Exploratory Study on the Learner eXperience in a Collaborative Learning Context Using Computational Resources

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Abstract: It is important to evaluate the Learner eXperience (LX) in a collaborative learning context, as there is a need to support students in their Practical work (PWs) groups that are beyond their reach. Therefore, this paper presents an exploratory study to investigate LX and collaborative learning using computational resources. 31 learners and a teacher of the Requirements Engineering subject participated in this study. Data collection was carried out using a questionnaire based on the 3C Model of collaboration (communication, coordination, and cooperation), and the results were analyzed quantitatively and qualitatively. The findings made it possible to identify strengths, needs, difficulties, and weaknesses. One of the strengths identified is that the learners had the freedom to choose their roles and felt comfortable. One of the difficulties identified was the frequency and availability of the learners for discussions and development of the PWs, as it occurred unevenly, with reports that there was a lack of commitment from some learners.

1 INTRODUCTION

Collaborative learning is two or more students working in groups with shared objectives, helping each other to build knowledge (Torres and Irala, 2014). Inaba et al. (2020) point out that interaction among students is partially surrounded by relationships between group members, which suggests that effective grouping is essential to achieve the benefits of collaborative learning. Therefore, it is crucial to organize students to develop skills such as argumentation, negotiation, conflict resolution, and sharing ideas. It is believed that despite advances in the area of collaborative work, it is known that learners have different communication, coordination, and cooperation skills, and collaborative learning is not always practical for all learners (Inaba et al., 2000).

Given this, it became necessary to investigate how collaborative learning can impact the Learner eXperience (LX), considering the diversity of learners and seeking to provide more effective and positive experiences. The evaluation of LX in a collaborative learning context is believed to be necessary, as students need to be supported in their learning experiences during PW to improve communication, coordination, and cooperation skills. Huang et al. (2019) recommend that LX be evaluated holistically to ensure all aspects of the experiences are considered. In this sense, we consider cooperation, communication, and coordination to be elements of investigating LX.

In this sense, an exploratory study was carried out, as it is used to discover new and relevant insights for the research topic (Swedberg, 2020). Thus, the study sought to answer the question: "What are the perceptions and experiences of learners in a collaborative learning context with the use of computational resources?". The study aimed to investigate and evaluate LX, learner communication, coordination, and cooperation (based on the 3C Model of collaboration (Fuks et al., 2008)) using computer resources. The study was conducted face-to-face with 31 learners studying the Requirements Engineering (RE) subject of the course in Computer Science and Biomedical Informatics (CS & BI) at the Federal University of Paraná (UFPR) in Brazil. The learners' responses were analyzed quantitatively and qualitatively. The findings showed that some learners enjoyed the experience of working collaboratively, while others had a more negative experience. Based on the 3Cs of collaboration, it is believed that LX was different for each learner, and the friendship/partnership relation-

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ship among the learners made a difference in the more satisfactory development of PWs.

This study contributes to the area of Informatics in Education, Computer Education, and Human-Computer Interaction (HCI) by providing evidence through the investigation of LX evaluation in a collaborative learning context using computational resources. The use of computational resources is interesting in this context, as they enhance the interaction and communication of group members in PWs. By integrating these research topics, we analyze and identify the weaknesses, needs, difficulties, and strengths within this context. In addition, we provide new insights into LX and help teachers analyze their teaching strategies to enhance their LX. We also aim to provide learners with a more holistic, engaging, and memorable LX (Huang et al., 2019) through communication, coordination, and cooperation skills.

2 BACKGROUND

Huang et al. (2019) define LX as learners' perceptions, responses, and performance through interaction with a learning environment, educational resources, and so on. Schmidt and Huang (2022) define LX as the class of users (the learner) engaged in a specific task (related to learning) while using a different type of technology (a technological tool designed for learning). For this research, the term LX is specifically related to the perceptions, responses, and performance of learners while interacting with educational resources in a collaborative context.

Reflecting on the concepts of LX presented, one can ask what constitutes LX and why it is essential to evaluate it. In this sense, it is necessary to observe, analyze, and evaluate the elements present in this experience (dos Santos et al., 2023). Thus, the definition of LX lies not only in achieving the desired results but also in the learner's satisfaction and other subjective experiences, such as confidence. In this context, computer resources are one of the most critical factors for improving LX, which, according to Huang et al. (2019), results in more engaging and memorable educational experiences. Therefore, LX assessment is centered on learner interactions because, according to Zeichner (2003) through assessment, it will be possible to value the existential experiences of learners.

Cooperation, communication, and coordination can be considered LX elements, and these elements are presented in the 3C collaboration model (Fuks et al., 2008). Fuks et al. (2008) explain that the three dimensions of this model should not be addressed in isolation, as they are interdependent. In this sense, the authors defined communication as the exchange of messages, coordination as the management of people, activities, and resources, and cooperation as the execution of tasks in a shared space. Collaborative systems are positioned in a triangular space, with the vertices representing the three dimensions of collaboration (Fuks et al., 2008). Although the aim of a system may be to specifically support one of the Cs, it will not fail to include aspects of the other Cs.

Fuks et al. (2008) show that, based on the 3C model, it is possible to identify the constituent elements of a synchronous communication tool and classify them according to the three dimensions. The communication dimension includes the following elements: language (written, spoken, pictorial, or gestural), transmission (one-off or continuous), and categorization (type of speech, discourse, or emotion). The coordination dimension includes the following elements: topic, access (who or how many can take part in the conversation), availability (status of the participant), roles (assignment of roles), frequency, addressing (indication of the recipient) and evaluation (qualification of the messages, participants or discussions). For the cooperation dimension, there are the elements: recording (storing messages and discussions) and space configuration (viewing and retrieving messages) (Pimentel et al., 2006).

3 EXPLORATORY STUDY

The exploratory study was conducted to discover new and relevant insights (Swedberg, 2020) for the research topic. In this sense, this study was carried out to investigate and evaluate the learners' experiences, communication, coordination, and collaboration (based on the 3C model of collaboration (Fuks et al., 2008)) using computer resources. The study was approved by the researcher's institution's Research Ethics Committee under CAAE: 84496124.0.0000.0102.

About **population and sample**, the study was conducted with learners from the (CS & BI) courses taking the RE subject at UFPR and with the respective teacher of this subject. The teacher was invited to participate in the study through an invitation letter sent by email. After accepting voluntarily, the teacher received the study guidelines. Together with the researchers and authors of this paper, the teacher invited the learners to participate in the study during one of the face-to-face classes, explaining the purpose of the study and what their participation would consist of. As prerequisites for the learner's participation, he/she would need to: be enrolled in the RE subject; have carried out the PWs collaboratively; and have carried out the PWs using computational resources. At this point, the 31 learners who expressed interest in participating in the study.

About **context**, one of the requirements for conducting the study in the RE subject is that the PWs should be collaborative. In this sense, the teacher informed us that she had planned for them to be carried out collaboratively. The RE subject was planned and organized by the teacher without interference from the researchers. The subject consists of three PWs. Thus, the exploratory study was carried out at the end of the last PW of the RE subject. The teacher also informed us that she left the learners free to form groups of four to six learners. As general guidelines, were to apply the practice of peer review, in which a learner should review the work of another learner in the group and document it.

PW1 consisted of eliciting requirements for an innovative mobile or web application. To carry out PW1, the teacher organized it in three steps: first, defining the team; second, eliciting the requirements; and third, delivering and presenting PW1. For the first step, the guidelines were: to form groups; create contact groups on social networks (suggestion, WhatsApp, Discord, among others); and manage the schedules and deadlines for executing PW1. For the second step, requirements elicitation, the guidelines were: each group should use at least four different requirements elicitation techniques to elicit requirements for a mobile or web application and document them in a report; for each technique used, the group should add to the report the artifacts used in the process of applying the technique, as well as the results achieved; for each of the techniques used, the group should explain how the technique helped in the requirements elicitation process. In addition, they should add all the problems and difficulties faced by the team during the application of each technique; present the list of functional and non-functional requirements elicited, and point out which technique helped to obtain each requirement. The third step consisted of delivering the report and presenting PW1 to the other colleagues.

PW2 consisted of developing a report containing use cases, activity diagrams, state diagrams, and conceptual class diagrams. The teacher suggested continuing with the same group, as defined in PW1. Another suggestion for PW2 was to consider the system proposed in PW1. Moreover, the groups presented PW2 to other colleagues. PW3 consisted of building low or medium-fidelity mobile application prototypes. This PW is a continuation of PW1 and PW2, in which the learners had to analyze the information in the previous reports to develop the prototypes. PW3 consisted of two steps: the development of the report and its delivery with a presentation. The report needed to contain the business rules, system messages, and navigability between screens; for each prototype, it was necessary to make it clear which requirement was followed as a basis; in addition to the need to add prints of all the prototyped screens; and finally, to carry out validation with a Product Owner to detect inconsistencies and problems in the requirements elicited. The second step consisted of delivering the report and presenting PW3 to the other colleagues.

The **instruments** used for this study were the ICF and the questionnaire exploratory study. ICFs were used, one for the learners and one for the teacher. The elaboration of the questions for the research artifact was inspired by the elements presented in Section 2. The questionnaire was previously evaluated by three PhD researchers and experts in Informatics in Education, Computer Education, and HCI. This evaluation was carried out to refine the information that could be collected. Thus, corrections were made to some questions to strengthen the learners' responses about the research question of this study.

The questionnaire used in the study consists of 21 questions, four of which are characterization questions and 17 questions based on the 3C's of model (Fuks et al., 2008). The questionnaire has closed and open questions and different types of scales for collecting learner feedback, such as the Likert scale and the SAM scale (Self-Assessment Manikin (Lang, 1980)). We used the Likert scale to quantitatively measure the learner's perception and the SAM scale to assess the learner's feelings. For characterization, information was collected, such as the course the learners were enrolled in, gender, and how many learners were present in PWs. For the communication dimension, three questions were collected based on language, transmission, and categorization. For the coordination dimension, eight questions were collected based on topic, access, availability, roles, frequency, addressing, and evaluation. For the cooperation dimension, six questions were collected based on registration and space configuration. The instruments used in this study are available¹.

About **preparation and execution**, before the study was carried out, a presentation, in which they were introduced to the study instruments and what the learner's participation in the study would consist of. The presentation lasted around 15 minutes. After the 31 learners who agreed to participate in the study signed the ICF and received the questionnaire in printed form. The learners answered the questionnaire during that class. It should be noted that the re-

¹https://figshare.com/s/150ebbda97d2f1ad8610

searcher was available to answer the learners' doubts about the questionnaire during the class. The teacher also signed the ICF and was responsible for monitoring the execution of the PWs.

About data analysis, the data obtained through the exploratory study questionnaire was analyzed quantitatively and qualitatively. The quantitative data was analyzed using descriptive statistics (Lazar et al., 2017). Before the qualitative analysis, the data was cleaned, coded, and then organized. To code and organize the qualitative data, we followed the steps partially of the Grounded Theory (GT) method (Corbin and Strauss, 2014). GT has three stages in the coding process: open coding (1), axial coding (2), and selective coding (3). In open coding (1), the data was coded according to the answers given by each participant. Subsequently, in axial coding (2), the codes were grouped according to their properties and related to each other, thus forming categories that represent their characteristics. No selective coding was carried out, as the intention was not to create a theory. The open and axial coding stages were sufficient to understand the LX, and 3C collaboration.

4 QUANTITATIVE ANALYSIS

Some data was collected regarding the **characterization of the learners'** profiles. Regarding the course, 87% (N = 27) of the learners are enrolled in the CS course, and 13% (N = 4) of the learners are enrolled in the BI course. Regarding gender, it was noted that 81% (N = 25) are male and 19% (N = 6) are female. About the number of learners who worked in groups, 68% (N = 21) worked in groups with 5 members, and 32% (N = 10) worked in groups with 6 members.

From the learners' descriptions, it was possible to identify the groups formed to carry out the PWs.Figure 1 shows the groups and their composition. The learners that participated in the study were coded from P1 to P31. Non-study participants were coded from NP1 to NP12. Learners who did not participate in this study were only presented in Figure 1 to demonstrate group formations, however, no other data from these learners is presented in this paper.

The exploratory study questionnaire has 17 questions to assess the three dimensions of 3C (Fuks et al., 2008) and LX. Thus, three questions on communication (Q2 to Q4), eight questions on coordination (Q5 to Q12), and six questions on cooperation (Q1, Q13 to Q11) were developed. For this questionnaire, learners answered according to their perception and experience of developing PWs in groups, and each learner could select more than one answer option



for each question. The results of the exploratory study questionnaire are presented below.

Regarding the resources that learners used to communicate with group members (Q1), learners chose to use WhatsApp² (37% | N = 26), Discord³ (30% | N = 21), Telegram⁴ (6% | N = 4), E-mail (4% | N = 3), Google Docs⁵ (1% | N = 1), and C3SL Moodle⁶ (1% | N = 1). It is believed that WhatsApp and Discord stood out as communication resources, as learners are more familiar with them. Regarding the communication languages used by the learner to communicate with the other members of the group (Q2), 44% (N = 31) of the learners communicated by writing (text), 39% (N = 28) by speaking (audio), 14% (N = 10) pictorially (image) and 3% (N = 2) gesturally (video).

Regarding the learner's communication with the other members of the group (Q3), 53% (N = 19) of the learners communicated continuously, and 47% (N = 17) communicated punctually. Regarding how the learner categorizes their communication with the other members of the group (Q4), 42% (N = 25) of the learners reported that it was of the inquiry type (doubts, questions), 30% (N = 18) reported that it was of the type of speech (affirmative and negative), 25% (N = 25) reported that it was of the type of speech (direct or indirect) and 3% (N = 2) reported that it was of the type of emotions (happy, sad).

For Q5 to Q7, Q9 to Q12, and Q17, we used emoticons from the SAM scale (Lang, 1980). To better visualize the results, the SAM scale was organized into three points, where dissatisfied responses are those marked to the left of the central column (1 to 3); neither dissatisfied nor satisfied responses are those marked in the central column (4 to 6); and satisfied responses are those marked to the right of the central column (7 to 9) (dos Santos et al., 2024). Thus, Figure 2 shows the learners' responses.

The results show significant satisfaction among learners with 87% (N = 27) concerning the topics dis-

³https://discord.com

²https://www.whatsapp.com

⁴https://web.telegram.org

⁵https://docs.google.com

⁶https://moodle.c3sl.ufpr.br





cussed in the group (Q5) (Figure 2), the number of members participating in the discussions and development of the PWs (Q6) and the communication, discussions, and decisions made in the execution of the PWs (Q12). This satisfaction among the learners was believed to be due to the good friendships and partnerships they cultivated.

On the other hand, Figure 2 shows that 6.5% (N = 2) of the learners were dissatisfied with the number of members participating in the discussions and development of the PWs (Q6), their availability for discussions and development of the PWs (Q7) and their frequency of communication with the group for discussions and development of the PWs (Q10). It is believed that these learners declared themselves dissatisfied, as they could have participated more actively in the group's discussions and decision-making and dedicated themselves more to improving communication frequency and rapport between group members.

Concerning the topics discussed in the group (Q5), their role in the group (Q9), and their communication, discussions, and decisions made when carrying out the PWs (Q12), Figure 2, shows dissatisfaction among learners with 3% (N = 1). This learner called himself an active leader, and it is believed that he was dissatisfied because some members of his group were not as dedicated as he was to carrying out the PWs. Regarding the feeling that specific topics, activities, and discussions are directed at the learner (Q11), 3% (N = 1) of the learners reported that this did not apply. It is believed that this learner was not present during the group's discussions and decision-making.

Regarding the learner's perception of their role in the group (Q8) (Figure 3), 55% (N = 18) of the learners called themselves active members, i.e., they were present in the group's discussions and decisionmaking. On the other hand, 6% (N = 2) of the learners called themselves passive members, i.e., they were not always present in the group's discussions and decision-making. Concerning leadership, 18% (N = 6) called themselves neutral leaders, 6% (N = 2) passive leaders, and 15% (N = 5) active leaders. It is believed that all the groups had a learner as a leader, i.e., they had a learner who managed the group's discussions and decision-making. There was also more than one learner per group, such as group two, where P13 declared himself a passive leader, and P3 declared himself an active leader (Figure 3).



Regarding how the learners organized the execution of the PWs (Q13), 58% (N = 21) of the learners divided the PWs topics among the group members, 33% (N = 12) of the group members worked simultaneously on all the PWs topics, 3% (N = 1) reviewed the PW part done by a member of their group, 3% (N = 1) reported that some PW topics were done individually, but others were done together, and 3% (N = 1) reported that PW topics were shared and discussions were also held. Most of the learners said that they divided the PW topics between the group members, as the PWs were large assignments and required dedication to complete simultaneously. In addition, the learners had demands from other subjects.

For Q14, a five-point Likert scale ranged from totally disagree (1) to totally agree (5). Thus, regarding the learner's perception that the exchange of knowledge between members helped in their knowledge acquisition (Q14), 45% (N = 14) of the learners partially agreed, 35% (N = 11) totally agreed, 16% (N = 5) were neutral, and 3% (N = 1) partially disagreed. It is believed that most learners were optimistic about the exchange of knowledge between group members, as this type of scenario provides a richer and more dynamic experience and exchange of knowledge between learners and fosters and assists a greater understanding of the PWs subject.

To the learner's self-perception of their profile about their group (Q15), 13% (N = 4) of the learners consider themselves to be more skilled than the other group members, 6% (N = 2) consider more knowledgeable than the other group members, 3% (N = 1) consider unfamiliar with the subject of PWs concerning the other group members, 3% (N = 1) consider to be more patient about the other group members, and the remaining 74% (N = 23) said that it does not apply. It is believed that most learners said that they do not consider themselves to have more excellent skills or knowledge than the other group members, as they are at the same level of education.

11 collaborative techniques were used for PWs in the learners' perception (Q16). The brainstorming and interview stand out with 33% (N = 28) each. These techniques were believed to be the most cited, as they required more than one learner to carry out. Moreover, other techniques were used, such as exploratory research (11% | N = 9), persona (7% | N = 6), empathy mapping (5% | N = 4), storyboarding (4% | N = 3), fly on the wall (2% | N = 2), questionnaires (2% | N = 2), storytelling (1% | N = 1), prototyping (1% | N = 1), and body storm (1% | N = 1). The last question sought to identify how learners felt about PWs being sequential (Q17), shown in Figure 2. Thus, 87% (N = 27) of the learners felt satisfied, 10% (N = 3) were neutral, and 3% (N = 1) felt dissatisfied. The results show that most learners liked doing the PWs gradually and sequentially.

5 QUALITATIVE ANALYSIS

To carry out the qualitative analysis, the Atlas.ti tool version 97 was used. Eight categories were created, and the codes identified in this analysis are presented below. For the category perception of PWs time and number of members, learner P17 reported that "many [learners] had little time" to carry out the PWs, and P28 said that "I liked it, I had enough time to develop the PWs". Regarding the number of learners per group, P30 reported that there were "more members than necessary" in his group. Analyzing the learners' comments and Figure 1, which presents the learners' grouping, it is noted that P30 (G3) was in a group with six learners and had a leader. It is believed that PWs with large groups generate greater dedication from the leader to manage the work of the members, and possibly not all learners worked equally.

For the category **perceptions about group interaction**, P3 reported that "I wish the group had interacted more. I stopped sending messages to encourage and sending messages to talk about the PWs". P3 also says that "I could not get everyone to collaborate. Everyone is capable, they just need to make an effort". P3 considered himself an active leader. It is the leader's role to encourage the group to carry out the PWs, but not all group members responded to this motivation. In situations like this, it is suggested that new motivation strategies be used in the group to obtain more promising results.

For the category perceptions about the group's communication, P28 reported that "I believe I communicate well" making P28 "the group communicated well", and P17 also mentions that communication occurred "through a phone call". However, P3 tells us that communication "at many times did not exist" and also when there were discussions and conversations "[...] not everyone joined in" (P3). P6 says that communication was sometimes "delayed or unresponsive". From the accounts of communication between group members, it can be seen that there were groups that were more closely knit and that there was a group partnership. However, there were groups where the members were not so closely knit or could not communicate to develop the PWs. Communication is very important, as it provides the exchange of information and knowledge between learners.

For the category perceptions about the organization of PWs, P3 reported that "one person did everything and the others [group members] only consented". In addition, P3 pointed out that "did some topics that were the responsibility of others [members], but I enjoyed doing them". Another report from P19 is that "the topics were divided up, most of them were left to me (PW2 and PW3)". Groups two and three had some disagreements among the members regarding the execution of the PWs. It is believed that these conflicts occurred because the learners organized themselves in the distribution of the PW topics, but not all followed through as planned. The PWs organization is essential, as it helps to improve the productivity of the group and also the quality of the development of the PWs.

For the category perceptions about the role played in the group, P28 pointed out that "the group trusted me for the PW and that I contributed positively" in his group. P10 reported that "sometimes, to get the team together, I had to take the initiative". Analyzing the learners' comments and Figure 1, which shows the grouping of the learners, it can be seen that P28 (G1) and P10 (G1) were in the same group. It is believed that because these learners considered themselves leaders, they were responsible for taking the initiative and managing the discussions and decisions. As a result, the group became closer, as P28 points out that "all [the learners] participated actively". Having a leader for the development of PWs is essential, as it manages conflicts and also directs the work to be developed for each member of the group.

⁷https://atlasti.com/

For the category negative perceptions about PWs, P22 reported that "PW3 suffered from the end of the period, but it was a rush" and P17 reaffirmed that "the last [PW3] made me angry with some participants". Because of this, the learners pointed out that the last PW suffered from the end of the semester. It is believed that this PW overload occurred because the other subjects the learners were studying were also ending, and they probably had to hand in PWs and other assessment activities. For the category positive perceptions about the PWs, P28 reported that "I put my knowledge into practice", P19 says that "it was very nice to develop the work and see the application grow", P30 says that it was the "first case of constructive evaluation I have had in the course so far", P5 says that "I liked the idea of it being the "same" work, being continued". An advantage of continuous PWs is that learners can strengthen the knowledge base acquired and put it into practice, in addition to seeing the evolution of the acquired content.

For the category perceptions about the exchange of knowledge, there were different reports, P3 commented that "at many times there were no conversations or discussions about the topics". Learner P28 said that he "liked it, the group was willing to answer questions" from the other members, and P10 said that "sometimes I had questions and other participants helped me". P19 said that he had "a lot of need to repeat instructions at different times to different members". It can be seen that the learners sought out their group mates to exchange knowledge and discuss the PWs' topics. The exchange of knowledge can help learners develop critical thinking, in addition to the development of social skills such as cooperation. It can also stimulate the collective construction of knowledge about specific content.

6 DISCUSSIONS

We would also like to emphasize some of the results obtained in this study. We consider some strengths, such as the communication language adopted by the learners. It is believed that the type of language used, including written and spoken conversations, and the computing resources used, such as WhatsApp and Discord, are in line with the learners' experiences. Another strong point is that some learners could define their roles in the group. It is believed that this is a positive point, as the learners had the freedom to choose their roles without interference from the teacher or researchers. Furthermore, the learners chose the role they felt most comfortable playing. Another positive point to consider is that PWs are continuous. It is believed that this continuity of PWs meant that the knowledge base acquired by the learners was put into practice, allowing us to see the evolution of the content acquired.

We identified the number of group members as a weakness. Some learners were dissatisfied with the number of members because the larger the group, the greater the leader's management work. It is believed that even if all groups had a leader who guided, motivated, and managed the work of the other members, not all members would embrace their role. Another weakness is the frequency of communication between group members. It is believed that even though the leader played his role in the group through incentives, guidance, motivation, and even work management, the learners' participation occurred unevenly.

We considered some difficulties, such as the frequency and availability for discussions and development of the PWs, since they occurred throughout the course. This meant that the learners continually provided a certain amount of dedication of time. However, it occurred unevenly, with reports that there was a lack of commitment from some learners. Another difficulty was the dissatisfaction of some learners with the role they played in the group. It is believed that some learners assumed specific responsibilities and sought an equal commitment from the other group members, which in some situations didn not occur.

Based on some strengths, weaknesses, and difficulties identified, we suggest that teachers adopt a role exchange for learners in group PWs, allowing more learners to acquire and put leadership skills into practice. Another suggestion is closer supervision by subject monitors and also by the teacher, about the groups, to have faster and more accurate feedback to assist learners in the weaknesses of group work. Therefore, in answering the research question of this study, the proposed objective was achieved. It was possible to discover some weaknesses, needs, difficulties, and strengths of the LX in a collaborative learning context. Furthermore, through the results identified in this study, it was felt necessary to continue investigating these topics since there is a lack of guidelines, instructions, and even support materials to assist the teacher in collecting LX in a collaborative context.

7 CONCLUSION

The analysis of this exploratory study showed that the LX was different for each learner regardless of how many PWs were in a group. About the roles played in a group, such as, one learner reported that the group trusted him to develop the PWs. However, another learner reported that he had to take the initiative to bring the group together and also that he had to develop PW topics that were not his responsibility, making him less satisfied with the development of the PWs. Overall, this shows that we got different accounts of experiences in a collaborative learning context and also that we got different accounts from members of the same group. It is believed that because three PWs were developed throughout the subject, some learners had more than one role in the group. This is because the PWs required commitment, dedication, willingness, and even the need to deal with conflicts in the group.

Some limitations were identified for this exploratory study. One limitation may have been that learners were given the freedom to form their groups. We did not want to interfere in this group formation process, but for the subsequent group formation for other PWs, we suggest characterizing the participants about the learner profiles to make the groups more balanced. Another limitation is the selection of participants, as it was carried out with RE learners, and there was no representation of other academic subjects. This may make it difficult to generalize the results, as there is no diversity of perspectives and experiences from different academics. Another limitation is that elements external to the scenario may have interfered with the results, such as noise in the classroom (parallel conversations of colleagues) and interruptions during the study's execution. However, based on the results, it was considered that the participants fulfilled all the tasks requested in the study and contributed to collecting LX in a collaborative context using computer resources.

Finally, this study is expected to contribute to researchers interested in LX assessment and collaborative learning through the 3Cs of collaboration. In future work, we intend to conduct a literature search to verify and characterize technologies that support the topics presented. The aim is to propose guidelines and/or even improvements in a platform that supports collaboration so that LX can be assessed effectively, efficiently, and agilely. In addition, studies will be conducted by considering a more varied sample of learners and taking teachers into account.

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REFERENCES

- Corbin, J. and Strauss, A. (2014). *Basics of qualitative* research: Techniques and procedures for developing grounded theory. Sage publications.
- dos Santos, G. C., Dos S. Silva, D. E., and C. Valentim, N. M. (2023). Proposal and preliminary evaluation of a learner experience evaluation model in information systems. In *Proceedings of the XIX Brazilian Symposium on Information Systems*, SBSI '23, page 308–316, New York, NY, USA. Association for Computing Machinery.
- dos Santos, G. C., Silva, D. E., Peres, L. M., and Valentim, N. M. C. (2024). Case study of a model that evaluates the learner experience with dicts. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems*, CHI EA '24, New York, NY, USA. Association for Computing Machinery.
- Fuks, H., Raposo, A., Gerosa, M. A., Pimentel, M., Filippo, D., and Lucena, C. (2008). Inter- and intrarelationships between communication coordination and cooperation in the scope of the 3c collaboration model. In 2008 12th International Conference on Computer Supported Cooperative Work in Design, pages 148–153.
- Huang, R., Spector, J. M., and Yang, J. (2019). *Educational* Technology a Primer for the 21st Century. Springer.
- Inaba, A., Supnithi, T., Ikeda, M., Mizoguchi, R., and Toyoda, J. (2000). How can we form effective collaborative learning groups? In Gauthier, G., Frasson, C., and VanLehn, K., editors, *Intelligent Tutoring Systems*, pages 282–291, Berlin, Heidelberg. Springer Berlin Heidelberg.
- Lang, P. (1980). Behavioral treatment and bio-behavioral assessment: Computer applications. *Technology in mental health care delivery systems*, pages 119–137.
- Lazar, J., Feng, J. H., and Hochheiser, H. (2017). Research methods in human-computer interaction. Morgan Kaufmann.
- Pimentel, M., Gerosa, M. A., Filippo, D., Raposo, A., Fuks, H., and Lucena, C. J. P. d. (2006). Modelo 3c de colaboração para o desenvolvimento de sistemas colaborativos. Anais do III Simpósio Brasileiro de Sistemas Colaborativos, 2006(2006):58–67.
- Schmidt, M. and Huang, R. (2022). Defining learning experience design: Voices from the field of learning design & technology. *TechTrends*, 66(2):141–158.
- Swedberg, R. (2020). Exploratory research. *The production* of knowledge: Enhancing progress in social science, 2(1):17–41.
- Torres, P. L. and Irala, E. A. F. (2014). Aprendizagem colaborativa: teoria e prática. *Complexidade: redes e conexões na produção do conhecimento. Curitiba: Senar*, pages 61–93.
- Zeichner, K. M. (2003). Formando professores reflexivos para a educação centrada no aluno: possibilidades e contradições. Formação de educadores: desafios e perspectivas. São Paulo: UNESP, pages 35–55.