Design Thinking and Material Utilisation Creativity in Early Childhood Teacher Education: A Case of Kyambogo University

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https://doi.org/10.58653/nche.v11i1.05
(Accepted: 8th November 2023/Published: 15th November 2023)

Abstract

Children are able to make greater gains in their early development when the teachers possess the necessary competencies to provide quality experiences (Litjens &Taguma, 2010). However, in Uganda, despite the existence of early childhood teacher education training, teachers still lack key creativity competencies to use learning materials to enrich children's learning experiences (MoES, 2018). This study was conducted in two teacher training institutions located in urban-rural Uganda to examine how the Art World Design Thinking Process can be used to improve teacher material utilisation creativity in early childhood teacher education. A quasi-experimental design used a concurrent embedded mixed-methods design of non-equivalent groups (Bhattacherjee, 2012). The study worked with 64 participants from two cohorts, the control group and the experimental group. The treatment was a one-month experiment using the Art World Design Thinking Process. The data collection instruments used were the teacher creativity observation tool and the focus group interview guide. Quantitative data was analysed using a t-test for independent groups, whereas qualitative data was analysed using thematic content analysis. Results from the post-test data showed that teachers had developed personal creativity in material utilisation. In conclusion, the study shows that the Art World Design Thinking Process has the potential to improve the development of material utilisation creativity skills for early childhood teachers. The study contributes to the discussion on how the Art World Design Thinking Process can be used to develop teacher creativity in Early Childhood education.

Keywords: *Creativity; Art World Design Thinking Process; material utilisation creativity; Early childhood teacher education*.

Background

Teacher training, in most early childhood education institutions in Uganda, is characterised by rote teaching using note taking, theoretical assignments and examinations. The focus is on passing examinations rather than understanding the basic teaching principles and how to apply them to teaching and learning in the classroom. Similarly, instructional material use is minimal, involves copy and paste from teacher to teacher, and basically includes charts, counters, ropes and balls. Yet, evidence shows that using materials with children requires creativity and well-planned teacher training activities (Elif, 2010). The way a teacher uses materials should be able to meet the child's needs (Harris, 2011; Stinnett, 2018; Toros, 2013). The teachers from these institutions join the teaching workforce with limited skills to apply (Mupa & Tendeukai, 2015), and they teach the way they were trained using rote methods which do not provide children with the opportunity to experiment with ideas and engage in critical thinking. To reverse the current situation, there is need to focus on creativity in teacher education. Despite its elusive nature, creativity is defined by several authors to consist of three elements that include the creative person, the creative process and the creative environment (Fryer, 1991; Sternberg, 1999). The creative person exhibits three traits that include information processing (cognitive), personality traits (conative) and affective traits (emotional). These interact with the creative environment and creative processes to enable the creative person to produce novel and relevant solutions to problems (Abraham, 2016; Barbot, Besançon, & Lubart, 2011; Runco & Jaeger, 2012).

Creative thinking is not developed in one day. Rather, it is a process that requires a nurturing environment. Teacher education programmes need to deliberately use approaches that prepare an environment that nurtures creative thinking skills in materials utilisation. Embracing creativity in teacher training and development requires a focus on adaptability, originality and participation in the course of the training (Eggleston, 1992, p. 5; Perkins, 1992). In trying to achieve the three elements, this study explored the use of the Art World Design Thinking Process as a stimulator for teacher creativity, which can improve teacher materials utilisation creativity (Prins et al, 2016). The theoretical guide for this study was the theory of identical elements as developed by Thorndike and Woodworth in 1901 (Aarkrog, 2011). The theory proposes that learning in one context enhances (positive transfer) or undermines (negative transfer) a related performance in another context (Perkins & Salomon, 1992). The theory requires a framework in which transfer of learning can occur which encompasses conceptual knowledge, procedural knowledge (skills) and strategic knowledge (Macaulay & Cree, 2007). This study adopted the Art World Design Thinking Process as a structural framework to transfer creative thinking.

Literature Review

The application of design thinking to improve teacher creativity focuses on its principles, methodologies and impacts within the educational context. At the core of design thinking are the stages of empathy, definition, ideation, prototyping and testing, which are used in a collaborative and iterative way. Teachers can apply these principles to better understand the needs and preferences of their students and develop innovative solutions to pedagogical challenges (Brown, 2008). Design Thinking can serve as a catalyst for a culture of creativity by embracing open-ended problem-solving, and teachers can explore unconventional solutions and approach learning materials in unique ways (Kelley & Kelley, 2013; Simon, 2013; Lockwood, 2019). By empathising with children, educators are able to design materials and activities that are child-centred and adaptive (Dam & Siang, 2020). Ideation encourages a teacher to conceive a wide range of ideas that can provide insights to enrich learning experiences. It provides teachers with an opportunity to brainstorm creative material ideas and teaching methods that enrich the learning and teaching experience (Brown, 2008). Design Thinking uses an iterative approach which nurtures a culture of continuously challenging oneself and improving (Blikstein, 2013). Design Thinking challenges teachers to address real-world problems, making education more practical and relevant. This approach encourages teachers to develop creative solutions to current educational challenges, such as inclusiveness, material usage, digital literacy and student engagement and, in the context of teaching materials, ideation leads to the creation of

innovative and engaging materials, such as interactive activity concepts and gamified learning resources, which presents exciting opportunities for creating innovative and interactive teaching materials (Dorst, 2011; Deterding et al., 2015). Design Thinking challenges educators to deal with real learning problems in teaching materials and critical thinking which enhances the creativity of teaching materials (Polly et al., 2017). Ideation provides different viewpoints that lead to more comprehensive idea exploration in material utilisation and also ensures that the ideas are user-friendly (Sonalkar et al., 2019; Ludden et al., 2008). Prototyping helps educators to create concrete, testable forms that can be tested and refined (Brown, 2008). Through visualising ideas and co-creating prototypes, educators can elicit valuable feedback, foster collaboration and ensure that the materials align with the needs and expectations of children (Buchenau & Suri, 2000). Design Thinking has the potential to revolutionise teaching material development and utilisation, fostering creativity and engagement in early childhood education. Through emphasising empathy, ideation and an iterative approach, educators can create and employ teaching materials that resonate with children, enhance learning and cultivate a culture of teacher creativity and innovation in the classroom.

Conceptual Framework

Figure 1: The Art World Design Thinking Process and material utilisation creativity

Source: Adapted from Teo Yu Siang and Interaction Design Foundation (2019)

Figure 2: The Art World Design Thinking Process

Source: Adapted from Teo Yu Siang and Interaction Design Foundation (2019)

The Empathy phase is the stage that helps a designer to gain deeper understanding of issues from user perspectives without allowing their own assumptions to block their thinking, with the aim of building a user-friendly product in a given context (Baeck & Gremett, 2012). It basically involves research into the challenge at hand from the point of view of the user. The Define phase is where a designer compiles the information collected in the first stage to make meaning (Nairman, 2019) and generate "how might we" (HMW) questions. The Ideate phase is where the designer uses the conclusions arrived at at the defining stage to get tentative solutions to the problem. Thinking big and wide is critical to helping build up ideas (Baeck & Gremett, 2012). The Prototype phase is where different solutions or ideas are made into samples or representations to see if they can answer the identified problem. A lot of building and breaking takes place

to find what fits as desired. Finally, the Test phase is where the final solution or idea is put to a real-context test (Waloszek, 2012). During the test, further modifications can be made to make things better.

Purpose of the Study

The purpose of this study was to use the Art World Design Thinking Process to develop teacher material utilisation creativity in early childhood teacher education.

Hypothesis

The study sought to test the following hypothesis:

H1: There is a significant positive relationship between each of the five stages of the Art World Design Thinking Process and teacher material utilisation creativity.

Research Methods and Design

The researcher used a concurrent embedded mixed-methods design in which both quantitative and qualitative data was used. Data was collected concurrently, analysed separately and embedded at discussion (Morgan, 2007; Creswell, 2014; Kumar, 2011). The study context was early childhood education and the study was conducted in two teacher training colleges in Uganda coded E for the experimental site and C for the control site. The study sample was 64 in-service teachers selected on a cohort basis with each cohort comprising 32 participants. Comparability of the control and experimental groups was the basis for the inclusion criteria. The year one cohort was used as it had sufficient numbers in both study sites.

The intervention

The treatment was a one-month Art World Design Thinking Process experiment with the experiment group well as the control group was left to receive only the standard college training as given to both groups. This was developed using the five-stage Art World Design Thinking Process model as a procedural framework.

Data collection procedure

Data collection was preceded by developing tools and validating in a pilot test from which the CVI was .78 and a .82 test-retest score on validity and reliability, respectively. After this, the research team secured all the necessary clearance, recruited participants and then carried out actual data collection which involved a pre-test, an experiment, a post-test and focused group interviews. Two tools were used to collect data, i.e. the creativity observation tool and the focused group interview guide, The first tool was used in both pre- and post-tests for teacher classroom observation. The tool had a rating scale of 1–5 in which 1 was the lowest score, showing low material utilisation creativity, and 5 the highest score, showing the highest level of creativity in material utilisation. The focused group interview guide was developed based on the creativity indicators used in the creativity indicator tool. The interview guide was composed of open-ended and semi-structured questions since the focus was on collecting a wide range of opinions. To ensure a smooth flow of the group interview, the researcher used different types of questions like introductory, open-ended, think-back, transitional and ending questions (Krueger, 2002). The interviews were conducted with five groups, each comprising six participants. The focus of the discussions in the interviews was on activities observed in the classrooms and demonstrations. The data collection involved four stages: the pre-test classroom observation, the experimental phase, the post-test classroom observation and the focused group interviews. A schedule was developed in collaboration with the participants for when and where the class observation would take place. Lessons of both the control and experimental group participants were observed to measure the different constructs. This was followed by the administration of the experiment. Activities were developed and aligned to the different phases of the Art World Design Thinking Process. In each of the phases, participants were involved in guided practical demonstrations, and conducted personal individual trials and classroom experimentation with the ideas. All this involved an iterative process of prototyping, testing and experimenting, discussing and improving. After the experiment, all participants were requested to prepare a lesson for the class level that was used in the pre-test observation and from

the same learning area. The participants were rated on the creativity levels exhibited. After the post-test observation, the experimental group was taken through the focus group interviews. The research team was interested in establishing what contributions the Art World Design Thinking Process experiment made to the teachers' use of materials in their perception. The focus group interviews period for each group was approximately 45 minutes.

Data analysis

Descriptive statistics and a t-test for independent groups were used to analyse quantitative data, whereas thematic content analysis was used for qualitative data analysis.

Ethical Considerations

Ethics in research concerns itself with providing guiding principles to researchers and ensuring that participants are protected (Ichendu, 2020; Creswell, 2014). This study ensured that the ethical guidelines were adhered to. Having taken the proposal through all the levels of presentation and being approved by all the relevant authorities at the university level, i.e. the departmental and faculty level, the researcher received clearance from the Graduate Board which was used to submit the work to the Research Ethical Committee of Gulu University (GUREC-077-19). The work was able to meet the expectations of the committee, which led to approval. Using the university introductory letter, the researcher also sought permission from the research sites. The GUREC clearance, the site clearance and the proposal were submitted to the Uganda National Council for Science and Technology (UNCST) for the final review and approval. After meeting all the requirements, the proposal was given the final approval (SS 5191). All participants received a clear explanation about their involvement in the study and signed a written consent as evidence of voluntary participation on their part in the study. To ensure confidentiality, all the participants' observations, lesson plans and documents were scanned into soft copies and kept in well-protected files. To ensure anonymity, all participants' documents were coded with numbers rather than names to reduce any possible association with the participants. All the audio and video recordings of the activities were destroyed after decoding all the necessary data.

Results from the Pre-test

Statistical analysis of the results showed that the two groups exhibited similar creativity competence levels across the creativity indicators associated with the five stages of the design thinking process. In some cases, the control group was insignificantly better, as shown in Figure 3, especially in ideation, and this can be attributed to college-specific elements like tutor skills, access to quality instructional materials and teachers' level of exposure.

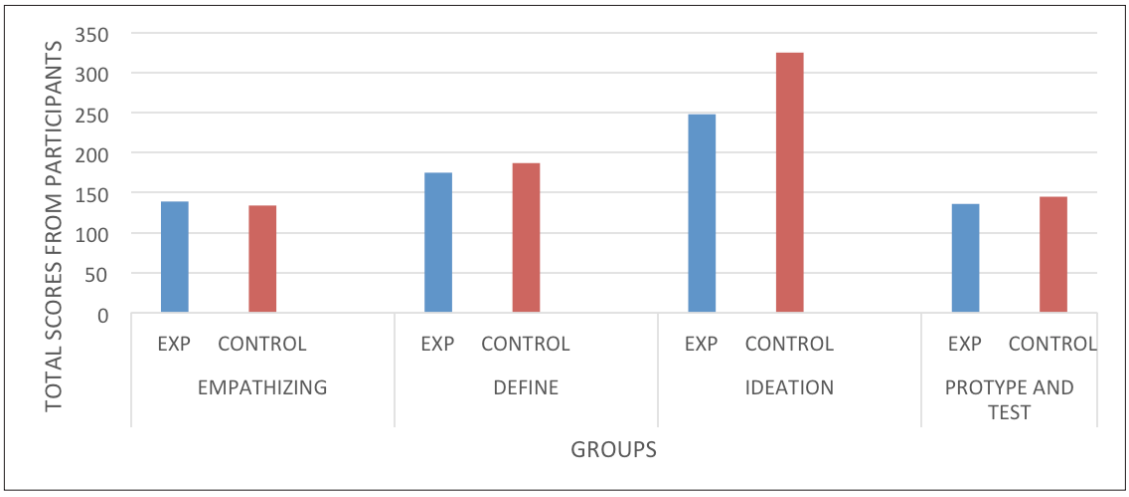

Figure 3: Comparison of control and experiment groups at pre-test level

To further understand this difference, the scores were analysed using the Statistical Package for Social Sciences (SPSS) to establish the mean score, as shown in Table 1 below:

Table 1: Mean table comparing the control and experiment groups at pre-test level

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRETESTCONTROL	23.7000	30	2.76867	.50549
	PRETESTEXPERIMENTAL	23.1000	30	3.25206	.59374

In Table 1 above, the control group scored a slightly higher mean average of 23.7 with a lower SD=2.7, as compared to the experiment group that has 23.1, SD=3.2. However, the mean difference of 0.6 can be considered negligible. The same data from the control and experiment groups was compared using a t-test, as shown in Table 2 below:

Table 2: Results from the t-test between control and experiment groups at pre-test

Paired Differences							t	Df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
					Lower	Upper				
Pair 1	PRETESTCONTROL PRETESTEXPERIMENTAL	.60000	4.09878	.74833	-.93051	2.13051	.802	29	.429	

In Table 2 above, the t= .802; p=.429; df =29. A p value of .429 is significantly higher than the critical p value of 0.05, which implies that there was no significant difference between the two groups at pre-test.

Results from the Post-test

After one month of teacher support training in the application of the design thinking process in material utilisation creativity and a one-month traditional approach to training, both groups were asked to prepare a lesson for post-test observation. The two groups were compared at post-test level and the statistical analysis revealed that generally the experimental group attained higher scores in the creativity indicators measured. As compared to the pre-test, the experimental group scores greatly surpassed those in the control group, as shown in Figure 4 below.

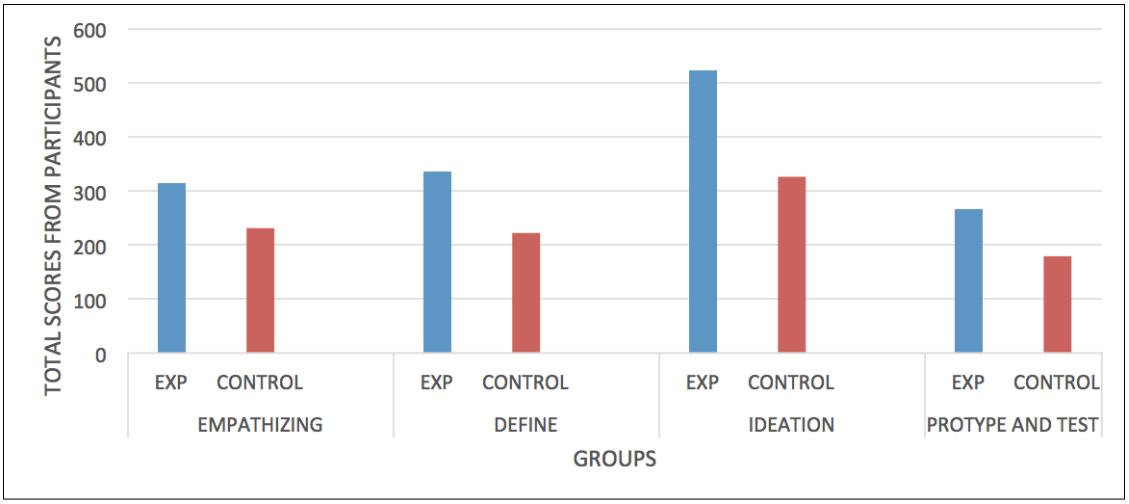

Figure 4: Comparison of control and experimental groups at post-test level

Further analysis was done using SPSS to obtain the mean scores for the two groups, as presented in Table 3 below:

Table 3: Comparison of control and experiment means at post-test level

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTTESTCONTROL	31.8667	30	2.14530	.39168
	POSTTESTEXPERIMENTAL	48.2667	30	5.25182	.95885

Table 3 shows that the experimental group had a higher mean score (48.3; Std=5.3) as compared to the control group (31.9; Std=2.1). With a mean difference of 16.4 in the post-test as compared to 0.6 in the pre-test, there was evidence that the scores in the experimental group were significantly different. The results, however, show that the experiment group has a higher SD, which could be attributed to individual differences in the participants.

To establish the difference between the control and experimental group, a t-test was used, as presented in Table 4 below:

Table 4: T-test difference between experiment and control groups at post-test level

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	POSTTESTCONTROL POSTTEST-EXPERIMENTAL	-1.64000E1	6.08900	1.11169	-18.67367	-14.12633	-14.752	29	.000

In Table 4 above, the analysis shows (t=-14.7; p=.000; df = 29). With a p value of .000, which is far below the critical p value of 0.05, it implies that there was a statistically significant difference between the experimental and the control groups.

The contribution of the Art World Design Thinking Process to teacher material utilisation creativity

To be able to establish the specific elements that contributed to material utilisation creativity as reflected in the statistical analysis, we conducted a focused group interview with five participant groups from the experimental group. The data was gathered, cleaned, coded and analysed under the five stages of the design thinking process as thematic areas.

In the empathising stage we worked on activities that basically focused on helping participants understand their use and the context in which they are placed. We took the time to observe the children in order to understand what motivated them, what they liked to do, and how they liked to do it. Engaging them in conversations about the things they liked and why they liked them was also one of the most interesting engagements. From the experiences and activities of this phase, the participants echoed several ideas:

> For the first time, I started thinking about what children liked rather than just making materials as learned from my college training. (E6)
>
> When you engage the children, it becomes easy to know what they like doing. (E1)

The above excerpts confirm that the Art World Design Thinking Process contributed to teacher material utilisation creativity because in the reflections, the teachers showed that engaging with the empathising phase had contributed to their willingness to consider learners' needs and experiences as important aspects in choosing materials.

The activities in the defining phase were tailored as a continuation of the empathising phase and the focus was on synthesising the information from the observations and engagements of the children and context to identify the core problems or challenges that are associated with materials. During this phase, participants were also supported to come up with personas in the form of point-of-view statements (POVs). Using the needs statement from the POVs, the teams were guided on developing the HMW questions. Based on the above process, below are the reflections from the focus groups:

> I observed children playing all the time, which means that we should use play in teaching them. (E2)
>
> I observed that children could play with anything that they had in the environment like leaves and stones; they have a strong imagination when left to play by themselves. (E05)
>
> The children were talking to each other more during the times of playing using the different objects. (E5)

The above excerpts showed that the teachers in the experimental group were able to allow learners to make their own choices and explore by themselves, which is linked to the creativity indicator of allowing children to choose. As it was not observed to have a high score in the pre-test, we are confident to associate it with the Art World Design Thinking Process as a contributing factor to this nature of creative approach to material utilisation creativity.

In the ideation phase, participants were taken through the process of brainstorming at both solo and group levels to generate possible ideas for answering the HMW questions that were generated in the define phase. The participants were supported in how to use convergent and divergent thinking to generate the individual ideas and later combine them to provide answers to the HMW questions, respectively. These activities contributed to the resultant scores of the post-test, as evidenced by some excerpts from the participants:

There is a way we came up with many different alternatives when we combined some parts of our ideas. (E2)

> There was no fear, members came up with ideas that were even looking impossible to use. (E1)
>
> If you want to be serious all the time, you will not get as many ideas as you may wish. (E3)

The above excerpts are evidence that the design thinking process made a contribution to the teachers' thought process. The reflections show that the participants were using the creativity indicators like divergent and convergent thinking, which contributed to the scores in the post-test phase.

The prototyping and testing stages were done concurrently in that as prototypes evolved the participants had the opportunity to engage with the children to test and refine their ideas. The activities included simplifying and combining ideas to make testable solutions. The developed solutions were tested on the children in teams and, based on the reflections from the teams and the children's experience of the solutions, adjustments were made. These activities contributed to the resultant scores of the post-test, which confirms that the design thinking process had contributed to the materials utilisation creativity of the teachers in the experimental group. This is confirmed by the following quotes from the participants:

> I learnt how to combine ideas to make new meaningful ideas. (E1)
>
> You get to know if something will work before using it with the children in the class. (E6)
>
> One is able to try out the materials with the children and see if they like them. (E2)
>
> I can now try them on my own at home and it really makes me happy to see what I can do. (E4)

The above excerpts portray that the Design Thinking process made a contribution to how the teachers were working and thinking, a justification to argue that the Design Thinking process made a contribution to teacher material utilisation creativity.

Discussion of Key Findings

Discussion of key pre-test findings

The study findings from the pre-test revealed that teachers lacked material utilisation creativity. Observations of the classroom activities revealed that the majority of the teachers generally used generic materials in the form of charts, counters and some common play materials like ropes and balls in limited and duplicated ways. These were used with a conformist approach to education, which does not encourage free thinking and creativity (Rogers, 1970; Kaila, 2005); yet without applying critical thinking to the teaching processes we deprive them of the necessary creativity (Shih-Yung, 2016) or even enhance the teaching-learning process (Fisher, 1990). We also observed that the teachers were using the 'one-size-fits-all' approach in the pre-test whereby the materials prepared were identical and instructions to use them were given in a similar way without creating provisions for a variety of ways for the children. This was also observed in the different classrooms, yet we know that children come with diverse learning needs (Hughey, 2011)

Many teachers were observed in the classroom teaching with hardly any child-centred materials. The teachers were using chalk, blackboard and books as the basic material for teaching in an early childhood setting. Yet a rich early childhood space requires programmes that encourage teacher and child interaction which happens mostly with the use of a variety of child-centred materials (Emir & Bahar, 2003).

Observations also revealed that the majority of the participants were found to be using materials as examples in dispensing knowledge to the learners. Teachers stood in front of learners with a material to show to learners or had charts hung up that they were pointing at. The majority of the materials used were for the teacher with limited learner engagement (Hargreaves, 2001). Yet evidence shows that quality early childhood teaching requires a creative environment that thrives on creativity that involves engaging children more (Grainger, 2004).).

Discussion of key post-test findings

After introducing the intervention to the experimental group, classroom observations revealed that, compared to the control group, the experimental group participants were seen to exhibit creative tendencies. For instance, the participants were more aware of diversity, they used diverse materials and the approach to the use of methods was more creative as compared to pre-test (Abraham, 2016; Stenberg, 1999; Craft, 2001; Craft, 2006; Deterding et al., 2015). At post-test, the experimental group was able to articulate lesson concerns in terms of being able to relate materials to competences more articulately, as compared to what we observed at the pre-test stage. The participants exhibited the ability to connect the dots between materials and what motivates learners, which we know is a key element in enhancing the connections between curriculum and pedagogy (Wilson, 2005). The participants in the experimental group had more child-centred materials and activities as compared to the control group. The experimental group participants had a variety of materials and ideas on how to use them. This was because they revealed in the pre-lesson conference that they did more work in the conceptualisation of the lesson during the planning (Dickhut, 2003). This led to a more creative approach to materials utilisation as compared to pre-test observations.

Strengths and limitations

The study had a time limitation. The time spent on the adaptation of design thinking was relatively limited since the in-service students had limited holiday time with so many activities to accomplish. This could have reduced by focusing on the adaptation process, which potentially affected the results of the study. It is advised that future studies consider categories of participants with more time available for the research project.

The second limitation to this study was that despite it being largely quantitative, it was not possible to use probability sampling as advised for most quantitative studies (Mweshi, 2020). This was not possible because the study required an experimental and a control group of students in the same year. The study adopted the use of cohort groups. Future studies could ensure probability sampling for purposes of being able to generalise the findings to the entire population.

Conclusion

It is self-confirming that using the Art World Design Thinking Process has a positive relationship with the development of teacher material utilisation creativity. The evidence from the post-test data showed that teachers had developed personal creativity, they were able to conceptualise materials in unique and enriched ways and they also used the teaching process in more creative ways. Enriching the teacher with such skills provides an opportunity for achieving better learning experiences in the classroom since the teachers hold better skills in material utilisation.

This study has successfully tested the theory of transfer of learning by demonstrating that a practice that has worked well in another field can be transferred and be used to inform related learning in a different context. In this case, Art World Design Thinking commonly used by designers in developing creativity in product development has been used successfully to develop creativity in material utilisation in early childhood classrooms. Though the study has explored the teacher materials utilisation creativity design thinking relationship, there is need to explore how this translates into learner creativity. If teachers use materials creatively, does it then mean that the same level of creativity is attained by children?

The model also needs further testing and adaptation as a more general approach to teacher training which, if well refined, holds great potential for developing a more reflective approach to teacher training in early childhood (Morais & Azeredo, 2011).

Recommendations

The findings revealed that the Art World Design Thinking Process can be adopted and adapted to improve teacher material utilisation creativity in early childhood education settings. Based on this finding, it is recommended that this model be popularised for usage in teacher training institutions to increase the creativity skill of teachers because of its increasing importance in our early childhood classes.

In adapting the art world design thinking process, the study developed an experiment with systematic instructions that can be used to support its usage in other contexts. Based on this, it is recommended that training institutions adopt this approach as one of the teaching instruction approaches by way of incorporating it into the teacher training curriculum.

Teachers who use the design thinking approach show individual progress in terms of creativity in material utilisation at school level. Based on this finding, it is recommended that local governments and individual schools try out this approach in their classes to improve the quality of learning.

Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Funding

The study was co-funded by the researchers together with Kyambogo University Research Fund.

Disclaimer

The views expressed in the submitted article are for the researchers and are not an official position of the institution or funder.

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