Transforming teacher pedagogy to maximize 21st century skills through the learning environment

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Abstract

As schools redesign learning environments and equip classrooms with flexible furniture, it is imperative to examine this impact on teacher pedagogy and student learning. We investigated if classrooms equipped with flexible furniture provided students more opportunities to engage in collaboration, communication, critical thinking skills, and creativity. A between-groups research design was used; classrooms were assigned to one of two groups: The intervention group received professional development (PD) and flexible furniture for eight weeks (n = 4 classrooms), and the control group maintained traditional furniture (n = 10 classrooms). Total recruitment included 327 students in grades two to four, with a random selection of 42 students. Classrooms were observed biweekly for eight weeks. Results of a series of independent sample t-test demonstrated teachers in classrooms with flexible furniture provided more opportunities for students to participate and actively engage in 21st century learning skills.

Keywords*:* Teacher professional development, 21st century learning skills, collaboration, communication, critical thinking, creativity

Our approaches in contemporary classrooms are rapidly evolving, and educational policy requires educators to move beyond teaching our students essential knowledge and skills to developing 21st century skills (Common Core State Standards (CCSS), 2010). The "21st century skills" movement began a decade ago, and educators continue to question how to adequately move education and curriculum forward through this new student-centered approach. In hopes to support this movement, in 2012, the National Education Association (NEA) built a new framework, the "Four Cs" (4Cs) in K-12 education. NEA helped form The Partnership for 21st Century Skills (P21) and explained the 4Cs as: communication, collaboration, creativity, and critical thinking skills (P21, 2015a).

As educators adopt modern teaching and learning strategies, it is imperative to prepare the next generation with the skill sets they need for new and emerging careers. Careers that increasingly rely on a workforce that are proficient communicators, creators, critical thinkers, and collaborators. While current research exists on each of the 21st century skills in isolation or in pairs, a limited number of studies examine all four together, specifically within redesigned elementary classrooms and the elementary curriculum (Urbani, Roshandel, Michaels, & Truesdell, 2017). Furthermore, as schools begin to redesign the learning environment and equip classrooms with flexible furniture, it is crucial to examine the impact this has on student learning and teacher pedagogy, specifically the 4C's of 21st century skills. This study investigates the use of redesigned spaces, particularly flexible furniture, to maximize student learning through the implementation of collaboration, communication, creativity, and critical thinking throughout the curriculum.

Overview of 21st century skills

The Partnership for 21st century skills is the national initiative of the integration of collaboration, communication skills, critical thinking, and creativity across all areas of the curriculum (P21, 2015). This framework, formally known as the 21st Century Learning and Innovations Skills, was developed by educational leaders, government officials, and businesses to include the skills students must acquire to prepare themselves for an ever-changing and evolving life and work environment (Ross, 2017). The individual definitions for each of the constructs follow.

Collaboration is the ability "to work effectively and respectfully with diverse teams. Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal. Assume shared responsibility for collaborative work and value the individual contributions made by each team member" (NEA, 2012, p.20). Furthermore, our school learning environments should center on the implementation of teaching and

learning strategies that support collaboration and provide experiences for students to utilize, manipulate, and crtically assess information through activities focused on solving authentic problems. In order to transition to a student-centered classroom, teachers must shift their to the development of shared knowledge that is constructed among their students (Brown, 1994; Brown & Campione, 1990; Scardamalia & Bereiter, 1992; Wenger, 1998).

Communication is defined as the ability to "articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts" (NEA, 2012, p. 14). Communication incorporates the ability to listen and interpret meaning effectively. More importantly, strong communication skills allow the establishment and development of knowledge, principles, feelings, and objectives. It is an essential skill to communicate well, as it is necessary for a variety of purposes, such as the ability to inform, instruct, motivate, and persuade. As a result, strong communication skills are requisite to reach diverse environments and clearly articulate information to multilingual and multicultural populations.

Creativity is defined as "using a wide range of idea creation techniques (such as brainstorming), creating new and worthwhile ideas. Elaborating, refining, analyzing, and evaluating original ideas to improve and maximize creative efforts" (NEA, 2012, p. 25). Students are expected to learn how to effectively grow, apply, and communicate innovative ideas and information to their peers and teachers. These 21st century skills are valuable as it has become essential for students to learn how to be open and responsive to diverse perspectives and collaborative with various individuals to input and collect feedback to their work. Additionally, teachers are influential in mitigating the effects of standardization on creative thinking and learning in the classroom (Beghetto, 2005). Prior research indicates that teachers equated higher intellectual capabilities with creativity. While some realized that the environment and personality of a student plays a role in the creative process, they could not further define in what manner personality or environment cultivated creativity (Mullet, Willerson, Lamb, & Kettler, 2016).

Critical thinking can be defined in a variety of ways; however, most definitions contain the capability to effectively reason, use systems thinking, make judgments and decisions, and problem solve (P21, 2011). The 21st century framework for education promotes teaching students at all levels to develop critical thinking skills across the curriculum. Critical thinking originated from John Dewey's reflective thinking and how it develops the problem-solving process (Bahatheg, 2019). Throughout the literature, Kennedy et al. (1991) and Jones (2004) advocated that curriculum, regardless of content or grade level, must teach our students to think critically. However, identifying the most effective strategies to develop critical thinking among students has posed many challenges (Bahatheg, 2019).

Previous research has indicated teachers should include critical thinking skills and encourage learners to use critical thinking skills while learning, such as knowing the reasons, observation, and logic, which they are not limited to learning and developing at higher levels of education (Kennedy et al., 1991; Facione, 1990). Empirical studies have shown an improvement in the credibility of different sources of information for children of four years of age (Koenig & Harris, 2005; Bahatheg, 2019). There are multiple studies in the nursing education field centered on teaching and measuring critical thinking. Yet, there are a limited number of studies examining critical thinking skills among students at the elementary level (Kettler, 2014).

Where learning and the environment intersect

While educational leaders are beginning to shift the curriculum to create more student-centered experiences, school facilities continue to fall behind due to their lack of change and inability to support modern learning. The physical layout and design of the classroom should facilitate and cultivate a stimulating learning environment for the students. School facilities in today's classrooms, however, do not represent a 21st century learning environment and do not provide the necessary support required to achieve optimal 4Cs learning (French, 2017). The recent push to implement 21st century skills throughout the curriculum has naturally created a need for the learning environment to be conducive to student-centered learning. This has resulted in increasing pressure to prepare teachers to develop instructional activities that are designed to support the complex needs of learners, specifically the 4Cs in the learning environment. In the literature, studies are beginning to document the relationship between the physical or built environment and how it might be able to enhance or support teacher pedagogy and directly influence student outcomes (Cleveland, 2011; Fisher, 2005; Jamieson, Dane, & Lippman, 2005; Clinton & Wilson, 2019; Blackmore, Bateman, Loughlin, O'Mara, & Aranda, 2011).

Furthermore, in order to best prepare students for a changing world and evolving workforce, educators are beginning to examine content and skills being taught in the classroom, specifically in relation to the environment, which has had little exploration. To support educators in the push to 21st century skills, schools have also recently begun to modify the learning environment. Developing effective communication and critical thinking skills among students are fundamental proficiencies for life and the connection between school architecture and teacher pedagogy has led to revolutionary changes in the learning environment that have created a synergy between teaching practices, curriculum, and the built (physical) classroom environment (Cleveland & Fisher 2014; Kariippanon et al., 2018;

Wagner, 2008). Teachers and students are being encouraged to become active learning participants, and classrooms are being equipped with furniture that supports this goal (Kariippanon, Cliff, Lancaster, Okely, & Parrish, 2018).

As educators continue to look to create learning environments conducive to active learning, concerns about space utilization, facilities, and furniture have arisen. This is due in part to the difficulties which arise when teachers implement student-centered pedagogies in classrooms designed for direct teach modalities. Therefore, there is an effort to consider the physical learning space in combination with best practices in teaching (Buckley, Schneider, & Shang, 2005; Cleveland, 2011; Cleveland & Fisher, 2014; Fisher, 2004; Hartnell-Young, 2006; Heppell, Chapman, Millwood, Constable, & Furness, 2004; Higgins et al., 2005; Rands & Gansemer-Topf, 2017; Taylor, 2009).

The most recent and cost-efficient trend in redesigning the learning environments has involved replacing "traditional classroom furniture" (e.g., stationary desks and chairs) with "flexible classroom furniture". The traditional classroom furniture used in most educational systems was designed during the industrial economy (Kariippanon et al., 2018). Traditional classroom environments enabled teachers to deliver content to large groups of students in a lecture format (Cornell, 2002). Despite changes in teacher pedagogy, traditional classroom furniture remains the primary design for the majority of learning environments. (Higgins, Hall, Wall, Wooler, & McCaughey, 2005).

Flexible classroom furniture includes work surfaces and seating that provides and supports student choice of seating, location, and comfort, encouraging classroom peer interaction (Attai et al., 2019). This type of flexible learning environment naturally promotes and fosters collaboration geared towards empowering students to become builders of knowledge. In redesigned learning environments with flexible furniture, students can move quickly, reconfigure, and even partially-condense the furniture within a short period as compared to the time of a class period (Attai et al., 2019). Currently, in PK-12 schools, both the physical learning environment and classroom furniture at the elementary level and its impact on teacher pedagogy have been minimally examined. This study examines the differences between flexible and traditional furniture and examines how flexible furniture can impact elementary teachers' pedagogy of the 4Cs.

The present study builds on curriculum literature by exploring how teacher pedagogy can be transformed in order to maximize the implementation of 21st century skills through the utilization of the learning environment. Additionally, this study explores how school facilities and furniture influence teaching practices in the contemporary learning experience. We hope to capture changes in teacher pedagogy and space, which might then empower

learners. The belief that physical space influences student learning to enhance the acquisition of 21st century learning skills suggests that research is needed to support or refute the notion that space may influence learning (Merrill, 2018). The current study fills a gap in the literature as it identifies how classroom learning environments, paired with teacher professional development, can develop and impact 21st Century Skills with elementary students. The current study asks, how do classroom learning environments support and encourage teachers to incorporate 21st Century Skills during classroom instruction? More specifically, do flexible learning environments equipped with flexible furniture allow educators to provide students with more opportunities for collaboration, communication, critical thinking skills, and creativity in elementary grades than traditional classrooms? In addition, once teachers provide opportunities for students to participate in collaboration, communication, critical thinking skills, and creativity, do students actively engage in the provided activities? It is hypothesized: training teachers in the use of flexible furniture and equipping their classrooms with flexible furniture will increase the opportunities for teachers to provide activities for students to engage in the 4Cs framework compared to peers in classrooms equipped with traditional furniture.

Methods

The proposed study aims to assess the impact classrooms redesigned with flexible learning environments equipped with intentional flexible furniture has on teacher pedagogy of the 4Cs: collaboration, communication, critical thinking, and creativity. This study used a between-groups research design involving fourteen classrooms. The sample pool was a recruitment of fourteen 2nd through 4th grade classrooms (N = 14 classrooms; N = 327 students) consisting of 165 males and 162 females. Participants were recruited from a public elementary school campus located in a suburban city within the southern region of the United States. The school campus demographics are as follows: African American 12.0%, Hispanic 26.1%, White 44.6%, American Indian 0.4%, and Asian 3.3%. The campus reports 35.0% of students to be economically disadvantaged, and 6.0% as English language learners (ELL). The campus has a mobility rate of 11.4%.

The sample for the observation data was randomly taken from each of the fourteen participating classrooms. Specifically, three students were randomly selected from each participating classroom and continuously monitored throughout the study (n = 42 students). Classrooms were observed biweekly for eight weeks and assigned to one of two groups. Group A (the intervention group) received both PD and flexible furniture (n = 4 classrooms) while Group B maintained treatment as usual (tau group) and their original (traditional) classroom furniture

provided by the school district (n = 10 classrooms).

Data Collection

Data were collected using two methods. The first observation method focused on individual level data using a sampling method described above. The second observation method focused on the physical space in the classroom. For this method, one trained observer observed the class for a total of twenty minutes and completed the developed observation protocol in the classroom environment (Figure 1).

Measures

Classroom Protocol of 21st Learning Skills. An observation form was designed specifically for this study to assess the dependent variables of creativity, communication, collaboration, and creativity. The observations focused on how exposure to flexible furniture impacted teacher pedagogy and student learning behavior over time. Throughout the study, 168 total observations were conducted. Inter-observer agreement was conducted on 20% of the observation sessions (32 sessions). Percent agreement (% agree) was calculated as the number of agreements between observers over the total number of observations. Inter-observer results are as follows: creativity = 87%; communication = 91%; collaboration = 82%; critical thinking = 84%.

Professional Development. All teachers participating in the experimental condition of the study received one full day of professional development, which focused on the utilization of flexible furniture in an elementary classroom to enhance their lesson planning and pedagogy. During the professional development sessions, teachers participated in a series of reflective activities to discuss the benefits and perceived roadblocks associated with the classroom environment, particularly classroom management and implementation. The goal was to showcase how the flexible nature of furniture can drive instructional choices that positively impact student engagement and student success. Teachers spent the day evaluating their current classroom environment and transitioning to a redesigned environment. Teachers also had opportunities to collaborate with their peers who have already transitioned to flexible learning environments. During the collaboration time, teachers participated in small group discussions and teachers engaged in various activities to enhance lesson planning. The flexible furniture was provided by Huckabee Inc., a statewide school architectural firm, and the professional development was developed and funded by Education Service Center Region 12 (ESC Region 12). ESC Region 12 is a nonprofit service organization devoted to supporting 76 school districts through educator professional development, expert assistance, direct services, and alternative certifications.

Data Analysis Plan

Following data collection, all raw data was input into an Excel spreadsheet then uploaded in IBM SPSS Statistics for Windows Version 25.0 for analysis.

Independent variable. The independent variable in the study was exposure to flexible furniture and teacher professional development (PD). In this study, flexible furniture is defined as furniture (work surfaces and seating) that provide and support students' choice of seating, location, comfort, and classroom peer interaction with the intent of fostering collaboration and empowering students to become builders of knowledge. Additionally, students should be able to easily move, reconfigure, and partially condense the furniture in a short period in comparison to the time of a class period. Furthermore, all intervention teachers received a full day of PD, focused on the utilization of flexible furniture in the elementary classroom to enhance lessons, and encouraged the incorporation of 21st century learning skills throughout their pedagogy developed by the Education Service Center Region 12 (ESC Region 12).

Dependent variables. The dependent variables were the observed times that teachers provided activities for students to participate in 4Cs activities and whether when provided, students actively engaged in the activities. The previously mentioned measurement tools measured the dependent variables.

Results

The purpose of this study was to investigate the impact flexible furniture has in the elementary classroom. The study hypothesized that students in classrooms with flexible furniture would report greater satisfaction with the environment than peers placed in classrooms with traditional furniture or tau classrooms. Following data collection, all raw data was input into an Excel spreadsheet then uploaded in IBM SPSS Statistics for Windows Version 25.0 for analysis. The data were analyzed using a series of independent samples t-test.

21st century skills provided

Data were analyzed in two parts. The first part of the analysis looked at whether or not teachers *provide* activities for students to incorporate 21st century skills. Specifically, we examined whether teachers in flexible learning environments provided more opportunities for students to participate in classroom activities that incorporated the 4Cs more than teachers in traditional classrooms (Table 1). Part two of the analysis examined *if the teacher provided* an activity to incorporate the 4Cs of learning, did the *student then actively engage* in the activity (Table 2).

Collaboration. During classroom observations, we observed that teachers with classrooms equipped with flexible furniture allowed more activities and opportunities for students to collaborate. An independent-samples t-test was conducted to compare the activities given to students that provide opportunities requiring collaboration with peers in flexible learning environments and control classrooms. There was a significant difference in the scores for flexible learning environments (M = .53, SD = .12) and control classrooms (M = .18, SD = .39); t(4.39) = 397, p = 0.00. The results suggest that teachers were flexible classrooms provide more opportunities for students to collaborate with their peers and the teacher throughout the observed time. Meaning, students and teachers were observed to have more purposeful interactions.

Communication. There was a significant difference in the scores for flexible learning environments (M = .95, SD = .21) and control classrooms (M = .79, SD = .41); t(2.50) = 125, p = 0.01. The results suggest teachers in flexible classrooms provide more opportunities for students to communicate. Specifically, the results suggest that when classrooms are equipped with flexible furniture, students are provided more opportunities to communicate with their peers and the teacher effectively.

Creativity. During classroom observations, we have observed that classrooms with flexible furniture provided students with more activities for students to be creative. An independent-samples t-test was conducted to compare activities that were given to students, which provided an opportunity for students to offer original ideas to their learning or activity in flexible learning environments and control classrooms. There was a difference in the scores, albeit insignificant, for flexible learning environments (M = .10, SD = .31) and control classrooms (M = .09, SD = .29); t(.48) = 403, p = 0.63.

Critical thinking. During classroom observations, we observed that classrooms with flexible furniture allow more opportunities for teachers to provide students with critical thinking experiences. To explain, an independent-samples t-test was conducted to compare the activities teachers provided to students. Specifically, activities that allowed students the opportunity to reason through problems, make decisions/judgments, and solve problems in flexible learning environments and control classrooms. There was a significant difference in the scores for flexible learning environments (M = .62, SD = .48) and tau classrooms (M = .51, SD = .50); t(2.01) = 403, p = 0.04 implying that teachers in flexible learning environments provided students with more critical thinking activities than in tau classrooms.

Table 1

Independent sample t-test results for classroom observation data for 4Cs activity provided

Variable	Intervention[a]		Tau[a]				
	M	SD	M	SD	df	t	p
Collaboration	.53	.12	.18	.39	397	4.39	0.00
Communication	.43	.49	.24	.43	405	3.65	0.00
Creativity	.10	.31	.09	.29	403	1.48	0.63
Critical Thinking	.62	.48	.51	.50	403	2.01	0.04

[a]*n* = 42 students

21st century skills engaged

The results that follow are part two of the analysis and examined *if the teacher provided* an activity to incorporate the 4Cs of learning did the *student then actively engage* in the activity (Table 2).

Collaboration. It was observed that teachers in flexible classrooms who provided students with collaborative activities had students who actively engaged more in the provided collaborative activity than students in traditional classrooms. Our findings show, there was a difference in scores, albeit insignificant, for flexible learning environments (M = .88, SD = .34) and control classrooms (M = .76, SD = .43); t(1.45) = 100, p = 0.14. Specifically, the results suggest that when a teacher is in a classroom equipped with flexible furniture, it appears to support a transformation in her pedagogy, and she provides students with collaborative opportunities that actively engage students in the activity with their peers or teachers. This implies that a flexible learning environment might maximize the number of times students spend collaborating with others in purposeful ways to support learning.

Communication. During classroom observations, it was observed that classrooms with flexible furniture allowed more opportunities for students to engage in activities that require students to communicate actively. An independent-samples t-test was conducted to compare group differences between learning environments. Teachers were able to actively engage students in activities that require communication with peers in flexible learning environments more than in control classrooms as shown by the significant difference in the scores for flexible learning environments (M = .43, SD = .49) and control classrooms (M = .24, SD = .43); t(3.65) = 405, p = 0.00. Once teachers provided students with the opportunity to participate in a communication activity, students would

actively engage their peers in conversations during learning in flexible classroom environments compared to students in control classrooms.

Creativity. Also, when teachers provided students the opportunity to participate in an activity that allowed them to be creative, the students would fully engage in the activity and utilize skills such as elaboration, refinement, analysis, and evaluation of original ideas to improve and maximize creative efforts. There was a significant difference in the scores for flexible learning environments (M = .47, SD = .51) and control classrooms (M = .08, SD = .28); t(3.66) = 53, p = 0.001. The results suggest that teachers in flexible classrooms can provide more activities that utilize creativity for the students. Once provided these activities, students will actively engage in the creative learning process provided by these opportunities.

Critical thinking. Furthermore, when teachers provide students with the opportunity to participate in a critical thinking activity, the students actively engaged in cognitive thought problems and made decisions/judgments, and solved problems more so in the flexible learning environments than compared to the tau classrooms. This was shown by the significant difference in the scores for flexible learning environments (M = .95, SD = .21) and tau classrooms (M = .85, SD = .36); t(2.09) = 230, p = 0.04. These results suggest teachers in flexible classrooms were able to actively engage in more activities allowing students to have the opportunity to use their critical thinking skills. These findings also show that a supportive environment can facilitate learning and engage students in 21st century learning skills.

Discussion

These findings discussed how schools equipped with purposefully designed classrooms could support teacher pedagogy to maximize the implementation of 21st century skills throughout the curriculum. The study examined the impact classroom space has on curriculum and teacher pedagogy with the intent of supporting deeper learning experiences for students to support collaboration, communication, creativity, and critical thinking. To date, there has been limited research conducted on how flexible learning environments can impact or enhance teacher pedagogy of the 4Cs. The present study provides several recommendations for the facilitation and implementation of 21st century learning skills in elementary classrooms to support the curriculum.

First, we examined whether or not teachers provided more opportunities to incorporate the 4Cs of 21st century skills in flexible learning environments than in traditional classrooms. As hypothesized, teachers in classrooms equipped with flexible furniture provided more opportunities for students to participate in collaboration,

communication, creativity, and critical thinking. In addition, the study shows a significant impact on teacher pedagogy when active furniture is in the classroom. Furthermore, it is imperative to note that during professional development, teachers were informed of the impact of the physical environment. Suggesting, when teachers understand the influence of the environment and are in a position to improve collaboration and creativity among the students by use of flexible furniture, they are empowered to rethink what they teach and how they teach it. Teachers in flexible classrooms were observed employing lessons that had less lecture-based material and more interactive with students, creating an active avenue for collaborative discovery. As a result, developing an understanding of how classroom furniture can be utilized to improve student engagement and the delivery of soft skills will allow teachers to fully maximize and enhance the learning experience for elementary students, specifically with the focus and support of the 4Cs.

Secondly, the intervention classrooms equipped with flexible furniture were purposefully designed to support teacher pedagogy of the 4Cs. Students placed in classrooms with flexible furniture were not only given more opportunities to participate in 4Cs activities, but they also were able to engage in the 4Cs actively more frequently once the activity was provided. Similarly, additional studies have shown learning environments equipped with "active" furniture provide opportunities to move around the classroom in order to create more collaborative learning experiences among peers than traditional classrooms (Parson, 2017; Rands & Gansemer-Topf, 2017). This study adds to the existing literature suggesting that classrooms equipped with purposeful furniture designed to support pedagogy allow teachers to enhance their lessons throughout the class day in a supportive environment that actively engages students. Therefore, it can be concluded that flexible classrooms impact teacher pedagogy and student learning and that the design leads to more opportunities for students to collaborate and communicate, creating deeper connections among peers and the teacher.

Finally, it should be noted that a positive environment suitable for learning can occur quickly for children and educators when they are inspired and curious. Thus, in order for teachers to utilize purposefully designed environments, professional developments should continue to be implemented to develop and sustain a mindset on how educators can engage students through authentic learning experiences in and outside of the built environments. Furthermore, posing questions or ideas for teachers to think about cultivates a design thinking lens. This might improve the way educators and architects imagine and develop the connections between space and teaching in order to create more profound, collaborative, creative-learning experiences supportive of communication and critical

thinking. Therefore, incorporating educators in the discussion about the intentional uses of space to support the pedagogical changes is essential to contemporary learning. As in other findings, the alignment of space and pedagogy in educational settings is a crucial connection (Cleveland & Fisher, 2014).

Limitations of the study and future research

As with all research, the present study has limitations. Ideally, it would have been best to use a random sampling method of classrooms with flexible furniture; however, the researchers did not pursue a random sample due to the cost, difficulty, and timeliness. Furthermore, classrooms were self-selected to have flexible furniture, with students semi-randomly placed in classrooms. The major drawback to self-selection of the intervention method is bias since the sample is less likely to be representative, limiting generalizations and inferences that might be made about the whole population. Future replications will need to be conducted across a variety of PK-12 settings and a variety of cultural contexts to increase the level of generalizability of the results.

Due to this, the findings of this study can only be generalizable to similar samples as the present study. Future research is needed to expand on our understanding of flexible furniture and the various ways it impacts teachers and their implementation and integration of 21st century skills into the daily curriculum. Academic outcomes were not taken into consideration in this study; however, future studies could assess whether flexible learning environments increase academic outcomes at the elementary level. In addition, teacher feedback and perceptions were not taken into consideration, and would provide a foundation for a lived experience phenomenological case study. Furthermore, operational definitions varied throughout the literature, and additional studies utilizing our protocol should be implemented and evaluated at different age levels in terms of knowledge, skills, and attitudes.

Conclusions

The current study draws three main conclusions: 1) Teachers in purposefully designed flexible learning environments provide students with more opportunities to participate in 21st century skills throughout the day in comparison to peers in traditional learning environments; 2) once teachers provided students with activities to participate in 21st century learning skills, students actively engaged in those activities more than students placed in classrooms with traditional furniture; and 3) additional professional development is needed to maximize the benefits associated with flexible furniture in order to further enhance learning. These findings are congruent with previous results, showing the need to consider the learning space as an additional component to teacher pedagogy influencing

the overall learning experience for the students (Cleveland & Fisher, 2014). Additionally, the examination of these new and redesigned learning environments via the implementation of flexible furniture is essential to help active learning and student-centered environments reach their fullest potential. Furthermore, there is an ongoing need for research and evaluation data in learning environments as decision-makers and school administrators look towards research-based evidence to inform their future decisions.

The present study shows the potential to impact teacher professional development throughout schools significantly. Currently, schools provide a variety of professional development opportunities throughout the school year to teachers based on the various needs of staff, students, and academic achievement results. However, limited professional development currently emphasizes increasing soft skills such as improving collaboration, communication, creativity, and critical thinking along with classroom space. This study demonstrates the synergy between purposefully redesigned classrooms and innovative learning environments that support quality, student-centered pedagogical strategies, which together influence student outcomes.

A variety of stakeholders in education can use the information gained from this research in learning environments. Specifically, this study provides a foundation for delivering useful research to both educators and architects, informing the effectiveness of classroom designs and furniture choices, developing modern or new approaches in furniture and design, and enhancing and support educators' pedagogical goals to improve student outcomes. School architects can use this research to inform design decisions and the consultation process with current and future clients which, typically consists of school administrators and facility planning committees. School administrators, who are responsible for allocating funds for new facilities and redesigning current facilities, can use this data to advocate for modern learning environments equipped with flexible furniture. Finally, this study provides information that can be utilized to guide policymakers' decisions regarding classroom design and equipment.

Understanding how the furniture/environment impacts students will also enable educators to design learning environments, develop curriculum, and enhance teacher professional development to maximize the learning experience for elementary students – overall leading to higher levels of engagement and academic achievement. This research adds empirical evidence and serves as a stepping stone in further refining and identifying the relationships between the learning environment, curriculum, and pedagogy. As such, this study contributes to the literature by providing supportive data that flexible furniture in classrooms has the potential to create more effective classrooms that support teacher pedagogy for modern learners. It also clarifies that teacher professional development

is necessary to optimize the impact of various modern classroom features such as furniture has on student learning. Future research is needed to better understand the connection between teacher professional development and flexible learning environments.

References

Attai, S., Reyes, J., Davis, J., York, J., Ranney, K., Hyde, T. (2019) *Investigating the impact of flexible furniture in the elementary classroom*. Manuscript submitted for publication.

Bahatheg, R. O. (2019). Critical thinking skills in elementary school curricula in some Arab countries--A comparative analysis. *International Education Studies, 12*(4), 217-235. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1211442&site=ehost-live&scope=site

Beghetto, R. A. (2005). Does assessment kill student creativity? *The Educational Forum, 69*, 254–263. http://dx.doi.org/10.1080/00131720508984694

Blackmore, J., Bateman, D., Loughlin, J., O'Mara, J., & Aranda, G. (2011). *Research into the connection between built learning spaces and student outcomes*. Victoria: Department of Education and Early Childhood Development.

Brown, A.L. (1994). The advancement of learning. *Educational Researcher, 23*(8), 4–12.

Brown, A.L., & Campione, J.C. (1990). Communities of learning and thinking, or a context by any other name. In D. Kuhn (Ed.), *Developmental Perspectives on Teaching and Learning Thinking Skills.* Contributions to *Human Development, 21*, 108–126.

Buckley, J., Schneider, M., & Shang, Y. (2005). Fix it and they might stay: School facility quality and teacher retention in Washington D.C. *Teachers College Record, 107*, 1107–1123.

Cleveland, B. (2011). *Engaging spaces: Innovative learning environments, pedagogies and student engagement in the middle years of school.* Unpublished PhD thesis, The University of Melbourne, Melbourne, AU.

Cleveland, B. & Fisher, K. (2014). The evaluation of physical learning environments: a critical review of the literature. *Learning Environments Research*, *17*(1), 1–28.

Clinton, V., & Wilson, N. (2019). More than chalkboards: classroom spaces and collaborative learning attitudes. *Learning Environments Research*, 1-20. doi: 10.1007/s10984-019-09287-w.

Common core state standards (2010)

Cornell, Paul. (2002). The impact of changes in teaching and learning on furniture and the learning environment. *New Directions for Teaching and Learning*, *92*(1), 33-42.

Facione, P. A. (1990). *Critical thinking: A statement of expert con- sensus for purposes of educational assessment and instruction. Research findings and recommendations*. Newark, DE: American Philosophical Association. (ERIC Document Reproduction Services No. ED315423)

Fisher, K. (2004). Revoicing classrooms: A spatial manifesto. *Forum, 46*(1), 36–38.

Fisher, K. (2005). Linking pedagogy and space: Planning principles for Victorian schools based on the principles of teaching and learning.

French, J. (2017, September). Design does matter. School planning and management. Retrieved from https://webspm.com/Articles/2017/09/01/Design.aspx

Hartnell-Young, E. (2006). Teachers' roles and professional learning in communities of practice supported by technology in schools. *Journal of Technology and Teacher Education, 14*, 461–480.

Heppell, S., Chapman, C., Millwood, R., Constable, M., & Furness, J. (2004). *Building learning futures.* Retrieved from https://www.buildingfutures.org.uk

Higgins, S., Hall, E., Wall, K., Wooler, P., & McCaughey, C. (2005). *The impact of school environments: A literature review*. London, UK: The Design Council. www.design-council.org.uk.

Jamieson, P., Dane, J., & Lippman, P. (2005, May). *Moving beyond the classroom: Accommodating the changing pedagogy of higher education.* Paper presented at the Forum of the Australian Association for Institutional Research in San Diego, CA. Retrieved from http://www.aair.org.au/pages/forum-2005.

Jones, A. (2004). Teaching critical thinking: An investigation of a task in introductory macroeconomics. *Higher Education Research & Development, 23*(2), 167-181.

Kariippanon, K., Cliff, D., Lancaster, S., Okely, A., Parrish, A. (2018). Perceived interplay between flexible learning spaces and teaching, learning and student wellbeing. *Learning Environment Research,* 21, 301-320. doi:10.1007/s1098-017-9254-9.

Kennedy, M., Fisher, M., & Ennis, R. (1991). Critical thinking: Literature review and needed research. In L. Idol, & B. F. Jones (Eds.), *Educational values and cognitive instruction: Implications for reform*. Hillsdale, NJ: Erlbaum.

Kettler, T. (2014). Critical thinking skills among elementary school students: Comparing identified gifted and general education student performance. *Gifted Child Quarterly, 58*(2), 127-136. Retrieved from http://dx.doi.org/10.1177/0016986214522508

Koenig, M., & Harris, P. (2005). Preschoolers mistrust ignorant and inaccurate speakers. *Child Development, 76*(6), 1261-1277. https://doi.org/10.1111/j.1467-8624.2005.00849.x

Merrill, S. (2018, June 14). Flexible classrooms: Research is scarce, but promising. Retrieved from https://www.edutopia.org/article/flexible-classrooms-research-scarce-promising

Mullet, D. R., Willerson, A., Lamb, K. N., & Kettler, T. (2016). Examining teacher perceptions of creativity: A systematic review of the literature. *Thinking Skills and Creativity, 21*, 9-30. doi:10.1016/j.tsc.2016.05.001

National Education Association (2012). Preparing 21st Century Students for a Global Society: An Educator's Guide to the "Four Cs". Washington, D.C. Retrieved from http://www.nea.org/assets/docs/A-Guide-to-Four-Cs.pdf

Parsons, C. S. (2017). Reforming the environment: The influence of the roundtable classroom design on interactive learning. *Journal of Learning Spaces*, *6*(3), 23-33. Retrieved from https://eric.ed.gov/?id=EJ1164644

Rands, M. L., & Gansemer-Topf, A. M. (2017). The room itself is active: How classroom design impacts student engagement. *Journal of Learning Spaces*, *6*(1), 26-33.

Ross, D. (2017). Empowering our students with 21st-Century skills for today. Retrieved from http://www.gettingsmart.com/2017/04/empowering-students-21stcentury-skills/

SBAC (2015). Preparing America's Students for College & Career: The Common Core State Standards—A Commitment to Student Success. Washington, DC: Smarter Balanced Assessment Consortium. http://www.svsd410.org/cms/lib05/WA01919490/Centricity/Domain/31/Parent%20CCSS%20Presentation.pdf

Scardamalia, M., & Bereiter, C. (1992). An architecture for collaborative knowledge-building. In E. De Corte, M. Linn, H. Mandl, & L. Verschaffel (Eds.), *Computer-based learning environments and problem solving.* [NATO-ASI Series F: Computer and Sys- tems Science] (pp. 41–46). Berlin: Springer-Verlag.

Taylor, A. (2009). *Linking architecture and education: Sustainable design for learning environments*. Albuquerque: University of New Mexico Press. Washington, DC: National Clearinghouse for Educational Facilities.

Urbani, J. M., Roshandel, S., Michaels, R., & Truesdell, E. (2017). Developing and modeling 21st-century skills with preservice teachers. *Teacher Education Quarterly, 44*(4), 27-50. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1157317&site=ehost-live&scope=site

Wagner, T. (2008). *The global achievement gap: Why even our best schools don't teach the new survival skills our children need—And what we can do about it*. New York, NY: Basic Books.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* New York: Cambridge University Press.

P21 (2011). *Framework for 21st Century Learning*. Partnership for 21st Century Skills (P21). http://www.P21.org

Partnership for 21st Century Skills. (2012). Framework for 21st century learning. Retrieved from http://www.p21.org/documents/P21_Framework.pdf

P21 (2015a). *Our Mission*. Washington, DC: The Partnership for 21st Century Skills. http://www.p21.org/about-us/our-mission

P21 (2015b). *Framework for 21st Century Learning*. The Partnership for 21st Century Skills. http://www.p21.org/about-us/p21-framework

P21 (2015c). *We Are Taking Teaching and Learning Above & Beyond*. Partnership for 21st Century Skills. www.p21.org/storage/documents/4csposter.pdf

P21 (2015d). *Core Subjects and 21st Century Themes*. The Partnership for 21st Century Skills. http://www.p21.org/about-us/p21-framework/57