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Using Non-Digital Games for Coordinate Geometry Algorithm Realism

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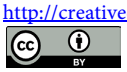

Abstract

Students faced difficulties in capturing introductory concepts of coordinate geometry henceforth affected algorithms realisms. The mixed action research was conducted to identify pre-knowledge misconception made by students, and examine the students' perceptions on the use of non-digital game-plays. The retrospective questionnaire, students' worksheets reviewing and reflective in-depth interview were employed for data collection. Findings showed that students experienced different pre-knowledge capabilities in capturing introductory coordinate geometry concepts and the use of non-digital games assisted to clear the misconceptions. Further, usability of non-digital games helped to enhance students to communicate, collaborate, engage in critical thinking, creativity, problem solving and perseverance competences as focus towards acquisition of algorithm realism. Implications were vested to the college mathematics instructors to utilize the non-digital play games for competence-based knowledge realisms; enhancement of catalysing the cognitive schemas into smoothly transferring in accommodating knowledge, competences and skills at higher taxonomies levels; non-digital game in learning is vested on creation of interested and motivational classroom activities, discarding students' anxiety and misconceptions on coordinate geometry contents for improving performance.

Keywords

Non-Digital Game Plays, Coordinate Geometry Concepts, Algorithm Realism, Students

1. Introduction

The non-digital game-plays are predefined as the useful pedagogical instructional approaches that assist attainment of realism of the subject matter (Ferreira, Gouin-Vallerand, & Hotte, 2016; Bigueras, 2020). Also, Yu (2021) apprehended

that the use of non-digital games is an improvisation process that beds other mechanisms out of digital devices and computer interactions in classroom teaching and learning activities. However, the practicality of non-digital game-plays depicted to focus on the involvement of physical artifacts during the training and teaching presentations, or working process out of digital and computers devices (Ge & Ifenthaler, 2018; Abbott, 2019). Further, Pacheco-Velazquez (2020) prescribed the innovative processes cribbed to foster the use of non-digital games that are seized into observable scenes: enhance the promotion of students' learning, develop self-directed learning, and foster knowledge acquisition; whilst the instructors are able to develop didactics focusing on changing teaching environment into creatively collaborative, and developing the academic contents based on meaning brought from students' perspectives.

The 21st century classroom practices are apprehended on learner centered approaches basically situated in utilization of various media to foster acquisition of indispensables (Kiili et al., 2018; Pacheco-Velazquez, 2020). Furthermore, non-digital games are stipulated in stimulating students to engage in cognitive reasoning processes (Ing et al., 2015; Homer et al., 2019; Yu, 2021). Despite, Park et al. (2019) and Sung et al. (2017) substantiated that non-digital game-plays have been used as rewards for learning to primary school students, but the same impacts had to adults and university students apprehended for bringing measurable learning outcomes to the university students (Guadana et al., 2020). Nevertheless, in the context whereas the digital video games are not accessible, contextual classroom-based innovation that fostered the use of non-digital game plays is employed to reduce abstract and difficulties in knowledge acquisition (Mulwa, 2014); as well as for motivating and fostering understanding (Ge & Ifenthaler, 2018; Abbott, 2019).

Significantly, non-digital game plays are an assistive in simplifying the language of mathematics, and improve performance (Homer et al., 2019). Likewise, the power of non-digital games is vested in driving students to engage in conceptualization of language, develop thinking capability, improve performance of activities, and foster interpretation of mathematics in different contextual perspectives (Accurso, Gebhard, & Purington, 2017; Chung et al., 2017). Apparently, in the classroom whereas there are realistic gaming enjoyments aspects, students are fostered to engage and promote cognitive processes in learning mathematics concepts (Mazana, Montero, & Casmir, 2020). In the colleges and universities, instructors are mainly employing lecturing as didactic approaches for delivering the subject matter contents. So far, poorly selection of mathematics content delivering approaches brought challenges to students' performance (Mbusi & Luneta, 2021) reflected in less interest and boredom in acquisition of mathematical concepts realism.

Additionally, Poor performance in mathematics is feedback on didactics approaches, strategies and methods oriented applied to students during the learning process (McLure, Fraser, & Koul, 2022). Moreover, engagement of non-digital

game plays in teaching mathematics concepts brought conceptual unified power in procedural gaps to students with different backgrounds and talents to engage into cognitive activities (Cózar-Gutiérrez & Sáez-López, 2016); develop competitiveness skills in creativity, problem-solving, collaboration, interaction and communication (Brezovszky et al., 2019; Sung et al., 2017). The Coordinate geometry concepts are anticipated for being difficult to teach and learn because needs human constructs in studying shapes, relationships, and exploratory properties as subsets of culture, history, art and design for linking intricate manner of thinking (Chen, Shih, & Law, 2020; Hamid, Zulkiply, & Mohamad, 2022). Although, the basic concepts of coordinate geometry were taught in primary and secondary schools; college students are experiencing difficulties in meta-cognitive conceptualization leading gaps in accurately capturing procedures for solving the related problems (Ju et al., 2022; Barana, Marchisio, & Sacchet, 2021; Kumar, Singh, & Chandra, 2022).

Correspondingly, there are articulated advantages on the use of non-digital game plays as advantageous teaching strategy in changing abstract mathematics concepts; translate mathematical images into augmented realisms hence foster long-learning process (Romero & Proulx, 2016; Bandara, 2018). Further, articulation of non-digital game plays in classroom contexts encompassed practicalities hands-on mechanics, aesthetics that enhanced students motivational aspects for solving coordinate geometry learning problems (Vitoria & Ariska, 2020; Wang & Zheng, 2021; Scalise, Daubert, & Ramani, 2020; Abbott, 2019). Consequently, Russo et al. (2022) apprehended on the use of non-digital game plays as instructional method to support transferability of investigative and acquisition of large scoped mathematical inquiries while making learning to be enjoyable and supportive to different learners requirements.

Subsequently, the non-digital game plays are also corresponding with cons associated by instructors including need of devoting time in selecting appropriate approaches to boost students' engagement and foster conceptualization. The module instructor are key objects for implementing non-digital games as appropriate artefact holding strategies and approaches to facilitate learning process activities to foster mathematical knowledge uptake to students (Chung et al., 2017; Brezovszky et al., 2019; Mazana, Suero Montero, & Olifage, 2019). Further, creativity and designing is the heart of bringing and implementing innovative non-digital game plays in the classroom setting (Kristiani & Usodo, 2022). Instructors in colleges are not familiar, with fewer experiences and limited exposure on designing the collaborative non-digital game plays to bring potential skills and knowledge during teaching and learning process (Parsons et al., 2019).

At the College of Business Education (CBE); Business Mathematics module is compulsory to the first year Diploma students specialized in business studies. Subsequently, business mathematics is among the modules found at the College of Business Education curricular whereas among others the topics of coordinate geometry inclusively. Subsequently, practical experiences shows that students

faced difficulties in capturing introductory part of coordinate geometry algorithms particularly on the concepts of: *x*-axis, *y*-axis, quadrants, slope, determining points in quadrants, points of origin, *x* and *y* intercepts (Kumar, Singh, & Chandra, 2022).

This paper entailed to evaluate the effectiveness of using innovative non-digital game plays in helping students to adapt the concepts of coordinate geometry through algorithm realism in the classroom setting with specific objectives for to:

1) Determine students' pre-knowledge and post-knowledge of coordinate plane concepts;

2) Identify pre-knowledge misconception made by students in the coordinate geometry concepts; and

3) Examine the students' perceptions on the use of non-digital game-plays in coordinate plane concepts post-knowledge algorithms realism.

The paper on using non-digital games for coordinate geometry algorithm realism is organized into the sections of introduction, literature review comprised of social cultural theory as part of theoretical aspects and scholarly empirical evidences. Moreover, the mixed methodologies, findings and discussion are thereafter presented. The main contributions are to instructors on consideration of selection and deployment of contextual based teaching strategies including non-digital game plays to foster students' cognitive captivity of business mathematics concepts including that of Coordinate geometry concepts.

2. Literature Review

2.1. Theoretical Perspectives

Social-cultural theory particularly activity theory framework pertained that classrooms are an activity system engaged two main actors involving module instructors as subjects and students worked as objects (Leont'ev, 1981). Certainly, classroom as the social-cultural system possessed predefined teaching and learning activities stipulated to reach module and curricular goals (Mathe, Verhagen, & Wiklund, 2022). However, classroom activities pertained delivering and capturing coordinate plane concepts through deployments of non-digital game-plays as an integrative tool or artefact and approach rooted from socio-cultural theoretical perspectives (Barwell et al., 2016; Brezovszky et al., 2019; Moschkovich, 2015a, 2015b) to catalyse teaching and learning activities. Further, the stance from social-cultural school of thought insisted on division of the responsibilities among main activities actors (Wang & Huang, 2021). Nevertheless, the theory entailed the classroom as discursive community of activities fostered the definite division of labour among students and teachers (Turchi, Fogli, & Malizia, 2019; Planas & Schütte, 2018; Moschkovich, 2015a).

Additionally, the acquisition of coordinate geometry knowledge, skills and competences are culturally governed by the rules mathematicians follows while doing their jobs (Qomario, Tohir, & Mashari, 2020). To the other side, non-digital game plays in classroom activities are further entailed to make stu-

dents engaging in reflective moments (Planas & Schütte, 2018); fostered articulation of algorithmic thinking pattern (Park et al., 2019); enabled develop self-directed learning skills (Pacheco-Velazquez, 2020). Consequently, students are motivated to engage in presenting the coordinate geometry concepts knowledge in accurately and appropriately manner (Ferreira et al., 2016). Also, students are articulated in gaming are advantageous in acquisition of multiple knowledge processing skills. Turchi, Fogli and Malizia (2019) insisted that collaborative game-based learning enabled students as end-users to acquire the designing skills that foster meta-cognitive design approaches to be used in different learning perspectives.

2.2. Use of Non-Digital Games Plays as Instructional Strategy

Game-based learning is among effective approach brought functional learning outcomes as Abbott (2019) signified on enhancing the acquisition of high cognitive authenticity, fostered tutors facilitation, create schemas positive tension between knowledge and confidence, uplifting multiple domains and create conducive learning situations. Consequently, Yang and Lu (2021) ascertained that the game-based learning is effective and efficient in reducing mathematics anxiety to help students learn well. In addition, Hamid, Zulkiply & Mohamad, (2022) emphasized on the deployment of non-digital games entailed of physical game models nature that designed by innovative instructor including the use of cards, dice, board games and more. Besides, the student's involvement in activities of planning and playing games became important in stimulating the exploration freedom to catalyse the context-based solutions realism (Radzi et al., 2017; Park et al., 2019; Rahutami et al., 2019).

Nevertheless, the approach of using non-digital game plays apprehended the initiation of active classroom learning environment. Observable measurable multiple performances are witnessed via boosted interaction, teamwork, investigative, information evaluation and decision-making skills among students and instructors (Chung et al., 2017). Basically, students engaged in non-digital game-based learning are significantly acquired better performance and higher self-efficacy (Wang & Zheng, 2021). Certainly, Chen, Shih, and Law (2020) contributed on cognitive and non-cognitive outcomes brought by the use of non-digital game-based learning in upbringing competitive talents. Nevertheless, the effectiveness of non-digital game plays are observed in teaching and learning of various mathematics concepts including measurement of angles (Vitoria & Ariska, 2020), geometric shapes (Chung et al., 2017), geometry lines, algebra (Michael & Anugwo, 2016), and numbers (Elofsson et al., 2016; Scalise et al., 2020).

2.3. The Role of Students' Pre-Knowledge in Learning

Pre-knowledge is disguised to be primitive in nature, holding concepts and ideas of being accommodated in students' schema for retrieval, worked as the foundation for linking the learning process to the advanced concepts (Pirie & Kieren

1994). Usually, the existing pre-knowledge are catalyse the acquisition of the new knowledge (Piaget, 1964). Subsequently, the background gaps existing in the learning process cycle makes students to develop anxiety in accommodating mathematics concepts including that of coordinate plane (Jupri & Drijvers, 2016). Furthermore, mathematics concepts are objects in nature, poor presentation creates ambiguity content consumption among students relatively to connecting the realism and hindered understanding (Qomario, Tohir, & Mashari, 2020).

Consequently, students' possessed passive pre-knowledge in different mathematics concepts are experiencing difficulties in new knowledge accommodation hence affects the attainment of expected learning outcomes (Lazuardi et al., 2017). The process of prior-knowledge memorization is an important aspect in learning cycle particularly in engaging cognitive linking, receptive, transferring and retrieving of different mathematics concepts at any time required. Besides, the innovative mathematics instructors should plan, design, and create conducive and supportive learning strategies and approaches that fostered students' readiness, linking, receptiveness and accommodation of the relative content subject (Farida, 2018). Game-based learning is among effective approach bringing functional learning outcomes. Subsequently, Abbott (2019) signified that students pre-knowledge has high cognitive authenticity, fostering instructors facilitation, create schemas positive tension between knowledge and confidence, and applicable in uplifting multiple domains.

2.4. Students-Centred Instructional Strategies

Based on Kul et al. (2018), learners centred approaches fostered students in accommodating concrete concepts in realism perspectives. Instructors are advocated to be constructivists in utilizing multi didactics and strategies in classroom entailed on students' concepts mapping, transferring, accommodation and understanding (Malatjie & Machaba, 2019). However, the creation of interactive and collaborative learning environment promote students to change from experienced abstract content material capturing approaches towards development of meta-cognitive and intuitive learning spirits that improves thinking (Gemechu, 2017). Besides, the practices in constructivism perspectives seek to capacitate individual learners to engage into conceptual thinking by shifting stored pre-knowledge from cognitive schema towards what learners can do, to what meaning learners can constructs (Teuscher et al., 2016; Yu, 2021). Yet, the classroom practices based on learner centred approaches, inquired instructor to be subjects through changing their roles and became partner in the learning process (Wilkins, Jones, & Rakes, 2021; Vlasenko et al., 2021) and encourage cooperation in the classroom practices (Adxamjonovna, 2021; McLure, Fraser, & Koul, 2022).

2.5. Misconceptions towards Realism

Besides, the practices involving non-digital game plays are associated with dynamics and misconceptions reflective to the realisms. Lux, Budke and Guardiola

(2021) highlighted the prioritization in using games for helping student to undertake mathematical problems that fostered engagement, reach the expectation to rectify perceived misconceptions and stereotyping. Further, Simarmata (2021) disclosed on the students being highly affected with habitual mind in reasoning towards converting active learning process that are participating to capacitate the construction of own knowledge. The non-digital games in classroom context are witnessed in bringing realism experiences as is fostered active students thinking, construct arguments and solving mathematical problems.

Consequently, to discard the likelihood of realism misconceptions, instructors are optimistically supposed to prepare non-digital games, focused towards full students' representation of mathematical curricular implications and outcomes (Lux, Budke, & Guardiola, 2021). Yet, Simarmata (2021) warned that the practices of utilizing the realistic approaches and models in content delivering are less dominated by intelligent student in creation of knowledge mapping and acquisition. Further, to reach realism the instructors had to emphasize reactiveness in overcoming wrong misconceptions of procedures, approaches, materials and time in designing, developing and implementations of non-digital game plays. Similarly, Sevinc (2022) also pointed that epistemological support is important for the instructors to craft mathematics problems into realistic approaches and methods.

3. Methodology

This mixed action research was held at the College of Business Education (CBE) Dar es Salaam campus involved first year Diploma students as the sample. Probability-simple randomly approach was employed to select 60 respondents. The researcher as a module instructor collaborated with the students to design and engage in playing non-digital game on coordinate geometry holding the assumption that the game plays are social-cultural activity with procedures fostered transformative changes, stimulates and create cognitive schema mind map to foster coordinate geometry concepts understanding. The designed game actions were into four steps: In the first step, students were provided with piece of papers and asked to provide prior knowledge through drawing the coordinate plane, label x-axis, y-axis, quadrants coordinates points of origin, x and y intercept. Pieces of paper were collected for pre-knowledge analysis.

During the second step, students were directed to formulate 10 groups each with 6 members then required to engage in repetitive non-digital game play for 40 minutes guided by instructors' narrations. In each group, students were directed to determine the features of coordinate plane concepts of x-axis, y-axis, quadrants, slope, points, point of origin, x and y intercepts into realism perspectives. During the third step each group member were given plane paper and required to demonstrate the studied concepts. Lastly, instructor and observer en-

gaged in filling retrospective questionnaire, students' worksheets reviewing thereafter followed by reflective in-depth interviews on the use of non-digital game play as instructional approach. The data were descriptively analysed based on its nature. Simple summary tables, narrative themes and figures were used to present the findings.

4. Findings and Discussion

The findings and discussion are presented based on attributes of pre and post-knowledge marginal changes in coordinate plane competences observable due to the utilization of non-digital game plays for content delivering. Besides, the difficulties students faced in capturing the coordinate geometry concepts were identified. Further, the students' perceptions on use of non-digital game-plays for algorithms realism were tabled.

4.1. Levels of Pre and Post-Knowledge in Coordinate Plane Concepts

The utilization of non-digital game plays brought changes for students' acquisition of algorithms realism in the coordinate plane concepts as presented in Figure 1 and Table 1. The findings disclosed the percentage changes on students levels in mastering the concepts of coordinate plane between pre and post-knowledge in the indicators as: favourable levels of correctly drawing the coordinate plane (53%), appropriately determine the x axis (52%) and y axis (50%); determine point of origin (35%), determining points for x and y intercepts being at the highest changes (72%). Additionally, there was an increased level of correctly identification of quadrants (68%) and appropriately determining of quadrants coordinates points (65%).

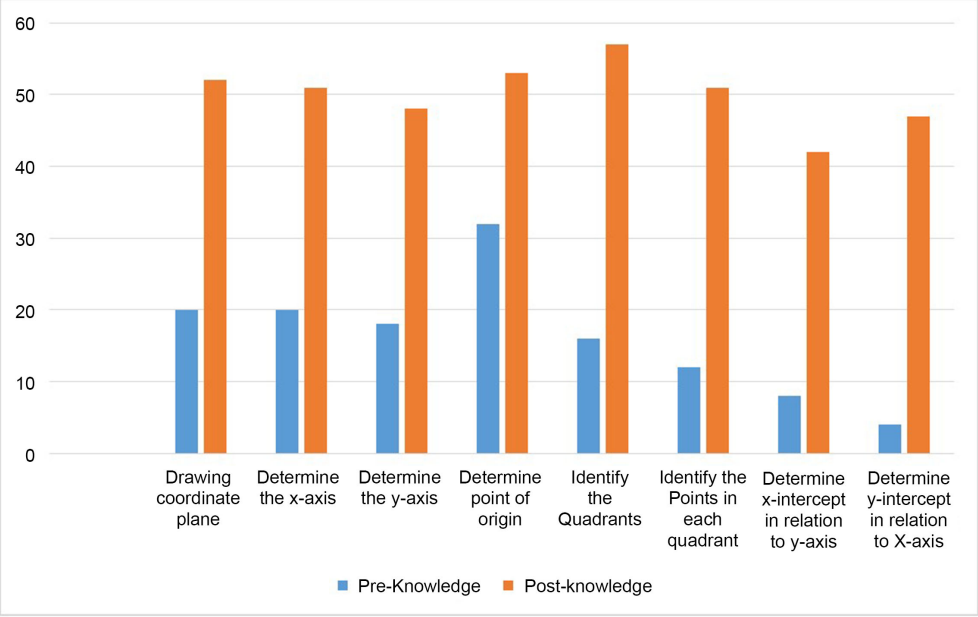

Figure 1. Status of pre and post knowledge in coordinate plane concepts (n = 60)..

Table 1. Marginal changes resulted by the use of non-digital game plays (n = 60).

Area Tested	Pre-Knowledge Observed gaps	Pre-Knowledge		Post-knowledge		Marginal Changes	
		Frequency	%	Frequency	%	Frequency	%
Drawing coordinate plane	Failure to show the arrows in the plane and express the meaning of arrows in *x* and *y* lines	20	33%	52	87%	32	53%
Determine the *x*-axis	Inappropriate, exchange naming and leave lines without naming	20	33%	51	85%	31	52%
Determine the *y*-axis		18	30%	48	80%	30	50%
Determine point of origin	Leave the plane blank, not able to plot the place presenting origin points	32	53%	53	88%	21	35%
Identify the Quadrants	The terminology seems not clear, failure to identify, not able to allocate properly, leave the plain blank	16	27%	57	95%	41	68%
Identify the Points in each quadrant	Wrongly allocating vertical and horizontal integers from the origin, difficulties in identification of points, mixture in presenting points (*x*, *y*) instead (*y*, *x*) or (*x*, *x*) and (*y*, *y*)	12	20%	51	85%	39	65%
Determine *x*-intercept in relation to *y*-axis	Puzzled in linking where is 0 for *y* in *x* intercept	8	13%	42	70%	34	57%
Determine *y*-intercept in relation to *x*-axis	Puzzled in linking where is 0 for *x* in *y* intercept	4	7%	47	78%	43	72%

The findings disclosed comparatively changes in coordinate geometry concepts at pre-and post-knowledge time followed non-digital play games. Subsequently, the deployment of integrative non-digital games plays encompassed the logics of the coordinate geometry concepts enhanced flipping classroom as social cultural system pertained to fulfil the clear objectives (Barwell et al., 2016; Mathe, Verhagen, & Wiklund, 2022). Furthermore, the observation made by this study is that in the classroom students are objects and instructor subject focusing on devoting time and efforts to engage into prescribed narrative procedural for non-digital game play in enhancement of acquisition of coordinate geometry concepts algorithm realism. Likewise, was mentioned in the study by Rojas, Fuentealba & Ranjan (2021) that game plays are didactic resource for learners to be motivated to learn, construct knowledge in more collaborative classroom activities.

Certainly, the evident changes on the use of non-digital game plays for delivering the coordinate geometry concepts are apprehended on students' engagement and participation as important components for catalysing acquisitions of cognitive, affective and psychomotor domains. Also, the sociocultural theory insisted on fostering the classroom to become community of teaching and learning practices whereby students are involved to participate into discursive activities for easily gaining new experiences (Turchi, Fogli, & Malizia, 2019; Planas & Schütte, 2018). Further, the author insisted on appropriately performing the intended classroom group of activities through utilization of the contextual and

friendly non-digital game plays fostering realism henceforth accommodation of knowledge, skills and attitude for independent and accurately working.

Besides, another apprehended outcome of usability of non-digital game plays were on bringing functional classroom outcomes through fostering: developing cognitive authenticity, raise tutors facilitation confidences, provide students' positive schemas tension between knowledge and confidence sided to Abbott (2019) that is uplifting multiple domains and create conducive learning situations; reducing mathematics anxiety (Yang & Lu, 2021); stimulating and catalysing freedom for exploration to obtain context-based mathematics solutions realism (Radzi et al., 2017; Park et al., 2019; Rahutami et al., 2019). Nevertheless, the findings implications are alerted on the need of colleges' mathematics instructors to utilize the non-digital play games and other learner centred approaches for mathematics concepts realisms articulated on competence-based knowledge creation.

4.2. Pre-Knowledge Misconception of Coordinate Geometry Concepts

The researcher collected 60 students' worksheet for pre-knowledge then post-knowledge, thereafter engaged in the thoroughly analysis on coordinate geometry observable concepts and mistakes made as reflected in **Table 1**. Apparently, was found that more than half number of students (32) were in position of determining the point of origin, one third were in position of drawing correctly coordinate plane (20) and labelled x axis (20). Nevertheless, pre-knowledge observations also showed less than one third students were not capable to determine location of x intercepts (8), y intercepts (4), determine the coordinate points in quadrants (12), identify quadrants (16) and determine y axis (18) appropriately.

The finding revealed that even though the students learnt basic mathematics as compulsory subject in ordinary secondary schools whereas among the topics found in form three is coordinate geometry, mostly were not capable to retrieve the existing knowledge from schema concerning the key concepts and present it correctly. Besides, the prior transferred and stored knowledge in schema are characterised as disguised and primitive in nature, worked as a step-stone in linking existing to new advances mathematics learning concepts. Students failed to retrieve the stored schema knowledge are highly victimized in creation of readiness, linking and receptive content (Farida, 2018), knowledge transferring (Malatjie & Machaba, 2019), accommodating new knowledge (Lazuardi et al., 2017) and be in position of smooth retrieval at any time (Umanath et al., 2023).

The notable pre-knowledge gaps in studied coordinate concepts necessitate the proper intervention through use of non-digital game plays to attain the realism. That stance was insisted by Qomario, Tohir and Mashari (2020) that poor presentation of mathematical concepts that are object in nature resulted in ambiguity hence affects the realism acquisition. Additionally, the study in hand emphasized the instructors to devote initiatives in designing friendly contextual

approaches for example the non-digital game plays in fostering students' engagement, motivation, collaboration, communication. Also, Lu and Ho (2020) expressed that there are fun built within game plays in stimulating students in understanding and sustainability of the learnt content. Subsequently, the study implied that non-digital game plays are recommendable as powerful learner centered approaches signifies to catalyse cognitive schemas into smoothly transferring and accommodating knowledge, competences and skills at higher taxonomies levels.

4.3. Students' Perception on Non-Digital Game Plays for Algorithms Realism

In responding to the reflective interview item what opinions do you have on the use of non-digital game in learning coordinate plane concepts? Table 2 presented summarised emerged themes on aspects of communication, collaboration, critical thinking, creativity, problem solving and perseverance.

Expressively, one of interviewee on the aspect of communication disclosed:

After being called by the instructor to take position in the game I was scared, but as time goes, I developed confidence and share ideas with my colleagues in the group hence everything went well (Respondent, Interview session 1).

Furthermore, the interview revealed that the non-digital gamification assisted on critical thinking as was pointed:

I was taught on plotting the coordinate plane several times despite of continuing making mistakes of drawing segments without showing arrows in both sides (Respondent, Interview session 2)

Likewise, another interview defined the coordinate geometry components mistakes made before exposition to non-digital game plays in learning as was cited:

Table 2. Students opinions on the use of Non-digital game in learning (n = 60).

Main Theme	Sub themes
Communication	Communicate the concepts using own language
	Facilitate conceptualization
Collaboration	Participate in groups
	Corporate
	Openly share ideas
Critical thinking	Engage in conceptual thinking
	Realism linking of the concepts
Creativity	Understand and creatively own ways of designing the game to understand the concepts
Problem solving	Application of learnt phenomenon to different contexts
Perseverance	Shows talents
	Stick on the work in hand
	Meet learning objectives

In drawing coordinate plane I didn't indicated arrows, proper numbering of integers from the point origin in both sides of coordinate plane. Always I was doing the awkward mistakes of exchanging naming of coordinate plane axis (Respondents, Interview session 1 and 3).

Certainly, devoted time instructor utilized to work with students in playing non-digital game inculcated positive impacts in developing collaboration, engaged in exploratory talents grooming, engaged in accurate advanced approaches, procedures utilized within the learning and teaching community as was mentioned:

The instructor was just showed us modalities of engaging in the game play, we use our own ways to do the same thing but differently. The lesson was enjoyable and we hope this mode of mathematics content delivering will be repeated several times (Respondents, Interview session 4).

The findings on students' perception proved the power of non-digital game play for enhancement of communication, collaboration, critical thinking, creativity, problem solving and perseverance competences as focus towards algorithm realism. Besides, Gemechu (2017) delineated that the interactive and collaborative learning environment catalysed students thinking towards developing of metacognitive and intuitive learning. Students and instructor worked as collaborative partners, communicate on classroom activities procedures into simplest and friendly manners bedded on the non-digital game plays. Likewise, scholars including McLure, Fraser & Koul, (2022) supported on lesson instructor to encourage cooperation to become partner in learning process (Vlasenko et al., 2021). Yet, students are articulated to be engaged in realism critical thinking, develop creativity competences and perseverance in solving coordinate plane concepts problems. Apparently, non-digital game plays are classroom teaching and learning tool for creating realistic experiences (Simarmata, 2021), construct arguments and solving mathematical problems (Lux, Budke, & Guardiola, 2021).

The deliverance of mathematical contents to the college students fostered the development of multi-skills, different competences and talents to individual and the entire classroom. Sevinc (2022) annotated that the non-digital game play provides the epistemological support in handling mathematics related problems into realistic approaches and methods. Additionally, McLure, Fraser and Koul (2022) insisted on appropriate selection of content delivering didactics approaches, strategies and methods that are students centred being powerful in improving the performance of the learning process. Also, the findings notified on the creation of learning environment that fostered on the students to become nervous in creation of self-creative realisms through rectifying the content related challenges.

Furthermore, authors of this paper observed theoretically that, students being classroom objects are focused towards acquisition of learning goals henceforth are intrinsically motivated to increase efforts towards the coordinate geometry concepts. The facts of using students centred approaches enabled developing self-directed learning, entailed inculcate intrinsic controlling of own learning

hence surpassed cognitive development (Naim, 2018). Implication of using non-digital game in learning is vested on creation of conducive, collaborative, of interesting and motivational classroom activities, discarding students' anxiety and misconceptions on coordinate geometry concepts and other mathematics contents for improving performance.

5. Conclusion and Recommendations

The conclusion made on retrospectives determination of pre and post knowledge assessments on coordinate plane concepts is of important to determine the deviation levels so as the content instructors to appropriately select intervention approach to serve the purposes of the cognitive, affective and psychomotor changes. Further, the mathematics instructors have to deploy innovative non-digital game plays as collaborative mathematics content delivering approaches to foster exploration, acquisition, transferring, storage and long run memorization. Yet, students perceived non-digital game play being comprised of realism didactics approaches, strategies and methods to improve performance in learning the coordinate plane concepts and other mathematics contents. The area needs to be more researched in the aspects of: college students' perceptions on the use of non-digital games for learning, readiness of mathematics modules instructors to engage students in designing the non-digital game plays activities and instructional approach, and classroom contextual environment to support the use of non-digital game plays instructional method.

Furthermore, to instructors, the recommendations done are on the use of non-digital game which is important in helping students to build contextual coordinate geometry concepts, realism henceforth could also be used as a tool for delivering other mathematics concepts. The study is recommended to the college students that are in need of explosion to the friendly and funny content delivering approaches like non-digital game plays to be motivated in learning coordinate geometry concepts. Moreover, it is recommended to students on positively perceiving non-digital game play for attainment of algorithm realism as well as higher order of learning taxonomies.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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