit of cardboard shapes and connectors, provided to 18 schools in Australia following the school reopening after covid lockdown. The case study reports a qualitative analysis of how a cardboard architecture project aided students’ transition back to school. Key themes revealed that students created safety structures and spaces for collaboration, thus highlighting the processes with which students interacted with spatial materials to narrate their affective response during the pandemic. Drawing on both research literature and our case study we identify design features of future cardboard architecture resources that can influence student wellbeing upon return to school.

COVID-19 and school closure

Since early 2020 the COVID-19 pandemic has impacted the social, health and wellbeing of people around the globe. In many countries, students were without regular classroom instruction for months as a result of state enforced home isolation and school lockdowns – many of these restrictions continued in 2021. In Australia, as has been the case in many countries, daily life changed with government measures to prevent the spread of COVID-19, such as social distancing, self-isolation, and for those who become infected with the virus, quarantine. In addition to school disruption, the pandemic restrictions required to protect the community have also limited children’s social interactions as participation in sports, extracurricular activities, extended family visits and even outdoor time have been curtailed. Prolonged disruptions in education, routine and social interaction due to these measures have contributed to mental health issues and behavioral problems (Jiao et al., 2020). Consequently, many of the measures adopted during the COVID-19 crises have put children and young adolescents at risk for physical, social and psychological harm (Jiao et al., 2020).

Children are particularly vulnerable to the challenges of effectively coping throughout a state of disaster (Sprang & Silman, 2013). Developmentally, children, especially very young ones, are often unable to process the events around them and to put them in context. Given a widespread access to media, anxiety in children can be easily exacerbated by the near constant and pervasive pandemic-related media reports and social conversations. During previous pandemics and disease containment phases, parents reported significant effect on their children’s mental health, including conditions such as acute stress disorder, adjustment disorder, grief, and post-traumatic stress disorder (Remmerswaal & Muris, 2011; Sprang & Silman, 2013). Schimmenti et al. (2020) identified that during a pandemic the interrelated fears of being alone, infection and death have an impact on a child’s sense of agency, behavior and perspectives when socially relating to others. For students, these feelings may manifest as a sense of helplessness, confusion, perceptions of a lack of safety and reduced control or autonomy.

One of the most critical components of children’s lives is school.
School functions not only as the place where children learn, but also where they socialize, and many obtain health care, meals, and social supports. However, the rapacious spread of COVID-19 virus has led to unprecedented school closures in nearly 200 countries, affecting over one billion students worldwide (Colao et al., 2020). The coronavirus (COVID-19) pandemic, and the safety measures countries across the world implemented, have caused major disruptions to education. Over 90% of enrolled learners (1.5 billion young people) were out of school for extended periods of time. The mental health and wellbeing of students, their social connections and academic achievements have been described as “the worst education crisis on record” (UNESCO, 2021). According to the World Bank (2020), direct academic learning losses in reading, writing and mathematical skills, due to school closures during the pandemic could be permanent. In addition to direct academic impacts, children’s learning and development are negatively affected emotionally and socially. For example, a recent survey of over 6000 children living in Germany, Finland, UK, US and Spain conducted by Save the Children found that nearly 65% of children suffered from isolation (Save the Children, 2020). There are also considerable risks to medically and emotionally vulnerable children. Medically vulnerable children, such as those with tracheotomies or feeding tubes are often highly dependent upon medical supports provided during school. Emotionally vulnerable children may have diagnoses of severe depression, anxiety, bipolar disorder or PTSD requiring learning environments that provide significant emotional support such as counseling, and small class sizes. Given that students in these categories rely heavily on school routines and medical and social supports offered through school, any disruption to their education can lead to negative impacts on their health and learning (Lee, 2020). Furthermore, those students with special educational needs, including autism, language, cognitive, and other developmental disorders, may suffer regression in their social and academic skills due to the protracted disruption of school routine and learning environment. Children living in poverty are also likely to face disproportionate risk from school closures, including a higher rate of drop-out (World Bank, 2020).

Unfortunately, these negative sequelae are unlikely to disappear once restrictions lift and schools reopen. For many parents, teachers and children, a return to the classroom can bring about both a sense of relief and dread. While families wish to have their children return to the classroom, they may be worried about the return to school. Educators may be concerned about the transition phase and the potential for emotional liability. In order to mediate these affective and behavioral reactions, educators need to make a conscious effort to provide children with practical and achievable classroom responses and resources to support the transition back to school. Additionally, the physical environment that students return to may be vastly changed, and in some cases unrecognizable to the school experience they enjoyed previously. Certain practices, including closures of school sporting and recreational areas, reducing movement by keeping students within one classroom, practicing social distancing during class-time, blending school- and home-based learning, staggered break times, and increased hygiene practices, may all act to reinforce the abnormal state of society for students. These fears may be expressed at home or upon returning to school through problematic behaviors including acting out, negative responses to critique or mild conflict and by becoming argumentative. To effectively support children during and after the COVID-19 pandemic, strategies targeted at students’ wellbeing, using physical objects as a vehicle for understanding, engagement as they return to school will potentially have the widest reach and the greatest impact.

This paper presents on the findings of a project designed to leverage the evidence on the benefits of parameters of the classroom physical environment to help support students’ transitions to in-person learning following lockdown. Our central question is what features of cardboard architecture in the classroom can influence student transition back to school after pandemic related closures. To address this question, we examine how material affordances can serve as a kinesthetic focal point to help support normalizing classroom life for students.

### Features of cardboard architecture

To understand the potential of cardboard architecture to mediate the return to school following pandemic shutdown, we draw on several multi-disciplinary concepts from the research literature on design affordances, student wellbeing, learning environments and embodied learning. These constructs include using play to build social infrastructure for learning and creating supportive, caring, and safe spaces in schools; building meaning and expressing emotions through interactions with physical building materials; and using imagination and creativity to re-construe classroom spaces.

### Design affordances and embodied learning

Applying evidence-based design to post pandemic classrooms requires an understanding of how specific parameters of the physical setting can support (or not) student learning and engagement. It is already well-established that play is a critical aspect of learning—in particular for younger students. Play-based interactions can positively influence social and emotional wellbeing and help establish relationships and routines that are the basis for school life (Bateson, 2015; Nijhof et al., 2018).

Cardboard architecture can provide resources to be used during play activities. Geometric shapes with joiners can be used as part of creative, narrative, structured or random play-based activities. Creating shapes or objects can be an enjoyable and creative activity, and a basis for positive social interactions (Weisberg et al., 2015); and can provide opportunities to enact and mediate affective experiences (Hirsh-Pasek et al., 2009). Golinkoff & Hirsh-Pasek (2006) and others state that play is a significant component of learning about emotions, behaviours and the world. Play can be a basis for a range of experiences to re-establish a sense of safety and security in the classroom. Play provides opportunities for students to express their feelings about their environment and experiences (Polizzi et al., 2020).

Social and collaborative play can reduce feelings of anxiety, insecurity, and fear of others as students initiate connections with each other by taking part in shared activities. Collaborative constructing and deconstructing play can build a sense of relational connectedness to peers, increasing positive perceptions of the classroom as supportive, caring and safe (Colle, 2020). The sense of safety includes social and emotional assets, in addition to physical safety of environments (Stengel & Weems, 2010). Activities that are free from fear, hostility, and self-doubt, such as imaginative and creative play with materials, can provide emotional interactions between students and school spaces.

### Student wellbeing and learning environments

The COVID-19 pandemic has produced additional challenges for educators, as they consider how physical spaces, social distancing, hands-on material activities and human interactions play an important role in student feelings of safety and wellbeing as they engage in social and learning activities in schools (Clemens et al., 2020; Stengel & Weems, 2010). It may be difficult to institute social distancing within classrooms that are congested and busy places. A lack of space can induce overstimulation or interpersonal conflicts. Creating spaces for independent play, or for hands-on activities may mediate these responses (Matthews & Lippman, 2018). The question is how to create spaces within existing classrooms. Cardboard architecture provides one option - an example is built niches or caves that provide respite from classroom congestion, noise, and activity. Such shelters can be temporary spaces, constructed by educators or students, providing a permeable refuge for individual or small groups; buffering students from the ambient stimulus conditions of the overcrowded classroom and addressing social, emotional and wellbeing needs (Lippman, 2013;
The stimulus shelter example demonstrates how students can actively imagine and create spaces for themselves within the classroom. Further, students can create or configure spaces as a means to communicate and demonstrate emotional responses to experiences (Landreth, 2012). Hands-on building materials can provide a language for students to express feelings through imaginative place and enactment (Trice-Black et al., 2013). The language of play, using material representation, provides a means for students to communicate their COVID-19 experiences without the need for words and an avenue for students to meaningfully express their feelings when lexical limitations are a constraint (Landreth, 2012).

Spatial and physical layout have long been shown to affect student’s engagement in the classroom (Cardellino et al., 2018). It is well recognized that the classroom environment is a product of a range of social, cultural, and spatial factors. Each individual student has a subjective experience of the classroom (Kutsyuruba et al., 2015). The COVID-19 pandemic has provided new challenges for the maintenance of a productive classroom environment. Educators need to adapt to this challenge by monitoring student actions, reactions, and interactions. This suggests that school learning environments need to incorporate material responses to mediate student emotional reactions to the pandemic experience. Different configurations and transformations will emerge as students create physical representations and expressions of their experiences. Already, many school systems have adopted the idea of spatial flexibility that include derivative spaces such as breakout spaces, niches and informal spaces to accommodate a range of learning preferences and needs (Deed & Lesko, 2015; Dovey & Fisher, 2014). Cardboard architecture may provide the resources to facilitate this spatial strategy.

Cardboard architecture assumes that classrooms can accommodate large construction projects that may temporarily transform one part of the space. These construction zones offer spaces for active and social engagement and learning activity; the open-ended nature of material building also supports development of learning autonomy (Deed et al., 2018; Palincsar, 1998). Students may determine how, where and with whom they will work in the classroom on a construction project. If it is largely a self-directed and open-ended building activity, students are likely to have autonomy to design, make and problem solve through the construction process (Stefanou et al., 2004). Construction activities influences students emotional state as they manipulate spatial, relational and personal space; using space and form to both respond to and create an experience within the classroom (Luck, 2014).

This section identifies key analytical themes for the use of cardboard architecture in the post-pandemic classroom. The physical setting and resources provide action possibilities: for a range of embodied activities comprising creative and imaginative play; to influence student well-being including their sense of social, emotional, and physical safety; to encourage representation of the pandemic experience, involving ideas for changing classroom spaces to support engagement, productivity, and wellbeing; and to use the construction process as a generative learning activity. In sum, we seek to identify design and material features of cardboard architecture that prompt social and emotional re-engagement in the post-pandemic classroom.

Case study: unboxy project

Development context and description

The Unboxy project originated with the leadership team at Australian firm Y2 Architecture. All staff time for design and development, marketing, product testing and research, was provided pro-bono. The ambition was to provide the Unboxy product at-cost to schools, funded by corporate sponsorship. The design team wanted the support of a research team (the authors of this paper) to inform the development of this product. Unboxy was based on the idea of providing students with hands on opportunities that would enable them to work creatively and collaboratively with one another, as well as create physical structures in their classroom environments that could serve as a point for additional socialization opportunities, or shelters for rest and rejuvenation. The natural inclination of the Y2 designers was to be creative and to physically build out their ideas. Toward that end, they came up with cardboard architecture, composed of a kit of cardboard shapes and connectors that can be used to create geometric forms. Unboxy provides a low cost, social, high impact, textural medium that may inspire students and educators to experiment with shapes, forms and processes that can be integrated into day-to-day learning. A core element was affording embodied ways of constructing ideas, spaces, and objects – playful, imaginative, and sensory experiences.

An Unboxy kit consists of 27 sheets of cardboard size 1110 mm x 570 mm with cut-out shapes, and one blank sheet. The shapes include large diamonds, large and small triangles, base plates, and connectors. The size of the kit allows students to build a range of structure types. Fig. 1 is a computer-generated image of two primary-aged students in a space created with the Unboxy product. This shelter was built by the Unboxy design team during prototyping of the resource kit.

It is important to note that this paper seeks to use the Unboxy project as a case study to highlight the effective design of cardboard architecture kits, that could then be used in post-pandemic classrooms. Other cardboard architecture projects are likely emerging across the world, and we have focused on the design concepts underpinning this hands-on approach within the classroom.

Research method overview

The Unboxy project was used as a case study example of cardboard architecture being used by students. A qualitative methodology was employed to explore children’s responses to, and the products created with Unboxy materials. Schools in regional Victoria, Australia, were invited to enter a competition – The Unboxy Challenge - via email; students were tasked with creating structures using the Unboxy materials under three categories. The engineering category was judged on the tallest single structure, the visual arts category was judged on the most artistic and the wellbeing category was judged by the best contribution to wellbeing in the classroom. Schools who elected to take part in the competition received a free kit of the Unboxy construction materials for their school. Photographic and video evidence along with a written reflection about the process of design and construction of 500 words from students was required for each entry. The submission was completely voluntary, and teachers and students were informed that documentation may be used for research purposes. A total of 18 schools responded to the invitation and each received a free Unboxy kit, with 15...
of those schools entering the competition: 8 entries from 7 schools in the Engineering section, 7 entries from 5 schools in the Visual Arts section and 4 entries from 3 schools in the Wellbeing section. 10 primary schools (age range 5 – 12), 1 specialist school (age range 5 – 18) and 4 secondary colleges (age range 12 – 18) participated.

The study invited schools to opt into the research through the competition advertising. An advertising brochure with links to a website was sent out to all of the schools in one region in Victoria. School Principals were asked to provide their contact email and expression of interest for inclusion in the research through the website. Consent forms were then emailed to school Principals with further information about the nature and purpose of the research. 15 schools responded to the invitation and became the data sets analysed for this study, referred to as the artifacts. The data collection for the project took place between November 2020 and January 2021.

In Victoria, Australia, the location of the data collection, the first lockdown lasted from March 30th to May 12th 2020, then again in July 8th to 27th October 2020. All schools (and businesses) were closed during this time pivoting to remote learning. The research was conducted in November 2020 after the second lockdown, where students returned to school for a brief period (there were further school closures called ‘circuit breakers’ shortly after the November return and throughout 2021).

Procedures and data analysis

Due to the voluntary nature of submissions, the researchers had no control over the nature or number of materials received, except that they showed either the process of making or the final product. These materials were provided to the researchers directly from the company (Y2 Architecture) who ran the prototyping, competition, and awards. The vast majority of materials received were composed of photographs of students engaged with the product, images of the final product/s and video recordings of the process being described by children. Added to this, students’ drawings and written reflections of the process and the final product were received.

The research team examined the data utilizing an iterative process to make meaning from the materials generated by the teachers and students. Firstly, common elements with strong potential for yielding an informative understanding of the experiences into emergent themes were identified in the data (Pietkiewicz & Smith, 2014). Following this, clusters of meaning from these common elements were construed which led to the generation of themes that can be expressed in terms of how the students used the product resources. A coding scheme of key themes was generated by the researchers during the data analysis process. Where areas of disagreement occurred among the research team as to the coding of a particular product, consensus was used to make the final determination.

The researchers’ analysis of the artefacts centered on identifying the design features of the Unboxy project that can be generalized to future resource development. The process of making and the purpose or use of the made product were important analytical reference points. This required analysis of choices being made, collaborative practices, skills being applied, and affordances or constraints of the materials used for construction.

Findings

Drawing on the research literature and based on the analysis of the data sets, including photographs, videos and other documentation provided by teachers, such as student quotes and drawings, three main themes were identified: safety, enactment, and expression.

Safety

The theme of safety is understood as the possibility to create secure environments within the materiality of the classroom. In other words, it is about re-imagining educational encounters within the post-pandemic classroom in relation to the spatial perceptions and sense of agency of students using social and collaborative activities as means of countering a fear of others. This then draws from the concept of stimulus shelter first presented by Wachs & Gruen (1982) as a classroom area that is physically cornered off that provides the child with a space for respite and relaxation. Stimulus shelters could be made of any existing furniture in the classroom such as a sheet to form a tent, a small bookcase to create a niche, or even a cubby outfitted with pillows and comfort items. During the last decade, research has looked into the stimulus shelter concept and the benefits that it offers to students from learning and emotional perspectives. The presence of these spaces helps to reduce the immediate impact of density and crowding—both of which have been found to raise stress levels in children and adults. Likewise, these spaces can be employed in the learning process for smaller group collaboration, time for thinking/reflecting and rest.

Photos of the students’ final Unboxy product show cardboard structures used for retreat for small group activities. The materials afforded the opportunity to create a contained space for one or a play space for a small group or, as some students created, a more metaphorical shelter for a toy. Students contained themselves, their peers, or their toys in a range of structures including walled areas, enclosed roofs and tunnels and could be easily reformed or transposed in multiple ways.

The Unboxy materials also provided students with a tangible means to contain their space and the agency to define their own boundaries within it. Several images documented students creating spaces to separate themselves from the group (see Fig. 2). Using shapes created from Unboxy, students constructed physical boundaries, which they defined in their working groups. The students had the opportunity to enter and activate their safe zone in different physical shapes and forms at different times and in different ways—responding to the individual preferences of students in the way they chose to be together.

From the video recordings, some students articulated the desire to be with others, as one student stated, ‘Cubby was my favorite because everyone could get inside’ (student in grade 4). Inherent in this video was the desire for and sense of containment such as the concept implied in the creation of a ‘cubby’. The students used the Australian term ‘cubby’ (similar to the UK, den, and the North American, fort) to describe some of their enclosures. Cubby building is often a ‘to-be-continued’ activity, with children returning to their constructions day after day (Tranter & Malone, 2004). The impermanence of the cardboard materials enabled the creation of temporary enclosures which could be formed and reformed.

The photos and videos show that the final product had undergone many iterations before a shape was found that would hold when children created enclosures that extended over their heads and contained their groups, and yet could be built with high levels of independence. Future makers of cardboard architecture should consider the importance of children being able to independently manipulate the material in multiple ways and include the opportunity for ongoing re-creation, enabling volitional and diverse ways of being together within classrooms.

Enactment

The enactment theme is understood as the process of acting something out. Through acting and re-enacting children can actively engage in their own meaning making. The processes involved in enactment can reflect underlying psychological processes necessary for healing and wellbeing as students make meaning in a new environment using the opportunities for construction, reconstruction, destruction as metaphors for relocation. Children’s active participation (agency) during traumatic events leads to better adjustment (Berberian 2008).

Enactment can occur through play which can positively influence
students social and emotional wellbeing (Golinkoff & Hirsh-Pasek, 2006). Play provides opportunities to enact and mediate affective experiences (Weisberg et al., 2015) and can build a sense of relational connectedness to peers (Collie, 2020). Unboxy provided material resources for active participation for creativity and play. Many images revealed students working collaboratively in small groups (see Fig. 3). Such images are reflective of the movement between material and symbolic, real, and imagined bodies, boundaries and borders’ supporting meaning and agency (Weems, 2010), as well as aiding in re-establishing the traditional routines of the young child’s classroom experience, such as meeting time.

The use of Unboxy materials provided a vehicle for active participation which emphasises doing through activity, practice, and communication. Perseverance with the tasks of co-creation were evident through student quotes as they would need to work and rework the Unboxy design to get the product to work so that it resembled their creative vision.

Some things that didn’t work was that we had to put bits and bobs together and then they wouldn’t hold so we had to redesign it and move things around (Annika, grade 3)

I really like that we were able to work as a team, but what didn’t work was finding all the right pieces and sometimes there wasn’t, and we had to re-adjust things (Pippa, grade 6)

We all had a part to build, and we all put it together at the end. There were a couple of failed attempts but it still kind of looks like a mushroom (Dasha, grade 6).

The applied learning and creativity during solving a design problem appeared to lead to great satisfaction and a sense of purpose when the design was completed. As one of the students claimed, ‘Me and Charlie were trying to build a holder for the basketball, and we had to try and try,
and then we tried making one thing like that and putting something in between and it did work.’ (Fi, grade 6).

Future cardboard architecture resources need to consider the use of materials that support the many different learning disciplines and processes in the contemporary classroom. In this case study, it was important to support open ended design and construction, and the use of sensory, physical, and cognitive capacities. Also, the inclusion of as a range of shapes and sizes could allow for interpretation and varied uses so that the geometric building materials can be joined in multiple ways. Enough materials are needed to allow for the construction of small shelters or extended walls; the materials need to be durable to allow for multiple uses, and consideration needs to be given to base plates to hold structures upright and stable. The key design features of products for classroom use to support wellbeing need to build spatial awareness and allow exploration of creative ideas, achieved through social and collaborative interactions.

Expression

The theme of expression is defined as the interpretation and expression of an (in this case unpleasant) event through material representation. Many children, especially younger ones may lack the expressive linguistic skills to fully describe their experiences of a pandemic (Lingman, Shalev, & Pearlman, 2000; Bruner, 1990). One student commented:

If they [the children] are feeling tired or grumpy they can go there [unboxy construction] and sit down or lay down with nobody to disturb them.

Students planning on what to do with the cardboard pieces provided opportunities to express different ideas towards a common goal. The drawing and sketches can be considered as the first step to exteriorize feelings and views about their environment. Images of the planning process show the idea generation process between children of different ages (see Fig. 4). The expression of material or spatial arrangements can provide insight into student preferences for engagement and learning location and modality and are expressed in a number a student’s quotes:

For a start our team looked at the pieces and people were paired up to make different kinds of pieces which all came together to make one big Christmas tree (Student from St. Joseph).

Looking at the needs of our community all this helped us reflect and improve our work in team

It can also serve as an indicator for teachers to pinpoint which students may be struggling to re-acclimatize to the classroom.

The act of designing provides tools for creativity and play and develops the artistic abilities of students. Unboxy enabled creative ways of solving a design problem as well as realizing how to get it right. Building the tallest tower to hold a basketball was a challenge for many of the students involved in the Engineering part of the competition. Students explain how they managed to make the structure stable.

How we made it was that we started with these big triangles, and we put them together into a bigger triangle, joint them all together to make a pyramid and then after that we put more triangles here and then we did the same here and then we did this holder for the basketball net. We used triangles because they are the strongest shape (Loki, grade 5)

Students felt a sense of accomplishment once the project stood on its own. The motivation was part of the process of designing with a specific purpose.

Future cardboard architecture products need to allow for a multiplicity of expressions, such as drawing, colouring, bending and cutting. Several different sizes can be provided for the cardboard pieces, allowing for geometric design, patterns, and creative interplay of pieces.

Discussion and conclusion

Many experts have noted that children quarantined during the COVID-19 pandemic are at risk for experiencing adverse psychological affects, similar to post-traumatic stress (Brooks et al., 2020). The challenges that COVID-19 brings, including school closures, are likely to have health and wellbeing impacts that will also impact on school engagement and learning. While much focus has been placed on readying classrooms from a health perspective, it is equally critical to prepare the material and spatial environment to adequately support students socially and emotionally during the home-to school transition.

The paper outlines how cardboard architecture can engage students with its materiality, encouraging exploration, playfulness, and imaginative construction. This is likely to occur when students experience their world through perceptual, motor and introspective states (Barsalou, 2008); these features are inherent in the materiality of physical construction activities. These multiple modalities of building and expressing ideas are the basis for many classroom-based learning processes (Lindgren & Johnson-Glenberg, 2013).

The research literature makes clear that as students imagine, plan, design and construct cardboard artifacts, they are using embodied processes such as body shape, movement and scale, motor systems, sensory perception and sensation (Ballard et al., 2013). Students physically and socially occupy, interact with, and create the environment of the classroom as they explore, build, and collaborate using cardboard architecture. The physical aspects of construction require students to exercise physical agility and flexibility as they jump, crawl, bend, twist and climb during construction. Through articulating their bodies within the

Fig. 4. Students’ planning process and ‘brief’ to create artifacts with Unboxy.
classroom space, students also develop a greater sense of spatial awareness, the basis for human experience of the multiple dimensions, aspects, dynamics and properties of classroom spaces (Cook & Hemmings, 2011).

The research literature has identified the potential of cardboard architecture for students’ transition back to the classroom post pandemic shutdowns. When students have opportunities to exercise their agency to create their own spaces and places, they are likely to re-establish a sense of ownership within the classroom. We propose that in the case of cardboard architecture, geometric shapes, and joiners, as illustrated in the case study, it can provide a kinesthetic and collaborative focal point for students to discuss, plan, design, construct and deconstruct their ideas. This increase in peer collaboration and engagement is believed to have a corollary effect on students’ learning, more generally. The social aspect of shared construction activities -may assist students regain their sense of classroom ownership and agency, students may benefit from increased concentration, focus, and engagement in both their didactic subjects and other learning components in the classroom. Student-led design of spaces during class time has potential to augment regulated classrooms; this is an example of how both educators and students can influence teaching and learning through spatial configuration (Cardelino et al., 2018).

Table 1 below, outlines the analytical themes, the learning process or artefact and the design implications.

Table 1

| Analytical theme | Evidence of learning process or artefact | Design implications for cardboard architecture |
|------------------|----------------------------------------|-----------------------------------------------|
| Safety           | Temporary enclosures, contained spaces, play spaces | Pieces that can be easily reformed or reused in multiple ways |
| Enactment        | Design and de/re/construction | Sufficient pieces to build an enclosed structure Base plates for stability Geometric shapes that support mathematics, science, and engineering projects |
| Expression        | Hands-on activity, textual Communication Manipulation and movement | Durability - pieces that can be reused multiple times Pieces that can be easily handled, blank, and writable |

Table 1, below, outlines the analytical themes, the learning process or artefact and the design implications.

Our case study example was limited by the examination of one type of cardboard architecture, and the pandemic limited collection of data to web-based images of artefacts. Accordingly, there may have been some self-selection bias in those schools and programs that chose to participate. Furthermore, the research team did not carry out any direct or extended observation of students in the classroom due to schools’ COVID-19 restrictions on visits. It is also noted that each school, community, and country experienced the pandemic in different ways. School closures, for example, in terms of duration and extent of blending with online learning, vary across regions and states within countries. Only a small number of sample schools were used, and the researchers had no influence over the types of images or artefacts selected by schools for public display.

Nevertheless, the potential influence of design and construction projects within a classroom on student engagement is highlighted through the case study. Cardboard architecture is a resource that enables students to construct an object such as a shelter, wall, imaginary artefact – the social and creative processes may help them transition back to school. As demonstrated in this study, students utilized Unboxy to collaborate with one another through creating structures. This action enabled students not only to re-engage in student-student interaction in an organic manner, but also provided a venue for students to reclaim some control over the school environment which had been disrupted multiple times due to COVID 19 mandates. Returning to school after a lengthy period of learning at home requires re-adjustment. This readjustment process involves building positive emotional and behavioural associations with the classroom environment. Gislason (2010) has claimed that classroom design and configuration is an active organisational agent of student activity. Temporary spaces and objects created by students may support the social, mental health and wellbeing needs present in educational settings post-pandemic shutdowns. How individuals interact, create, and relate with spaces can influence social relationships and activity (Hertzberger, 2008). These paradigms aid in hypothesizing how the use of cardboard architecture in the classroom provides a healthy support for students. The benefits of cardboard architecture are that it can provide a low-cost, sustainable, and manipulable resource for the post-covid classroom. Its primary benefit is that is can be used in any way for any student, as part of either engagement, learning or wellbeing. Table 1 provides the main action possibilities of cardboard architecture: safety and simplicity, enactment through building or creation, and to express ideas in built form. These benefits imply that post-pandemic interaction between wellbeing and material spatiality in the classroom is a field of research that emphasises the physical aspect of human learning. Ongoing research is needed to determine how teachers can effectively utilize the physical environment of the classroom to best respond to extended school shutdowns and the introduction of new school routines such as social distancing, in order to address potential student wellbeing issues (Lee, 2020).

Declaration of Competing Interest

None.

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