Influence of Social Personalization on Performance in Group Learning

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***Abstract*—Though personalization has been proposed as an approach that addresses learners' individual differences, the focus of studies in this domain has mainly been on tailoring learning to individual learners' needs as compared to group learning. The few studies that have factored the aspect of learner personality in group learning have overlooked learners' sociological preferences when modeling learner personality. However, it is of essence for learners' social personalities to be considered in group formation since social presence is the basis for collaborative learning. Furthermore, sociological preferences differ among learners and this contributes to individual differences. This paper explored the effect of taking into account the social personalities of a learner in creating collaborative groups. The study was based on the use of PECALE software prototype that enhances personalization and learner engagement through context awareness. The group performance was measured based on how long a group could take to solve a given collaborative task. The results showed that groups that had similar sociological preferences spent significantly less time solving a task than the groups that were formed with no consideration of sociological preferences. Assigning learners into groups while adhering to their sociological needs may offer a platform for equity and inclusion in collaborative learning since every learner's needs are addressed. This may in turn enhance group productivity. Furthermore, the study's approach may also be useful in formation of teams that can work effectively together in the workplace.**

Keywords— Collaborative learning; Group learning; Personalization; Social Personalization; Sociological Preference.

I. INTRODUCTION

With the benefits of collaborative learning (CL) being clear and with the rapid development of Technology Enhanced Learning (TEL), the use of technology to facilitate effective and inclusive CL is vital. There have been several innovative means to include and ensure effective CL in both face to face and online learning environment. One of the approaches that have been effective is the use of small group learning. Even though the advantages of small group learning are well documented, researches have also shown that many of the unsuccessful outcomes from group work stem from the composition process [1, 2]. Studies have indicated that the structure of groups has an impact on group productivity and effectiveness [1, 2, 3]. As Abawajy [3] further asserts, group productivity in both individual and group performance is very much determined by how well members work together. Therefore, establishing effective opportunities for this form of CL requires care in creating groups.

II. PERSONALIZATION IN ADDRESSING INDIVIDUAL DIFFERENCES

Several studies have been done in creating learning groups and several approaches for creating learning groups have been proposed. The focus of most of studies in group learning has been on how to ensure that learners can collaboratively work with all kinds of people. Though to learn to work with all kinds of people is an essential skill worth of acknowledgement, however creating learning groups tailored to individual learners' needs may also be of significance importance in group construction. This is because learners exhibit a wide range of diverse individual differences in learning needs. Therefore, considering needs of each learner when assigning them in a learning group, may be a strong contributor to enhanced productivity in a learning group.

To cater for individual differences, one of the approach that have been widely proposed to provide learning experiences that are tailored to learners' needs while involving them in the learning process is personalization [4, 5]. There are currently research initiatives in this domain and a number of applications applying personalization in TEL have been developed. Personalization has been used to cater for individual learner needs in different capacities for example providing personalized course content [6], personalized learning schedule [7], supporting adaptation of learning activities and the adaptations to the educational resources, tools and services [8] among others. Though majority of studies and applications developed have been focusing on individual learners, there are a couple of studies that have attempted to explore learner personality in creating learning groups. For example, Bekele [1] developed a software tool that automatically grouped learners based on their personality attributes and performance level. Yang & Chen, [9] study proposed a learning grouping algorithm based on user personality for users to learn in groups. In their study, they modeled the learner personality based on learning interests, learning capability, learning style, learning activity, sex and age.

Though these studies and similar studies in this area have factored the aspect of learner personality in group formation, however, one major aspect they have overlooked is the consideration of learners' social attributes when modeling learner personality. Just the why learners differ in primary

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learning styles (thus auditory, visual, kinesthetic, and tactile), studies have shown that learners also differ in sociological learning styles for example preference for learning in groups, pairs, peer, alone, from an adult/expert, or need for variety versus routines among others [10, 11]. Since these sociological preferences differ among learners, this may contribute greatly to individual learners' differences. Based on these arguments, assigning learners into groups while adhering to their sociological learning styles may provide a platform for equity and inclusion in CL since every learner's needs are addressed. This may result in a more satisfying and positive learning experience that enhances both individual and group performance in a learning group.

Personalization has been explored to address individual differences of learners, however, social personalization as a basis for creating learning groups in order to efficiently adhere to learners' sociological needs still needs to be explored, hence the focus of this study. Social personalization as used in this study refers to providing a CL experience that is tailored to the learner's sociological learning preference [12]. The study specifically investigated whether social personalization as a basis for group formation had any impact on both individual and group performance in a learning group. The investigation was carried out using PECALE (Personalized and Engaging Context-aware Learning Environment) by Mayeku et al. [13] as an experimental platform. An overview of PECALE is presented below. The rest of the paper presents the study's experimental setup, the experimental results and discussion of the results and finally the conclusion and future work.

III. PECALE Overview

Personalized and Engaging Context-Aware Learning Environment (PECALE) is a software prototype designed with the aim of enhancing personalization and learner engagement through context-awareness.

In PECALE, learners' leaning preferences were considered as internal context. This is because, considering learning preferences provide conditions that optimize learning for each learner making it an important key for reaching diverse individual learner needs. This in turn provides personalized services. Since PECALE's aim was to enhance personalization and learner engagement in collaborative activities, collaborative group formation was vital. In PECALE, social personalization was used as a basis for group formation. This was based on the argument that group learning is a CL approach hence social presence is vital. Therefore the learners' social personalities were considered when forming a learning group as well as when offering personalized services that come along with CL. To achieve social personalization, the study specifically considered learners' sociological preferences as context. Sociological learning preference as mentioned earlier involve preference for learning in groups, pairs, peers, alone, from an adult/expert or need for variety versus routines among others [10, 11].

Sociological similarity preference strategy [12] was then used as the basis for group formation. The similar objects attract each other characteristic was used to group learners with similar sociological preference. The argument behind this approach was based on the similarity-attraction theory. The theory attempts to explain and predict interpersonal liking by asserting that people are attracted to others who are similar to themselves [14, 15]. Researches as noted by Lacewell [15] indicate that perceived similarity is a possible important interpersonal factor related to learning group performance.

The sociological preferences considered in PECALE included preference to work in pairs and preference to work in a group/team. A small group comprised of a minimum of 3 to a maximum of 5 members. Learner grouping was done in two phases. The first phase involved learners being grouped based on their sociological preferences. In this case, two categories of sociological preferences were considered namely learners with preference to learn in group and learners with preference to learn in pairs. Based on their similarity in preference, learners with preference to learn in a group were clustered together and the same with learners who preferred to learn in pairs. These in turn formed two main branches thus pair-based (PB) and group-based (GB) clusters as illustrated in Fig. 1. The second phase involved grouping learners within their preference clusters formed in phase one. Within these clusters, random assignment was applied to further group learners in small groups or in pairs within their respective clusters. The first phase of grouping captured basically the homogenous aspects of the group. However, when it comes to formation of learning groups, there have been numerous discussions in the literature on importance of both homogeneous and heterogeneous aspects of the groups. The study's assumption was that the other attributes like learning capability, sex etc. within a similar sociological preference cluster defer hence bringing the heterogeneous aspect within the groups.

PECALE was expected as its output to recommend learning activity to the learner and assign collaborative partners based on the learner's contextual information which in this case was the learner's sociological preference as shown in Fig. 2. below. The teacher function allowed the teacher to create collaborative Learning Activity (LA). Based on the learner's preference, collaborative activities could either be PB or GB. PB LA required learners to work in pairs (i.e. in twos) on a collaborative task. While a GB LA required learners to work in a small group of minimum of 3 to a maximum of 5 students on a collaborative task.

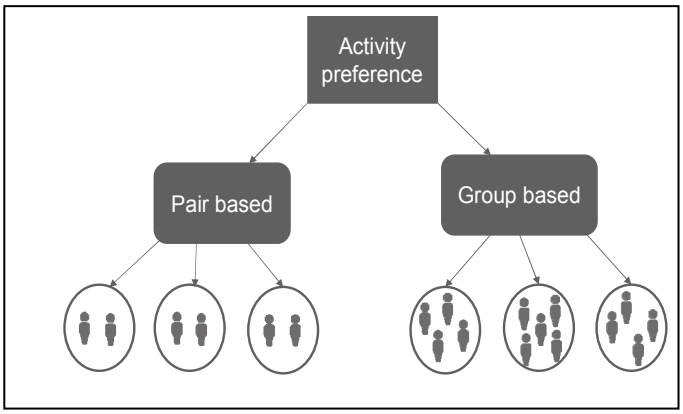

Fig. 1. Grouping based on learners' sociological preferences

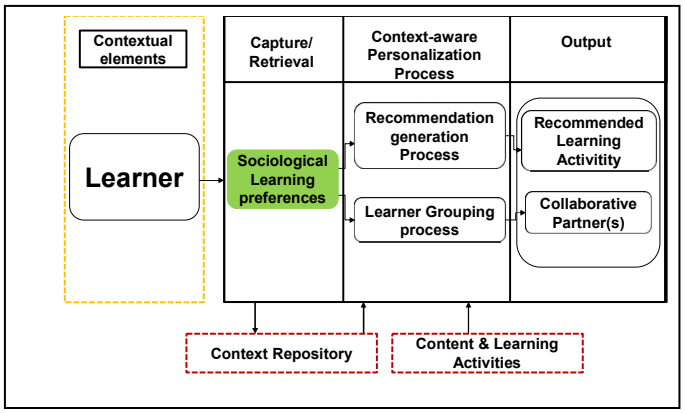

Fig. 2. PECALE System Architecture

In order to achieve a wholesome and rich learning experience, PECALE tool was integrated in the existing Canvas Instructure Learning Management System (LMS). Canvas is a cloud-native, open-source learning platform and has open API (application programming interface) which makes it easy to integrate with other applications.

IV. Experimental Setup

The goal of this particular experiment was to determine whether social personalization had any influence on the individual learners' performance and group performance in a small group CL. In learning groups, assessing both individual and group performance is vital in determining the effectiveness of a learning group since it involves both individual and group effort. The key for example to successful CL is maintaining both individual accountability and positive interdependence in which students reach their goals if and only if the other students in the learning group also reach theirs [16]. As Johnson & Johnson [16] further pointed out, the way to ensure individual accountability and positive interdependence is to assess both individual and group learning. It has also been noted that aggregating individual performance characteristics across members of a group is indicative of the group's overall performance [17].

Group assessment in itself is a complex and challenging process. A number of studies have proposed several dimensions that are key in group assessment. The main basic dimensions include assessing the final product (i.e. the group output) and the process (e.g., group efficiency for example how quickly groups establish norms of interaction, the ability to meet deadlines, contribute fairly, and communicate effectively among others) [18, 19]. In addition to evaluating the group's output, there is also need to find ways to determine how groups function and the extent to which individuals contribute to the effort. These dimensions to assessment of group work guided this study's experimental set up and the design of the collaborative learning activities.

In terms of product dimension, the group performance in this study was gauged based on the correctness of the solution(s) to the given task. This was done by the help of the course instructor who evaluated the groups' solutions to the given task. Since the process dimension comprises several aspects depending on the nature of the task, this study only focused on the group efficiency component. One measure of group efficiency is how quickly groups establish norms of interaction which may in turn determine how long a group could take to complete or solve a given task. In this study, time was used as a measure of efficiency in terms of both individual and group performance in the collaborative task. The time measurement was done on the group works that had correct solutions based on the course instructor's evaluation.

The experiment was carried out in a Kenyan public University. It was administered to the second year Computer Science and Information and Technology university students, taking Systems Analysis and Design course. The test group comprised of 60 students, however, 30 students actively participated in the entire process. Since the experiment required two tests to be administered to the same subjects, the group's working schedule and environmental setting made it convenient to carry out a Test 1 and Test 2 experiment on the same group under similar environmental condition. Two similar LAs but with different group composition mechanisms were given to the same group of students in Test 1 and Test 2 experiments. The learning activities were designed with the help of the course instructor expertise. In this particular experiment, the grouping and the submission of given tasks or solutions was done online. However, the actual collaborative work was done face to face to enable working within the scheduled time and for easy monitoring.

For the Test 1, Canvas's grouping approach (Canvas GA) was used. Canvas allows the teacher to assign the groups by splitting students into equal groups randomly. Therefore, learners were split into equal groups of 5 students who were randomly selected. The performance was measured in terms of the time the learners spent to complete a given LA. For Test 2, PECALE's grouping approach (PECALE GA) was used on the same group of learners. The sociological preferences considered in this study as mentioned earlier included pairs and group. In that learners could work in pairs or groups based on their preferences. To reduce the testing threat, both Test 1 and Test 2 platforms were new to the users i.e. they were using each for the first time to avoid the effect that can be brought about by familiarity of the learners with one environment over the other. The tests were carried out on two different but consecutive days and same time of the day thus from 11.00a.m to 1.00p.m for a duration of 2 hours each. In order to have the students relaxed and be as natural as possible, they were not told that the time they spent on a LA was being measured. This was done to avoid unnecessary pressure that may have risen if they had the knowledge that they were being assessed or timed. To be able to assess both individual and group performance, the LA flow as structured in PECALE required a learner to complete a task both individually and collaboratively. In that, the initial phase of the LA required the learners' within each group to work on a task individually before they could proceed to the collaborative work. The outputs or contributions of individual tasks formed the basis of collaborative work. This offered a platform for the learners to achieve goals individually and collaboratively. This also provided a platform to measure both individual and group performance on a given task.

V. Comparison of Performance between Canvas and PECALE Grouping Approaches

In order to ascertain whether the study's approach was effective, a paired t-Test was performed to compare both individual and group performance when using Canvas GA and when using PECALE GA. A paired t-Test was used because the study needed to make a comparison of two different treatments applied to the same subjects. The treatments i.e. use of Canvas GA and use of PECALE GA were applied.

The individual performance for each student was measured in terms of the time taken by each student to complete the LA when using both Canvas GA and PECALE GA as shown in (1) below. The average individual performance was then calculated as shown in (2).

$$\textit{Individual Performance (IP)} = \textit{Completion Time (CT)} - \textit{Start Time (ST)} \quad (1)$$

Where:

Completion Time (CT) – Stands for the time LA is completed – i.e. the time when a collaborative task was submitted

Start Time (ST) – the time an individual started to work on an activity

$$\textit{Mean Individual Performance (MIP)} = \textit{(Total IP) / (No.of students)} \quad (2)$$

The group performance was determined by first capturing the time every individual in a group accessed the LA. The average start time for all members in each group was then calculated to determine the group start time as shown in (3). The next step was to determine group performance for each group as shown in (4). The average group performance for all the groups was then determined as shown in (5).

$$\textit{Group Start Time (GST)} = \textit{Total ST / No .of group members} = \textit{Average group members ST} \quad (3)$$

$$\textit{Group Performance (GP)} = \textit{Completion Time (CT)} - \textit{Group Start Time (GST)} \quad (4)$$

$$\textit{Mean Group Performance (MGP)} = \textit{Total GP / Total No. of groups} \quad (5)$$

The results were then compared using t-Test to determine the difference in both platforms. The alpha level for the t-Test was set at a level of 0.05 which is the recommended level for most social research [20]. The hypothesis for the comparison of the means in this setting was as follows:

H_0: $\mu_1 = \mu_2$ (the means of the two grouping approaches i.e. Canvas GA denoted as (μ_1) and PECALE GA denoted as (μ_2) are the same)

This was tested against the alternative:

H_a: $\mu_1 \neq \mu_2$ (the means of the two approaches are different)

To determine whether PECALE's GA enhanced group performance in terms of time spent on a LA as compared to using Canvas' GA, the difference (d_g) was calculated as follows:

d_g = μ_{1g} "mean of Canvas GA MGP" - μ_{2g} "mean of PECALE GM MGP"

The hypothesis tested was:

H_0: $\mu_{dg} = 0$ (the mean of the difference is zero; i.e., PECALE's approach was ineffective).

This was tested against the alternative:

H_a: $\mu_{dg} > 0$ (the mean of the difference is positive; i.e., PECALE's approach was effective).

The results of the t-Test as shown in Table 1 indicated that each individual and every group spent around 52 minutes on average to complete the assigned LA when using Canvas GA and around 28 and 29 minutes on average respectively when using PECALE's GA. The output on the calculated t-statistic (with 11 df) was around 3.182 with a two-tail p-value of 0.0087 and *t* Critical two-tail value of 2.201 as shown in Table 1. The results revealed that *t* Statistic > *t* Critical two-tail, and the mean of the μ_{1g} minus μ_{2g} differences was positive hence supportive of the alternative hypothesis that $\mu_{dg} > 0$.

TABLE I. Comparison of Individual and Group Performance between Canvas and PECALE

	Individual Performance		Group Performance	
	Canvas	PECALE	Canvas	PECALE
Mean	52	28	52	29
Variance	236	230.72	238.45	210.02
Observations	30	30	12	12
Pearson Correlation	-0.16182		-0.39268	
Hypothesized Mean Difference	0		0	
Df	29		11	
t Stat	5.73405		3.181848	
P(T<=t) one-tail	1.66E-06		0.004366	
t Critical one-tail	1.699127		1.795885	
P(T<=t) two-tail	3.31E-06		0.008732	
t Critical two-tail	2.04523		2.200985	

Based on the results, PECALE's GA had a positive impact on performance at both individual and group level as compared to Canvas GA. In that there was a significant reduction in time groups with similar sociological preferences spent on solving a task hence they were more efficient than the groups formed randomly. The fact that groups with similar sociological

preferences took shorter time to solve the given task could be attributed to the fact that they were able to quickly establish norms of interaction due to compatibility in their social personalities. This led to the conclusion that social personalization has significant impact on both individual and group performance in small group CL.

VI. CONCLUSION

This study was aimed at investigating whether social personalization has any influence on group performance at both individual and group level. This was determined by looking at the efficiency of the groups in terms of how long a group spent to solve a given task. The experiment was carried out on PECALE platform. The results from the experiment indicated that groups formed on the basis of social personalization spent significantly less time on solving a task as compared to groups that were randomly selected. Therefore social personalization plays a key role in the formation of effective learning groups. The findings of this study may be of significant importance not only in formation of productive learning groups but also may be applicable in forming teams in the workplace. The study's approach may be useful in hiring and teaming up people that match so that they can work effectively together.

VII. FUTURE WORK

This work is still in its early stages. There is still need for further research. For example, one of the challenges that came up during the experiment was the aspect of designing the learning activities in relation to the type of grouping that best fits the task. In this study, the activities used were designed in a way that they can be performed by either a PB or GB groups, however, there is need to explore the relation between the task and the type of grouping that best fits the task. Secondly, in this study, the main measure of performance used was time. Using time only has its own limitations. For example, it can only be limited to certain types of problems learners are solving. It has also been argued that time only tells you how quickly a solution can be realized, but it does not tell you about the depth of learning. Therefore it would be essential to understand the quality of the solution as a measure of productivity. There is also need to find out if there is any correlation between time to completion and distribution of learning thus how much is learned and the amount of time spent on the task. Apart from time, in future work, consideration of additional methods, for example, peer and self-evaluations may be useful for understanding individual contributions and individual and group learning.

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